

*The*  
**AIRCRAFT  
YEAR BOOK**

*For 1941*



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**AIRCRAFT YEAR BOOK FOR 1941**



#### NIGHT FLYING BY MOONLIGHT

A 33-passenger Boeing Stratoliner, powered by four Wright Cyclone engines, in TWA transcontinental service makes its trip "over the weather."

*The*  
AIRCRAFT  
YEAR BOOK

*(Registered U. S. Patent Office)*

*For 1941*

TWENTY-THIRD ANNUAL EDITION

HOWARD MINGOS

Editor



*Published by the*  
AERONAUTICAL CHAMBER OF COMMERCE  
OF AMERICA, INC.

30 Rockefeller Plaza

New York

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OF AMERICA, INC.  
NEW YORK, N. Y.

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THE COLONIAL PRESS INC., CLINTON, MASS.

## TABLE OF CONTENTS

CHAPTER	PAGE
I. THE WAR IN THE AIR . . . . . An Old Military Theory Exploded—The R.A.F. Saves Eng- land—Carrying the Air War to the Enemy—Need for More American Planes—The Outlook for Aerial Supremacy.	11
II. RAPID GROWTH OF U. S. AIRCRAFT PRODUCTION . . . . . The Aircraft Manufacturers Perform an Industrial Miracle —Scope of the Production Program—Expansion of Plants and Other Facilities—Value of Experienced Management— Adequate Supply of Warplanes Assured.	17
III. THE U. S. ARMY AIR CORPS . . . . . Secretary Stimson Transmits as of "Potentially Profound Historical Significance" Assistant Secretary Johnson's Report —Record for Peacetime Purchases of Airplanes—General Arnold Describes Rapid Expansion to Meet International Situation—Industry Responds to Unprecedented Demands— Mounting Strength of the Air Corps—The "Flight Strip" —Achievements—Awards of Merit.	31
IV. AIR FORCES OF THE U. S. NAVY . . . . . Acting Secretary Compton's Comment—The Navy's Principles of Aircraft Operation Proved Sound by European War—Rear Admiral Towers Makes Comprehensive Report—Operations with the Fleet—The Neutrality Patrol—Activities of the Squadrons—Improved Performance—Aviation Shore Stations— Naval Reserve on Active Duty—Appropriations—Increase in Flying Hours—How Manufacturers Improved Efficiency of Planes, Engines, Propellers and Accessories—Need for Con- tinued Experimentation—Awards and Citations.	45
V. U. S. GOVERNMENT ACTIVITIES . . . . . Bureau of Foreign and Domestic Commerce—Civil Aeronau- tics Administration—Civil Aeronautics Board—Division of Aeronautics in Library of Congress—Division of Controls— Division of International Communications—Federal Communi- cations Commission—National Advisory Committee for Aero- nautics—National Bureau of Standards—Office of Production Management—U. S. Forest Service—U. S. Public Health Ser- vice—U. S. Weather Bureau.	61
VI. TRAINING AND EDUCATION . . . . . Thousands of Americans Volunteer for Air Force Training— Program of the Army Air Corps and the Navy Bureau of Aeronautics—Magnitude of the Civilian Pilot Training Pro- gram—Achievement of the Industry in Training New Em- ployees—Vocational Training—The Three Programs of the U. S. Office of Education—Work of the Schools.	97

CHAPTER	PAGE
VII. AIR LINES OF THE UNITED STATES . . . . .	129
Record Growth of Traffic—Increase in Personnel—The Lines Demonstrate Their Value in National Defense—A Million Shipments by Air Express—Pan American Airways Expands Its Services—Plans of American Export Airlines—Development of Air Pick-up Service—Transcontinental and Western Air Starts Stratoliner Operations—Activities of Other Lines.	
VIII. PRIVATE FLYING . . . . .	151
Increase in Pilots and Planes—Problems Incident to the Defense Program—New Uses for Civil Aircraft—New Record for Safety—Development of Cross-country Flying by Private Owners—Sales Promotion Efforts by Light Plane Manufacturers.	
IX. MISCELLANEOUS ACTIVITIES . . . . .	161
Aeronautical Chamber of Commerce of America—Air Transport Association of America—Aircraft Owners and Pilots Association—Institute of the Aeronautical Sciences—Manufacturers Aircraft Association—National Aeronautic Association—National Intercollegiate Flying Club—The Soaring Society of America—Society of Automotive Engineers.	
X. AIRPORTS AND AIRWAYS . . . . .	179
Increase in Number of Landing Places—Congressional Appropriations for New Airport Program—The Federal Policy—Need for More Airports for Defense and Postwar Civil Flying—The Federal Airways System—New York the Busiest Air Terminal—C.A.A. Expansion Program—New Radio Facilities.	
XI. THE AIRCRAFT MANUFACTURING INDUSTRY . . . . .	187
The Industry's Full-out Effort for National Defense—Work of the Individual Manufacturers—Expansion of Plant Facilities and Personnel—New Planes, Engines and Accessories.	
AIRCRAFT SPECIFICATIONS TABLE . . . . .	401
ENGINE SPECIFICATIONS TABLE . . . . .	407
AIRCRAFT AND ENGINE DESIGNS . . . . .	190-332
DIRECTORY SECTION . . . . .	429
FLYING FACTS AND FIGURES . . . . .	547
INDEX TO ADVERTISERS . . . . .	596
INDEX . . . . .	598

# ILLUSTRATIONS

	PAGE		PAGE
Boeing Stratoliner . . . . .		Frontispiece	
Aerotorque Windshield Wiper . . . . .	333	Cessna	
Aeronca		Air Corps Trainer . . . . .	98
Super Chief . . . . .	183	Airmaster . . . . .	156
Tandem Trainer . . . . .	99	Civilian Pilot Training Pro-	
Air Lines of the U. S., map . . . . .	128	gram, map . . . . .	126
Air Transport Graphs . . . . .	130, 131, 132,	Consolidated	
133		B-24 Bomber . . . . .	14, 39
Aircooled Franklin Engines . . . . .	201	PBY Patrol Boat . . . . .	78
Aircraft Accessories Selector		PBY-5A Amphibion . . . . .	168
Valve . . . . .	335	PB2Y-2 . . . . .	52
Aircraft Carriers . . . . .	51, 55	Plant . . . . .	213
Alabama Institute of Aeronau-		Production . . . . .	25, 82
tics . . . . .	112	Continental Engines . . . . .	204, 205
Allison		Culver Cadets . . . . .	169
Engines . . . . .	202, 203	Curtiss	
Engine Test . . . . .	33	Dive Bomber . . . . .	49
Training . . . . .	99	Interceptor Fighter . . . . .	174
Aluminum Company's Templin		P-40 Pursuit . . . . .	12, 94
Machine . . . . .	337	Production . . . . .	23, 41
Babcock LC-13-A . . . . .	173	Scout Observation . . . . .	57
Beech		Transport . . . . .	147
Air Corps Beechcraft . . . . .	70	Curtiss-Wright Technical Insti-	
Air Corps Transport . . . . .	175	tute . . . . .	113
Beechcraft P17D . . . . .	157	Douglas	
Beechcraft Transport . . . . .	130	B-10 . . . . .	38
Bell		B-23 Bomber . . . . .	93
Airacobra . . . . .	18, 35, 163	DB-7A . . . . .	13, 24
Assembly . . . . .	84	DC-3 . . . . .	148
Plant . . . . .	107	Havoc . . . . .	171
Production . . . . .	30	Production . . . . .	83
Bellanca Liaison Plane . . . . .	182	Torpedo Bomber . . . . .	48
Bendix Brake . . . . .	340	Eclipse Supercharger . . . . .	350
Boeing		Engineering & Research	
Clipper . . . . .	90, 137	Ercoupe . . . . .	62
Flying Fortress . . . . .	34, 178	Fairchild	
Production . . . . .	21, 44	24 . . . . .	150
Stratoliner . . . . .	145	Assembly . . . . .	91
Brewster		PT-19 Trainer . . . . .	101
Buffalo . . . . .	172	Farnham Forming Roll . . . . .	355
Fighter-Bomber . . . . .	58	Finch Facsimile Unit . . . . .	356
Fighters . . . . .	66	Firestone Light Buoys . . . . .	359
Plant . . . . .	86	Fleetwings NBT-12 Basic	
Cal-Aero Academy . . . . .	112	Trainer . . . . .	100



	PAGE		PAGE
General Light Plane . . . . .	93	Basic Combat . . . . .	192
Goodrich Test . . . . .	391	Bomber . . . . .	42
Grumman		Harvard . . . . .	15
F4F-3 . . . . .	181	Plant . . . . .	245
G-36A . . . . .	92	Production . . . . .	26
J2F-2 . . . . .	49	Pursuit . . . . .	37
JRF-2 Amphibious . . . . .	68	Northrop	
Navy Fighters . . . . .	54	Patrol Bomber . . . . .	97
Widgeon . . . . .	152	Plant . . . . .	253
Hamilton Propeller Test . . . . .	304	Plant Interior . . . . .	87
Harlow PC5A . . . . .	103	Parks Air College . . . . .	110
Harvill Die-Casting . . . . .	307	Phillips Engine . . . . .	308
Interstate Cadet . . . . .	81	Pioneer Parachutes . . . . .	380
Jones, Casey, School of Aero- nautics		Piper	
Aircraft Design Department . . . . .	114	Cub Coupe . . . . .	185
Engine Department . . . . .	114	Cub Cruiser . . . . .	158
Jacobs Engines . . . . .	296, 297	Cub Trainer . . . . .	104
Kinner Engines . . . . .	299, 300	Pitcairn-Larsen Autogiro PA-30 . . . . .	195
Learadio Machine Shop . . . . .	371	Porterfield	
Link Trainer . . . . .	128	Cabin . . . . .	155
Lockheed		Collegiate Trainer . . . . .	105
Assembly . . . . .	85	Pratt & Whitney	
Hudson Bomber . . . . .	10, 73, 74	Assembly . . . . .	29
Lodestar . . . . .	143	Engine Progress . . . . .	310
P-38 . . . . .	40, 164	Engines . . . . .	311, 312, 314, 316
Production . . . . .	22	Plant Interior . . . . .	309
Luscombe		Ranger Engines . . . . .	318, 319, 320
8A . . . . .	184	Rearwin	
Plant . . . . .	160	Cloudster . . . . .	167
Luscombe School of Aeronau- tics . . . . .	115	Engine . . . . .	322
Lycoming		Sportster . . . . .	155
"Break In" Stand . . . . .	77	Republic	
Engines . . . . .	302, 303, 304	2-PA Guardsman . . . . .	180
McArthur, Warren, Chairs . . . . .	375	EP-1 Pursuit . . . . .	164
Martin		P-43 Lancer . . . . .	43
167W . . . . .	16	Reynolds Metals Company Plant . . . . .	383
B-26 Bomber . . . . .	36, 189	Roosevelt Aviation School . . . . .	117
PMB-1 Navy Patrol Boats . . . . .	53, 69	Ryan	
Plant . . . . .	241	Dragonfly . . . . .	64
Production . . . . .	27	PT-20 Trainer . . . . .	95
Self-Sealing Tank . . . . .	65	Production . . . . .	88
The 1918 Bomber . . . . .	188	S-T Trainer . . . . .	118
Menasco Engines . . . . .	305, 307	ST-3 Trainer . . . . .	265
National Advisory Committee for Aeronautics		Ryan School of Aeronautics . . . . .	116
Free Flight Wind Tunnel . . . . .	72	Safair Flying School . . . . .	119
Pressure Wind Tunnel . . . . .	60	St. Louis Aircraft	
North American		PT-1 Trainer . . . . .	106
Assembly . . . . .	71	PT-LM-4 Trainer . . . . .	123
BT-9 Trainers . . . . .	102	Solar Exhausts . . . . .	387
		Southern Aircraft BM-10 Trainer . . . . .	107
		Spartan NS-1 . . . . .	59

# ILLUSTRATIONS

ix

	PAGE		PAGE
Spartan School of Aeronautics		Assembly	20
Air Corps Training	120	F4U-1	50, 109
Engineering Department	122	Helicopter	150
Sperry		OS2U-1 Scout	50
Aircraft Detector	301	S-43 Amphibian	141
Scorsby Testing Device	386	SB2U-3	168
Stearman		Vultee	
Model 91 Trainer	108	Attack Bomber	180
N2S-1 Trainer	47, 76	Basic Combat	162
PT-13-B Trainer	70	Plant	284
PT-18 Trainer	170	Production	10
Stewart Technical Trade School	121	Pursuit	186
Stinson Voyager	153	Valiant 51	32
Taylorcraft		Vanguard 48	80
Plant	170	Waco	
Plant Interior	154	Model E	140, 154
Tandem Trainer	100	UPF-7 Trainers	111
U. S. Air Corps		Warner Engine	323
Parachute Training	124	Westinghouse Light Buoys	359
Randolph Field	125	Wright	
U. S. Public Health Service	86	Engines	325, 326, 328, 330, 331
Vega Model 35 Trainer	110	Plant	75, 324
Vought-Sikorsky		Production	28

## AIRPLANE DESIGN DRAWINGS

Aerona	100, 101	Martin	242, 244
Babcock	192	North American	246, 249, 251
Beech	193, 194	Northrop	255
Bell	195	Piper	257, 258
Bellanca	198	Pitcairn-Larsen	250
Boeing	199, 200, 202	Porterfield	260
Brewster	205, 206	Rearwin	261
Cessna	208	Republic	263
Colgate-Larsen	210	Ryan	266
Consolidated	211, 212	St. Louis Aircraft	268
Curtiss	214, 215, 217	Southern Aircraft	260
Douglas	218, 221	Spartan	270
Engineering & Research	223	Stearman	271, 274
Fairchild	224, 225	Stinson	275
Fleetwings	227	Taylorcraft	276, 277
General	228	Vega	279
Grumman	220, 230, 231	Vought-Sikorsky	280, 281, 282
Harlow	232	Vultee	285, 286, 287
Lockheed	235, 236, 237	Waco	288, 290
Luscombe	239		

## ENGINE DESIGN DRAWINGS

Kinner	298, 301	Ranger	318, 319, 320
Lycoming	301, 303, 304	Rearwin	321
Menasco	305, 306	Warner	321
Pratt & Whitney	311, 313, 315, 317	Wright	327, 329, 332



British Air Ministry photo  
AT EVACUATION OF DUNKIRK

One of the Lockheed Hudsons on reconnaissance over the famous armada that saved the British troops.

## CHAPTER I

### THE WAR IN THE AIR

An Old Military Theory Exploded—The R.A.F. Saves England—  
Carrying the Air War to the Enemy—Need for More American  
Planes—The Outlook for Aerial Supremacy.

**A**S this edition of the Aircraft Year Book goes to press in May 1941, it is apparent that from now until the end of the war in Europe, air power will play a much more decisive part in that tragic drama than it has even during the last 12 months, a period in which the war in the air has assumed increasingly great significance day by day.

It was only a year ago that German planes roared over the defense lines of Holland, Belgium and France, smashing not only their land armies but the troop concentrations and supply depots far behind the defense lines—and whole cities and small towns, too, anything in fact that the invader felt it necessary to destroy in order to open the way for his tanks and mechanized columns that followed in the wake of his bombers. As wave after wave of the German squadrons blasted away the will to resist the aggressor on that part of the continent, they also obliterated a comfortable illusion which had been a fetish among the generalissimos in charge of Allied strategy. Gone for the rest of the war was the military theory that defense is the best offence, that the defenders can sit it out while the invader becomes weaker and weaker by crashing headlong into the defensive walls. This war was different. The enemy went over and around the walls. But it was too late for all except Britain. The English Channel saved Britain as it had again and again in the past; saved Britain, that is, for the time-being, while the Germans paused at the water's edge to consider, and from time to time practise, the new invading tactics which they had perfected, so they thought, for this last major conquest in Europe. That was nearly a year ago.

The British warded off the invader for nearly a year by counter-



#### CURTISS P-40 PURSUITS OVER ENGLAND

Rapidly increasing numbers of R. A. F. squadrons in the Fighter Command were in active service with these machines early in 1941.

offensive warfare; and it was largely a counter-offensive by way of the air. While the Navy continued to perform miracles in front of the Channel ports, as during the evacuation of Dunkirk, when under the covering planes of the R. A. F., it saved most of the expeditionary army; or along the coast of Norway and on the open seas where it handled the convoys with considerable success; while the Navy performed its allotted tasks and performed them exceedingly well, it was the Royal Air Force that saved England from invasion during those breathless months after the collapse of France.

The Germans knew, apparently, that before having a chance to

gain a foothold on the "tight little isle" they must first knock out the R. A. F., destroy its bases and its morale, its whole fighting strength, even as they had done with the air forces of other nations which dared to rise up against them. But they did not knock out the R. A. F.

The British Royal Air Force lacked the necessary striking power to keep out all enemy planes, even if it were possible, which is extremely doubtful. It did not have enough machines and there was a serious shortage of pilots sufficiently trained to meet the very large numbers of enemy pilots who, of course, had enough planes for any mission. The Germans could fly at the heart of England by hundreds at any time. But, so acute was the shortage of British planes and pilots during that period that R. A. F. fliers were compelled to go out on mission after mission, several flights in a day or a night, under nerve-racking conditions which made one such assignment enough in 24 hours for any man's nervous stamina. No, it was not enough, this air force that the British had during the latter months of 1940 and the first half of 1941. London and other English cities paid a frightful price for the smug, careless policy of unpreparedness that Winston Churchill had recognized and warned against year by year as the Germans developed their striking air force.

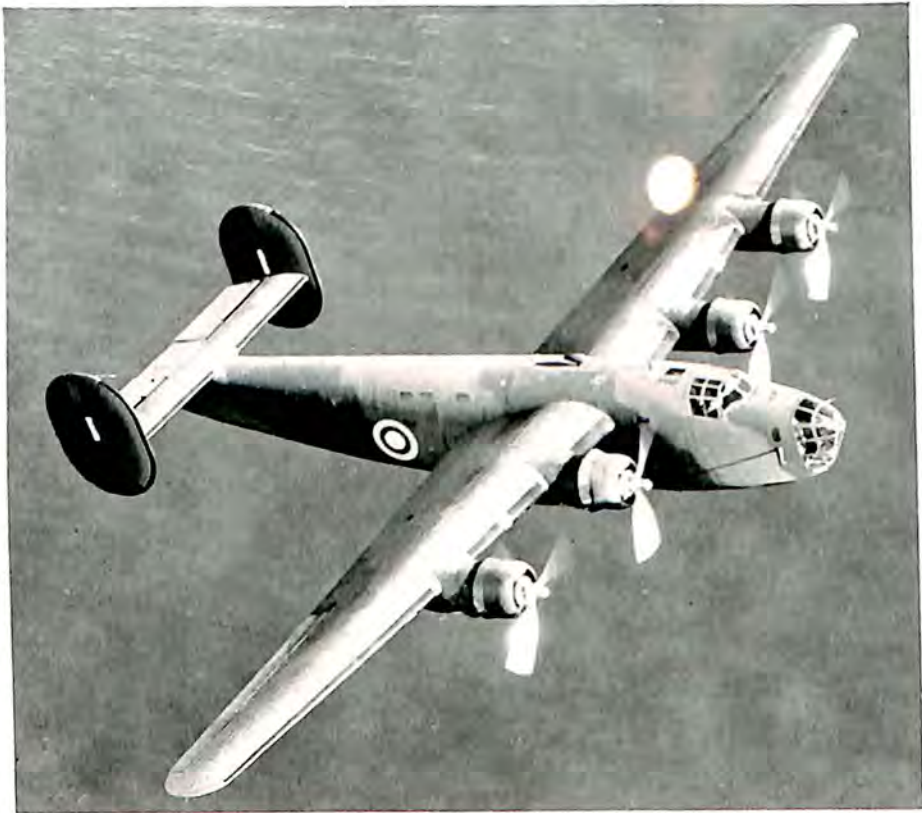
Yes, the price has been too high. Too much of England has been destroyed; but the invader has been held off for a year and the British have brought down five German planes for every machine they have lost. As Churchill said in words that will live forever: "Never in the field of human conflict was so much owed by so many to so few."

It was not all defense: and that is the point we are trying to make



DOUGLAS BOMBERS READY FOR R. A. F.

DB-7A twin-engine bombers receiving final check-up at Los Angeles Municipal Airport before fly-away delivery.



#### CONSOLIDATED'S LAND BOMBER FOR BRITAIN

One of the four-engine long-range patrol bombers—B-24—for the British Royal Air Force delivered by the Consolidated Aircraft Corporation.

here. Immediately after Churchill assumed the task of leadership, he spurned the old theory of defense, and set out after the enemy, trying to hit where it would hurt most. The R. A. F. had the major part of that job.

With all the fighters and bombers that could be made available, the R. A. F. has carried the war into the camps of the enemy and back to his sources of supply, his air fields, his docks and shipyards, his munitions factories, his railroad junctions and his cities. As British war-plane production has increased, augmented by the growing quantities of equipment from the United States, so have the R. A. F. raids on Germany increased, both in number and intensity. That is the present British strategy.

The effectiveness of all-out offense by way of the air has been demonstrated repeatedly in recent months. The R. A. F. has carried

on a routine bombing of the "invasion ports" across the Channel. Whenever and wherever there is activity among the German forces, it is spotted quickly, and the R. A. F. makes its nightly call. The history of the conflict will not be complete without a chronology of the British raids, when it becomes available.

Insufficient numbers of combat aircraft up to the present time also must be noted by way of explanation for the failure to dissipate the German effort. "We must have more planes from the United States," was the appeal from official Britain early in 1941. "Those that we are receiving are doing great work, but we must have more. We especially need very large numbers of American bombers."

British officials who were charged with the responsibility of having much larger shipments of aircraft sent overseas quickly were not at all reticent about the use to be made of the American machines. They were to be employed on all fronts. Even as shipments increased month by month in 1941, word came back from England, from North Africa and from the Balkans, that American planes were in the thick of the fighting, but that more were needed, urgently.

The next few months should witness a great reversal in air supremacy in this war. Heretofore the Germans have had the tremendous advantage of numbers. Their vast productive facilities have enabled them to keep on active duty many times the number that Britain has had available at one time. That has given them a twofold advantage. It has enabled them to use air power full-out at will, whenever strategy demanded, and still have plenty of replacements. At the same time, it has given them sufficient numbers of planes with which to defend their own bases reasonably well.



British Air Ministry photo  
NORTH AMERICAN TRAINERS WITH R. A. F.

The British named them "Harvard." They credited them with having trained thousands of the best pilots in the R. A. F. More than a thousand of these trainers had been delivered to Britain at the beginning of 1941.



Now, however, conditions appear to be changing. From all accounts, and they are from fairly reliable sources, the British combat plane production combined with the American output is superior to Germany's in those highly important categories such as fast pursuits, long-range and medium bombers and patrol flying boats. At the same time American dive bombers and upward of a score of newly designed combat aircraft soon will be leaving the factories in large numbers. This tremendous production from the United States, added to the greatly increased production in England, may have a decisive influence on the trend of the war in the coming months.

An indication of its possible reaction on German hopes for an easy victory is seen in the official complaint printed in the Italian newspaper "Messaggero" on March 28, 1941, after the British had shown up Italy's aerial prowess as almost non-existent. Said "Messaggero"—"Italian aviation today celebrates this 18th anniversary of the formation of the Italian air force (Fascist) in an atmosphere of fierce warfare in numerous sectors in both Europe and Africa. We are faced by an enemy who is mobilizing the best technical construction which America has been able to produce. . . . Our air war is difficult and full of sacrifices for our pilots, who realize they are facing an enemy equipped with the most modern fighting machines."



MARTIN ATTACK BOMBER 167W

Powered by two Pratt & Whitney Twin Wasps. In use by both the U. S. Army Air Corps and the British R. A. F.

## CHAPTER II

### RAPID GROWTH OF U. S. AIRCRAFT PRODUCTION

The Aircraft Manufacturers Perform an Industrial Miracle--Scope of the Production Program--Expansion of Plants and Other Facilities--Value of Experienced Management--Adequate Supply of Warplanes Assured.

**A**S this is written in May, 1941, the increase in American aircraft production under the national defense program is recognized by all informed persons to be an industrial miracle and one destined to become a decisive factor in ultimately ending the cataclysmic struggle between democracy and totalitarianism. From 2,141 warplanes in 1939 to 5,800 in 1940—the year was three-fourths over before American aircraft manufacturers received their quantity orders—the number of machines produced has grown steadily—1,131 in January, 1,216 in March and 1,427 in April, 1941, with a rapid rate of acceleration promised from now on throughout the emergency. The entire American program for aid to Great Britain and the defense of the Western Hemisphere has been based on what those officials who have charge of it know the industry to be doing and capable of doing in future. The program is as simple as it is awful. It is to return the holocaust to those who set Europe aflame, to continue the destruction of totalitarianism where it breeds, until the whole dirty mess is blown into oblivion and those who have dared to wreck the peace of the world are themselves definitely chastened by avenging fire. These last 12 months of totalitarian war have proved conclusively that fire must be fought with fire, that only superior air force strength, overwhelmingly superior strength, can bring a satisfactory end to this conflict. So that is the gist of the program; on analysis it means that the planes must be made available, which means in turn that the American aircraft manufacturers must perform that vital task, which now transcends in importance all other activities concerned with flying. President Franklin D. Roosevelt first made



U. S. Army photo

#### BELL AIRACOBRA FOR PURSUIT

The 39th Squadron of the 31st Pursuit Group, U. S. Army Air Corps lined up for inspection at Selfridge Field, Mich. This was the world's first fighter squadron to be equipped with tricycle landing gear, with the third wheel in the nose for safer take-offs and landings. The Bell Airacobra is Allison powered.

that fact officially apparent to the American people on May 16, 1940, when in his defense message to Congress he said: "During the past year American production capacity for warplanes, including engines, has risen from approximately 6,000 planes a year to more than double that number, due in greater part to the placing of foreign orders. Our immediate problem is to superimpose on this production capacity a greatly increased additional production capacity. I should like to see this nation geared up to the ability to turn out at least 50,000 planes a year. Furthermore, I believe that this nation should plan at this time a program that would provide us with 50,000 military and naval planes."

From then on, it has been a matter of increasing demands for quicker and greater production. First, however, there were preparatory stages. The Government had to prepare. It had to make a plan, formulate a directive. Enabling legislation was necessary. Appropriations were necessary. The air services had to decide what they wanted in the form of equipment, for both present and future. The British needs had to be considered. Negotiations with official agencies were seemingly endless throughout the summer of 1940, pending Congressional action which would permit the agencies of Government to proceed. The aircraft manufacturing industry, meanwhile, had to prepare for its task. Although much expansion of facilities already had been accomplished by far-sighted manufacturers, there had been no possible way by which the industry could have been totally prepared for the immense job it was handed.

Early in 1938, as the shadow of totalitarianism began to spread menacingly over Europe, American aircraft manufacturers were building about 100 military planes a month. Suddenly, the French government placed an order for 200 pursuit planes—a then-unprecedented quantity order. Munich, September, 1938, followed. The shadow broadened. Britain and France began ordering larger numbers of warplanes in the United States, against the dark days they knew were coming.

The early French and British orders totaled about \$20,000,000. Those orders and the prospect of more to come let the American aircraft industry expand plant facilities and develop methods approaching straight line production so essential to quantity output.

Early in 1939 it was putting out about 200 military planes a month. At that time the Government officials were told by industry leaders that if they should want a program of as many as 5,500 planes a year, the industry could do it, provided the program was well-coordinated and that the orders were for models and types which already existed and had passed satisfactory service tests. The manufacturers added that additional machine tools would be needed to eliminate certain bottlenecks. They pointed out that the industry had about 36,000 shop employees, and would need double that number to produce 5,500 military planes a year. They also told the Government that



U. S. Army photo

#### PRODUCTION FOR DEFENSE

Part of Vultee Aircraft plant at Downey, Calif., showing straight line production. These are basic trainers for the U. S. Army Air Corps.



VOUGHT-SIKORSKY FINAL ASSEMBLY

change orders—changes in design or engineering specifications—would so slow up operations as to seriously disrupt the production line.

Such a program, for about 5,500 planes, was approved by Congress a few months before the outbreak of the war in Europe. At the same time the British and French were negotiating further orders in the United States. But all that amounted to only 13 per cent of what it was to become within a year. Poland, the declaration of war, the fall of Norway and Denmark and of the Low Countries in May, 1940; and the world was completely awakened to the threat that confronted it. But because of the deliberate processes of democracy, the Government could not give the industry the signal for full-out production until the Fall of that year.

The manufacturers, however, were not idle. They had felt, ever since the first World War, that such an emergency might materialize, and they had been preparing for it. The management of United States aircraft plants, almost without exception, went through the World War in aviation, either in the defense establishment or in the plants of the manufacturers. For more than a score of years thereafter, that management struggled to set up a new industry and keep it alive through all the various economic vicissitudes and disarmament programs which intermittently threatened to starve it to death. That experienced management was important. It knew that the day was

coming when the nation and other peaceful peoples would need airplanes in ever-increasing numbers, airplanes of superior performance, machines of far greater performance than those which the enemy might choose to bring against them or our friends abroad. They knew all that. Every man in aviation had watched for more than a decade the stupendous effort which the Germans were making toward rearmament. They were using all the brilliant skill and scientific knowledge which they possessed. In the postwar years, when the limitations of the Versailles Treaty restricted the use of high-powered engines and limited the output of any kind of aircraft engine, the German Army was training a race of pilots on gliders and the German scientific world was working day and night in more than 30 Government-subsidized laboratories, developing the best aeronautical technique of which they were capable. When the totalitarian regime came into power, this effort was intensified past all imagination.

The American manufacturers knew what they would be called upon to do if war broke out in Europe. After the President sounded the alarm in his defense message on May 16, 1940, many of the



#### BOEING FLYING FORTRESS PRODUCTION

Interior of one of the Boeing Aircraft Company's plants at Seattle, Wash., showing intermediate stage of assembly on fuselages for four-engine Wright Cyclone-powered long-range bombers for both American and British air forces.



#### LOCKHEED BOMBERS FOR BRITAIN

A corner of the huge Lockheed Aircraft Corporation plant at Burbank, Calif., with rapidly increasing production of Hudson bombers and P-38 interceptor-pursuits.

manufacturers, disregarding the possibilities of financial loss, proceeded immediately to expand their productive facilities. They ordered materials in quantities which experience had taught them that they would need for increased production. They sent agents all over the country negotiating with subcontractors, pending the actual receipt of big orders. Some of them actually started huge plant expansion programs, arranging for new buildings, ordering machine tools, starting intensive personnel training programs and devising new methods of quantity production.

By January, 1941, the industry had a fine record of expansion, and of preparation. The airplane plants had increased factory floor space from 9,605,936 sq. ft. on January 1, 1940, to 17,943,087 sq. ft. on January 1, 1941. The aircraft engine manufacturers had expanded from 3,017,604 to 6,463,481 sq. ft., and the propeller plants had come up from 491,881 to 1,049,853 sq. ft. in the same period.

Employees had increased proportionately; airplane personnel from 65,677 to 144,583, engine employees from 21,257 to 42,567 and propeller from 2,959 to 6,743—all during 1940.

At the beginning of 1941, the industry had orders for about 37,000 military planes, including everything from trainers to huge, four-engine bombers. About 21,000 machines were for the American air forces. The remaining 16,000 were for the British. Delivery was scheduled to be completed about the middle of 1942. It was a large order; but it was only half of what was to come.

Speaking before the United States Chamber of Commerce in Washington, D. C., on April 30, 1941, Col. John H. Jouett, president of the Aeronautical Chamber of Commerce of America, the trade association for the aircraft manufacturing industry, explained how events in Europe had forced still greater expansion of the program, outlined the problems of warplane construction, and described the accomplishments of the industry in meeting its tremendous defense assignment. Col. Jouett said: "As of today our industry has orders to build about 44,000 military airplanes, broken down as follows: For the Army about 16,500; for the Navy about 8,500; for the British, including Canada, about 16,000, and 3,600 bombers under the Knudsen Plan. The immensity of the job can be realized when I tell you that in 1939, the industry did \$225,000,000 worth of business; in 1940 our people increased dollar volume output to \$544,000,000, at the same time carrying on a tremendous plant expansion, and that this year we intend to turn out \$1,500,000,000 worth of airplanes."



#### RECORD PRODUCTION FOR DEFENSE

Here in the plant of the Curtiss Airplane Division of Curtiss-Wright Corporation at Buffalo, N. Y., 10 P-40 pursuit planes a day were being produced for the U. S. Army and British air forces when this photo was taken; and production was increasing rapidly.





#### DOUGLAS BOMBERS FOR BRITAIN

DB-7A twin engine bombers receiving final grooming as they emerge from the plant of the Douglas Aircraft Company at Santa Monica, Calif.

Explaining why warplanes require a great deal of work in construction, Col. Jouett said: "Warplanes today must perform functions undreamed of during the last war. They must be larger, carry greater loads, fly farther and faster, perform more difficult maneuvers with attendant immeasurably increased stresses. The modern warplane must embody all these capabilities in order to hold its own against the new machine that the enemy is always working on. It takes time and precise workmanship. There are 50,000 separate inspections on an aircraft engine; 30,000 man hours of labor go into a medium bomber; 450,000 rivets go into a heavy bomber; in one medium bomber 30,000 parts, not including bolts, nuts and rivets, are worked into 650 minor subassemblies, and these in turn into 32 major subassemblies, before they are put into the plane.

"In addition, the lessons taught almost daily by the war must be assimilated and their substance translated into performance by the aircraft we are building. The tempo of this war is breathtaking; each side is constantly heightening the fire power of its planes, increasing the strength of armor plate, and incorporating new offensive and defensive features in its warplanes. These advances we must meet and surpass as we learn of them. This calls for re-design-

ing. Re-designing takes time. Yet, since the graver phase of the emergency began, in other words since July, 1940, our industry has built nearly 7,000 warplanes. The production curve has been accelerating steadily. In the 20 months since the outbreak of the war, nearly 3,500 American-built military planes, ordered from our people by the British, have been exported. That once was no mean air force in itself.

"Production will increase as rapidly as new plant facilities come into operation. Each month will see sharply increased numbers of planes rolling off production lines. This year alone, our estimates show, 18,000 planes will be turned out; and next year, under present programs, 30,000.

"The planes we are building and will build equal or surpass the best being built, or to be built, elsewhere. We hear much about new German types about to enter the war arena. We know that the Germans have a new twin-engine fighter, the Focke Wulf FW-189, powered with 2,750 h.p., and carrying eight guns, including cannon. We know the Germans are to bring into service the new Heinkel HE-113, a fast fighter. Another new German fighter is the Focke Wulf FW-158, a single-engine craft with pusher propeller. Four new bombers are slated for service, including two four-motored ships, a new Heinkel and the Focke Wulf Kurier. But our people



#### PRODUCTION FOR DEFENSE

Long-range four-engine bomber production at the plant of the Consolidated Aircraft Corporation in San Diego, Calif., increases steadily. Note the tent roof of one of the assembly sheds on the right. Production was started here without waiting to put on a roof.



#### PRODUCTION FOR DEFENSE

Outside the Inglewood, Calif. plant of North American Aviation where pursuits, bombers and trainers are in quantity production. In the foreground "Harvard" trainers ready for delivery.

are engaged on new models, too. They are military secrets, of course, but I can tell you that there are at least 16. I can say that interceptors to combat night bombing—one form of attack which Britain has been unable to repel up till now—are being developed in the United States. Rest assured that our planes will not be excelled. We must build the best. An inferior warplane is worse than no plane at all.

"Programs are in the mill today looking to placement of orders for additional thousands of planes for our air services and Britain, and for other governments eligible for aid under terms of the Lend-Lease Law. Scope of these programs has not been made public, but, I am told by Government sources, requirements under consideration will bring the total of planes on order from the present 44,000 up to 80,000! The aircraft manufacturing industry, which has made amazing progress against great odds in the last year, is ready to tackle any new assignment handed it. However, in the best interests of the defense program, I would like to offer these suggestions in connection with the new program: First, let every possible source of suitable subcontracting be utilized before launching another time-consuming plant expansion program; second, let any expansion of

orders be in proportion to the available supplies of material and personnel.

"That's the aircraft situation as of today. We are, with all justification, I think, satisfied with it. Not complacent, however. World events hourly demonstrate the gravity of the moment. A long succession of American and British officials have told us that they are well pleased with our progress, both in number of planes built and in their quality. American-built warplanes have, despite some assertions to the contrary, participated on every front since the war began, are today performing meritoriously on every front—over England, in Africa, over the Mediterranean, in the Near East, over the English Channel and the Atlantic."

In another public statement, Col. Jouett made this comment: "There are many bright spots in our program at present. We have learned how to improve our product and develop new designs while turning out increasing numbers of frozen models in the same plant. That is because we put into engineering research and development at least 10 per cent of what we took in in the form of revenues in the years past. Another reason was our two years experience in meeting the constantly changing directives of Britain and her Allies, as the changing war forced upon them different kinds of equipment. It is due also to our expensive but necessary methods of training our own labor in our own plants. Thus far, the draft boards have been disposed to give us deferred status in most instances so that we have been able to retain nearly all the personnel that we wanted to keep or that wanted to stay with us. A surprisingly large number have voluntarily left their jobs to go in Service. Acknowledging the need



#### PRODUCTION FOR DEFENSE

A corner of the Glenn L. Martin plant where there is rapidly increasing production of bombers for the American air forces and Britain.



#### WRIGHT CYCLONES FOR DEFENSE

Wright Cyclone engines manufactured in steadily increasing quantities shown here ready for shipment at one of the plants of the Wright Aeronautical Corporation in Paterson, N. J.

for an increasing flow of aircraft, the Government thus far has been disposed to give us priority on essential materials and tools at the expense of other industries. That has relieved some of our shortages. But we still have bottlenecks, and we are still up against the problem of priorities, and most of us believe it will remain a problem until the next Armistice.

"Another thing in our favor, there is more aviation experience in the Government than prevailed during the last war. There is more experience in Congress. We find a surprising number of men in the Government bureaus who had had actual aviation experience, some of them in the last war and others in industry. We find many of them in Congress who really know this industry and its problems with relation to the defense program.

"The industry's main problem at present is the bottleneck. Within the last few weeks I have seen plants turning out bombers and waiting for a half-dozen or more pieces of equipment which had to go into the bombers before they could be flown away. As soon as one bottleneck was broken at that plant, another would take its place. Throughout the industry they are waiting for one thing or another that at times retards production to a certain extent. We must depend

on the Government and upward of 50 allied industries, including more than 2,000 different manufacturing organizations, to see that we are supplied with the things that we must have in our plants in order to turn out a flying machine. If the bottleneck problem is solved in any degree, then to that extent we shall increase our production proportionately. But if for one reason or another, through Government action or lack of it, through strikes in other industries or in our own industry, through sabotage activities in our own plants or anywhere else, then more bottlenecks are created and to that extent will our program lag, and eventually we shall have to account for it."

The motor car industry was one of the many with which the aircraft manufacturing companies were doing an increasingly heavy subcontracting business in 1941. One form of that subcontracting was embodied in the plan conceived by William S. Knudsen, Director General of the Office of Production Management. The Knudsen

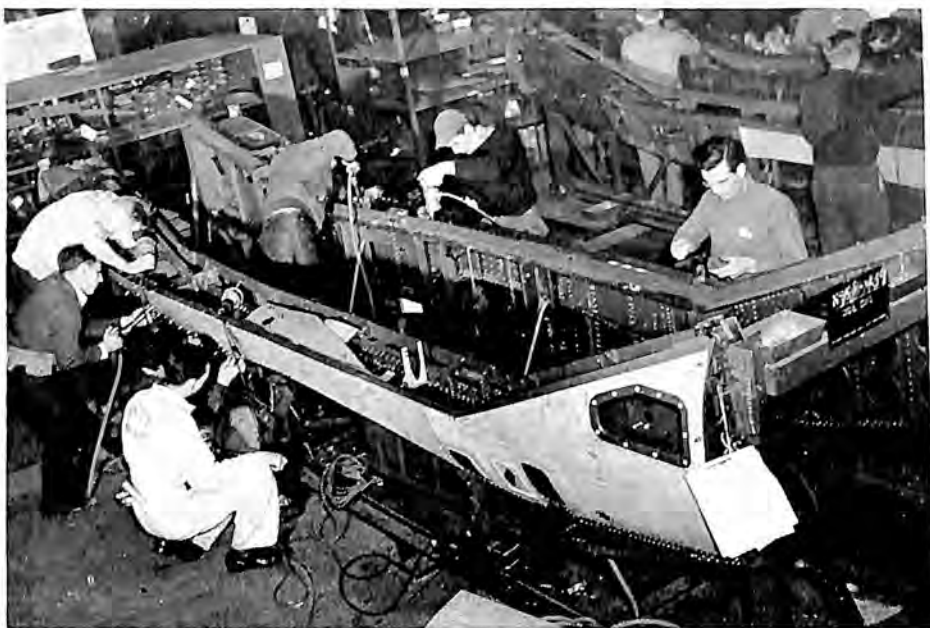


#### PRATT & WHITNEY ENGINES FOR DEFENSE

Looking down the preliminary assembly line in the new plant of Pratt & Whitney Aircraft Division of United Aircraft Corporation at East Hartford, Conn.

plan provided for the establishment of large assembly plants, built by the Government, and operated by aircraft manufacturers who would assemble into two and four-engine bombers the subassemblies built by the automotive industry. Early in 1941 plants were being put up for that purpose. Automotive engineers and other key personnel were in the aircraft plants studying the admittedly new and different art of building parts for aircraft. Officials in charge of the defense program hoped that this subcontracting system with the automobile industry would begin to contribute materially to production in 1942, augmenting the tremendously increased output which the established aircraft industry would surely have.

The following chapters give in detail other phases of the emergency defense program including activities of the Army and Navy air forces, the training of pilots and—in the last chapter—the story of how each aircraft manufacturing company is producing for defense.



#### WHY AIRPLANES ARE EXPENSIVE MACHINES

High performance and the maximum of safety factors in American aircraft require thousands of man hours of labor. Photo shows a crew at work on the two longitudinal beams that form the fuselage of a Bell Airacobra. The light dots are rivets.

CHAPTER III  
THE U. S. ARMY AIR CORPS

Secretary Stimson Transmits, as of "Potentially Profound Historical Significance", Assistant Secretary Johnson's Report—Record for Peacetime Purchases of Airplanes—General Arnold Describes Rapid Expansion to Meet International Situation—Industry Responds to Unprecedented Demands—Mounting Strength of The Air Corps—The "Flight Strip"—Achievements—Awards of Merit.

**A**N old saying that history is the last man's idea of the truth applies with equal force to the statistics for 1940 dealing with the United States Army Air Corps. Under the biting lash of stern necessity as wielded with ever-mounting tempo by the war in Europe and elsewhere, the Air Corps strove manfully to meet the changed and changing requirements of a situation unparalleled and, in part at least, ungrasped.

As this is written at the end of March, 1941, the Air Corps faces a world crisis in a state of flux. From a few hundred planes to "50,000 planes a year," from a few hundred newly-trained pilots to 6,000, then 12,000, then possibly 30,000 a year, was a dazzling transition.

Described by Secretary of War Henry L. Stimson as of "potentially profound historical significance," the annual report for the fiscal year ending June 30, 1940, presented by the then Assistant Secretary of War, Colonel Louis Johnson, stated that "In the past 12 months the War Department has made more progress toward providing our military establishment with necessary arms and equipment than in any similar period since the World War."

Col. Johnson added: "Under the enlarged Air Corps program of April 3, 1939, the number of airplanes contracted for amounted to more than six times the average annual purchases of Army airplanes





VULTEE VALIANT 51

Basic combat and advanced trainer with Pratt & Whitney Wasp engine.

in recent years. At the same time there were being placed with the industry of the country large orders for airplanes, engines and accessories and other military equipment to meet the needs of Great Britain, France and other foreign countries. The total effect has thus been to develop and increase materially the productive capacity of the country for the furnishing of aircraft and other munitions."

Procurement of aircraft presented substantial problems. How were these met? Col. Johnson continued: "During the fiscal year 1940 an aircraft procurement program was entered into with a view to increasing the strength of serviceable airplanes for the Army to as near the maximum of 6,000 authorized by the act of April 3, 1939, as was possible within the limits of appropriated funds. While it had previously been the accepted policy to allow sufficient time between the issuing of circular proposals and the opening of bids for any qualified manufacturer to design and construct sample airplanes, it was evident that the exigencies of the expedited program would not permit such protracted delay. Resort was therefore had to procurement by design competition, as authorized by the act of July 2, 1926.

"Under this method of purchase, designs of aircraft accompanied by specifications and performance guaranties were requested from all qualified bidders and awards made as a result of evaluation of the designs submitted. With a view to future needs, bids were requested upon larger numbers of aircraft than it was expected actually to contract for during the fiscal year, in order that such contracts might contain options for further procurement when and if the Congress made appropriations for their purchase.

"During the fiscal year 1940 there were actually delivered to the War Department 886 airplanes, having a total value in excess of \$49,000,000. Under the fiscal year 1940 appropriations, new contracts

were awarded for 3,117 airplanes at an approximate cost of \$172,000,000, including bombardment, attack bombers, observation, photographic, one- and two-engine pursuit, training, and transport types.

"Of the 886 airplanes actually delivered, 602 were received under contracts placed under appropriations pertaining to this fiscal year and are included in the 3,117 airplanes for which contracts were awarded during that period. The number of airplanes purchased from current funds far exceeded previous peacetime purchases in any one year and, in fact, almost equaled the aggregate number purchased during the preceding eight years.

"No major difficulties in aircraft procurement occurred as a result of the profit-limitation provisions [of the Vinson-Trammell Act]. However, under the terms of the act approved June 28, 1940 (Public, No. 671, 76th Congress), the allowable profit for aircraft was reduced from 12 to eight per cent of the contract price. As a result of this change, coupled with important questions as to amortization of costs for expansion of facilities under the augmented aircraft program of next fiscal year, it is anticipated that serious delay and difficulty in consummating contracts may be encountered."

Describing rapid expansion to meet the serious aspects presented by the international situation, Major General Henry H. Arnold, Chief of the Army Air Corps, stated: "Congress made funds available to



#### ALLISON ENGINES FOR DEFENSE

An Allison V-1710 engine passing its final acceptance test at the plant of the Allison Division of General Motors Corporation at Indianapolis, Ind.



U. S. Army photo

#### BOEING B-17D FLYING FORTRESS

One of the latest of the armada of four-engine long-range bombers delivered to the U. S. Army Air Corps in 1941.

start the ball rolling in the Spring of 1939, with the 5,500 plane program as an objective. Not all of these airplanes were combat airplanes. Many of them were training airplanes. The completed program called for the creation and equipping of Heavy, Medium, and Light Bombardment Groups, single-engine Pursuit Groups, and Fighter Groups. Building up this force required doubling in number our Squadrons.

"In order to operate this expanded air force, it became necessary to increase tremendously the number of our enlisted personnel from about 18,000 to about 43,000 men. We had to train them. Hence, we built and increased in size the great technical schools at Chanute Field, Rantoul, Ill., at Scott Field, Belleville, Ill., and at Lowry Field, Denver, Colo.

"To train a total of 2,400 new pilots within a year, we revised our whole system of pilot training. Fortunately we were able to create on short notice an efficient system for pilot training that could be very greatly expanded by using certain available civilian flying schools. We selected nine of them to give primary training of flying cadets. This system has worked out so well that our plan for an output of 2,400 pilots in a year has since been changed to one of 12,000 a year. We now carry on all of our primary training of flying cadets at civilian schools, and the basic and advanced training at our own training centers.

"As the emergency became more critical, greater expansion became necessary. A much larger Army air force was required if we were to provide security against aerial attack for ourselves and our neighbors in the Western Hemisphere. We thought that the 5,500 plane program was large, but it has since been doubled and tripled. Con-

gress last summer appropriated funds for an additional 14,000 airplanes, so we now find ourselves at work recruiting, training, organizing and equipping 54 groups—instead of the 24 that we first planned. Our present objective (January 10, 1941) is about 170,000 officers and enlisted men and 14,000 planes."

Aircraft production was a matter of grave concern to General Arnold. Describing it as "perhaps the most critical element in the expansion program," he added: "It takes time to build airplanes. In peacetime 18 months were required to turn out the new model of a bombing plane. We of the Air Corps thought that this time might be cut down somewhat by building in larger quantities, but found that modernization with self-sealing tanks, increased fire power and armor gave the industry little opportunity to cut down on the time required for production. These improvements spell the difference between an effective fighting plane and one that is easy meat in modern aerial battle. So today we still find that it takes more than a year to build a modern combat plane. The task which we have set out to do will tax to the utmost the capacity of the manufacturers in this country. Our sights are still high, and we will not be satisfied with anything less than the best.

"We maintain constantly a number of trained Air Corps observers in Europe today, and we are incorporating the very latest technical developments and improvements into our new combat planes—changes that combats thousands of feet in the air have proven essen-



U. S. Army photo

#### THE BELL AIRACOBRA

One of the hundreds of high speed pursuit planes which the Bell Aircraft Corporation, Buffalo, N. Y., is producing for the U. S. Army Air Corps and the British Royal Air Force. The Airacobra is powered by an Allison engine.



#### MARTIN B-26 IN FLIGHT

One of the high performance bombers being produced in large quantities, product of The Glenn L. Martin Company.

tial in all fighting planes. Our fighting planes will compare favorably in quality with any in the world."

How did the aircraft industry respond to the challenge? General Arnold went on: "Our industry was given a tremendous task, for simultaneously with the Army expansion program it had to meet one almost as large for our Navy—and then, superimposed upon those two, there were those very important and exceptionally large orders from Great Britain, orders which we are very glad that our industry can fill.

"All together, the industry was called upon to produce some thirty-odd thousand planes in about two and one-half to three years. That would not have been such a difficult task were all the new factories running full steam, but we were just starting their expansion.

"The total payroll in the aeronautical industry was increased from about 35,000 in 1938 to 150,000 in 1940, and will reach over 250,000 in 1941. New plants had to be built and equipped almost overnight. Production lines have been created, the length of which were beyond our most optimistic dreams a few years ago. However, the industry is not yet out of the woods. There are bottlenecks in machine tools, materials, skilled workers, aeronautical engineers and sub-contractors qualified to produce parts and sub-assemblies.

"As should be expected, the industry took the first part of its expansion in its stride, but then it became much harder. Perhaps we

expected to reach our objectives too soon. Perhaps we were too optimistic as the experienced personnel in the plants were spread too thin—almost impossibly thin, but in spite of that the bottlenecks are being eliminated one by one, and we have high hopes for the future.”

Difficulties confronting the industry were fully appreciated by General Arnold, who stated: “We can always recruit and train personnel quicker than we can get material, planes, engines, guns and radio equipment. Realizing that, we started the industry working toward maximum production a year and a half ago. But there is no substitute for time. We can find some short cuts, we can utilize mass production machinery and we can put on three shifts, but the yard stick—man hours—still is the determining factor. That goes for production of planes, engines, tanks, guns or bombs.

“We get in the habit of thinking that American ingenuity, mechanical skill and industrial planning can do anything, that millions of dollars appropriated and expended will make up for years of indecision and lack of suitable military industrial facilities. It can't be done. It requires from nine months to a year to build an airplane factory.

“Machines, tools and equipment are getting much more difficult to obtain, and the time required for delivery has increased to well above six months, and for the larger items to nine months or a year. It takes another six months to reach maximum production. Where



NORTH AMERICAN'S NEW PURSUIT P-51

Powered with the Allison engine it is in production for the U. S. Army Air Corps and the British, who named it “Mustang.”



#### THE DOUGLAS B-19 BOMBER

This huge bomber for the U. S. Army Air Corps was designed and built by the Douglas Aircraft Company at its Santa Monica, Calif., plant. Powered by four Wright Duplex Cyclone engines aggregating 8,000 h.p., the B-19 has a gross weight of 82 tons, measures 212 feet between wing tips and carries 11,000 gal. of fuel. It has a crew of 10; and if used as a troop transport, can carry 125 men.

are we going to get the aeronautical engineers? A difference of ten pounds in an automobile, a tank, an armored car, makes no difference. In an airplane it may mean the difference between life and death—between success and failure. We must have engineers, trained engineers, in large numbers in all our plants.

"We of the Air Corps realized this when our program was first suggested, and so announced, but too many people expected a magic wand to be waved and the problems all solved. The wand may be waved, but the problems are not solved by a long way. We still have lots of planning to do, training of skilled workmen to carry on, supervisory and engineering personnel to discover. Our task is a hard one, but not an impossible one. Germany took six years to build up her mighty air armada; we are trying to do it in three years; and we believe that we can do it."

During 1940 the Army Air Corps expansion program moved rapidly forward. On June 30, 1940, a definite goal had been set—54 combat groups comprising all types of airplanes. At that time there were 16 skeleton groups and wings.

Four Air District Headquarters were activated on December 18, 1940, together with 14 additional Wing Headquarters.

While on June 30, 1940, the Air Corps consisted of 3,322 Regular Army and Reserve officers, 1,894 flying cadets and 45,914 enlisted men, as of January 15, 1941, it had expanded to approximately 6,180 officers, 7,000 flying cadets and 83,000 enlisted men. With the complete personnel allotment under the 54-group program set at approximately 16,000 officers and 166,000 enlisted men, it was anticipated that by June 30, 1941, 10,100 officers, 15,000 flying cadets and 151,000 enlisted men would be in the Air Corps.

Activation of four Air Force Headquarters provided for decentralization of training and inspection duties of the Commanding General, GHQ Air Force. Air Force Headquarters were being located initially at Mitchel Field, N. Y., Tampa, Fla., March Field, Calif., and Spokane, Wash. Wing Headquarters, including those previously in existence, were being established at Westover Field, Mass., Mitchel Field, N. Y., Selfridge Field, Mich., Langley Field, Va. and Bowman Field, Ky., all in the Northeast Air District; Augusta and Savannah, Ga., West Palm Beach and Tampa, Fla., New Orleans, La., all in the Southeast Air District; Tucson, Ariz., March Field, Fresno and Hamilton Field, Calif., all in the Southwest Air District; Spokane, Wash.,



CLOSE-UP OF CONSOLIDATED B-24 BOMBER

Showing tricycle landing gear, and two of its four Pratt & Whitney Twin Wasp engines and Hamilton Standard propellers.





U. S. Army photo

#### LOCKHEED P-38 IN FLIGHT

The twin Allison-powered single-seat interceptor-pursuit plane was in production for both U. S. Army Air Corps and British R. A. F.

Portland, Ore., and Salt Lake City, Utah, all in the Northwest Air District.

Training of those new units was placed under the direct charge of the Commanding General, GHQ Air Force, comprising all four air forces, 17 wings and 39 of the 54 combat groups. Training of pilots, navigators, bombardiers, radio, armament and engineering personnel devolved upon the Chief of the Air Corps, also responsible for supplying aircraft and other equipment for this air combat force.

Entering 1940 with but 17 permanent bases for its 60 squadrons, with an air force of 288 squadrons authorized by the Congress, the Air Corps began its greatest building program within the continental United States, a similar expansion occurring in territorial and foreign stations.

Sites for additional bases were acquired, and at the end of 1940 many air bases were in process of construction by various agencies of the Government, leased from State or municipal operators, or otherwise made available. With the Air Corps expanding on schedule, it was anticipated that by the spring of 1941, 19 permanent bases and 23 other air stations would be ready for operation. In addition, approximately 100 other landing fields had been approved by the War Department and were being improved by the WPA.

The number of training centers had been increased from one, the Gulf Coast Training Center at Randolph Field, San Antonio, Tex., to three, including the South East Training Center at Maxwell Field,

Montgomery, Ala., and the West Coast Training Center at Moffett Field, Calif.

The three Air Corps training centers were augmented by establishment of many new Air Corps schools which were placed under supervision of the various centers. These schools included: Ellington Field, Tex., Advanced; Montgomery, Ala., Airport, Basic; San Angelo, Tex., Basic; Selma, Ala., Advanced; Stockton, Calif., Advanced; Macon, Ga., Basic; Albany, Ga., Advanced; Eglin Field, Valparaiso, Fla., Specialized; Brooks Field, San Antonio, Tex., Advanced; Victoria, Tex., Advanced; Bakersfield, Calif., Basic; Taft, Calif., Basic; Mather Field, Calif., Advanced; Phoenix, Ariz., Advanced; Las Vegas, Nev., Gunnery and Panama City, Fla., Gunnery. Civilian schools giving elementary pilot training were increased by 19, from nine to 28. Civilian schools giving mechanics training were increased by eight, from seven to 15.

Previously given the Cheney Award for 1939, Captain Harold L.



#### WHY FIGHTING PLANES COST TIME AND MONEY

A crew of riveters are shown here attaching Alclad metal skin to the semi-monocoque fuselage of a Curtiss P-40 pursuit plane. About 75,000 rivets are required in each ship.



NORTH AMERICAN NA-40A BOMBER

This twin-engine medium bomber is in heavy production for the U. S. Army Air Corps, and is on the quantity list in the defense program. It is powered by two Wright Cyclone engines.

Neely was awarded the Distinguished Flying Cross for riding a bombing plane to a crash landing near Hill City, Kans., on December 18, 1939, in the belief that an enlisted passenger had been unable to abandon the plane after both engines had ceased to function.

Other awards of the Distinguished Flying Cross were made to the following: Captain S. R. Harris, for his especially brilliant record in testing experimental airplanes during four and one-half years as test pilot at Wright Field. Captain George E. Price, of Wright Field, for courage, sound judgment and skill displayed on January 6, 1940, at Buffalo, N. Y., while flight-testing a new pursuit ship. With landing wheels locked in retracted position, Captain Price made a crash landing in a foot of snow, and thus saved immensely valuable experimental equipment. Private Raymond U. Whitney, Wright Field, for personal risk as an experimental subject in carrying out studies at the Aero Medical Research Laboratory to determine the limits of human endurance. Captain Franklin C. Wolfe, for his extraordinary achievement January 28-February 13, 1939, flying from France Field, Panama Canal Zone, to Santiago, Chile, and return, carrying medical supplies to earthquake victims and transporting to safety 65 injured persons. Captain William T. Hudnell, Jr., for heroism at Langley Field, Va., on April 23, 1940. With his control stick locked in neutral position at 2,000 feet, Captain Hudnell stayed with the plane and landed on his second attempt. Captain Willard W. Lazarus, who on March 5, 1940, while flying from San Juan, Puerto Rico, to St. Thomas, Virgin Islands, had both engines cut out at 2,500 feet. He ordered four passengers and his sergeant crew chief to jump, then landed skillfully. Sergeant Thomas F. O'Malley, 27th Reconnaissance Squadron. On March 5, 1940, flying from San Juan, Puerto Rico, to St. Thomas, Virgin Islands, with both motors dead at 2,500 feet,

Sergeant O'Malley was ordered to jump. After helping four officer passengers overboard, Sergeant O'Malley chose to remain with the pilot in a crash landing.

Posthumous award of the Distinguished Flying Cross was made to Lieutenant Virgil Hine, Air Service, and presented to his son, Tom Hine. June 28-29, 1923, Lieutenant Hine acted as pilot of the refueling plane in the first successful experiment in refueling an airplane in the air. For manipulating the hose lines from the refueling plane, 1st Lieutenant Frank W. Seifert, Air Service, also was awarded the Distinguished Flying Cross.

The Mackay Army Award for 1939 was presented to the officers and men of the Army Air Corps who flew medical supplies in a B-15 from Langley Field, Va., to Santiago, Chile, following the earthquake in February, 1939. Members of the flight were Major Caleb V. Haynes, pilot, Major William D. Old, Captain John A. Samford, Captain Richard S. Freeman, 1st Lieutenant Torgils G. Wold, Master Sergeant Adolph Cattarius, Technical Sergeants Harry L. Hines, William J. Heidt and David L. Spicer, and Staff Sergeants Russell E.



REPUBLIC P-43 LANCER

With Pratt & Whitney Twin Wasp engine and Curtiss electric propeller.

Junior and James E. Sands. The Columbian Trophy for 1939 was presented to the 2nd Bombardment Group (Heavy) Langley Field, Va., which maintained an 0.075 accident rate during the 1939 training period.

The Soldier's Medal was awarded to Private Frederick H. Wilson, Air Mechanic, 2nd Class, for his heroism in extinguishing fire in a burning plane at Mitchel Field, N. Y., July 5, 1938. Also to Lieutenant James W. Anderson, Jr., Air Reserve, for rescuing two officers from a burning airplane at Wright Field on April 11, 1939. The Soldier's Medal also went to Corporal Ethan C. Bullard, Air Corps, for extricating a pilot officer from a crashed and burning airplane near Lead, S. D., on August 13, 1939.



#### NEW BOEING FACILITIES FOR DEFENSE

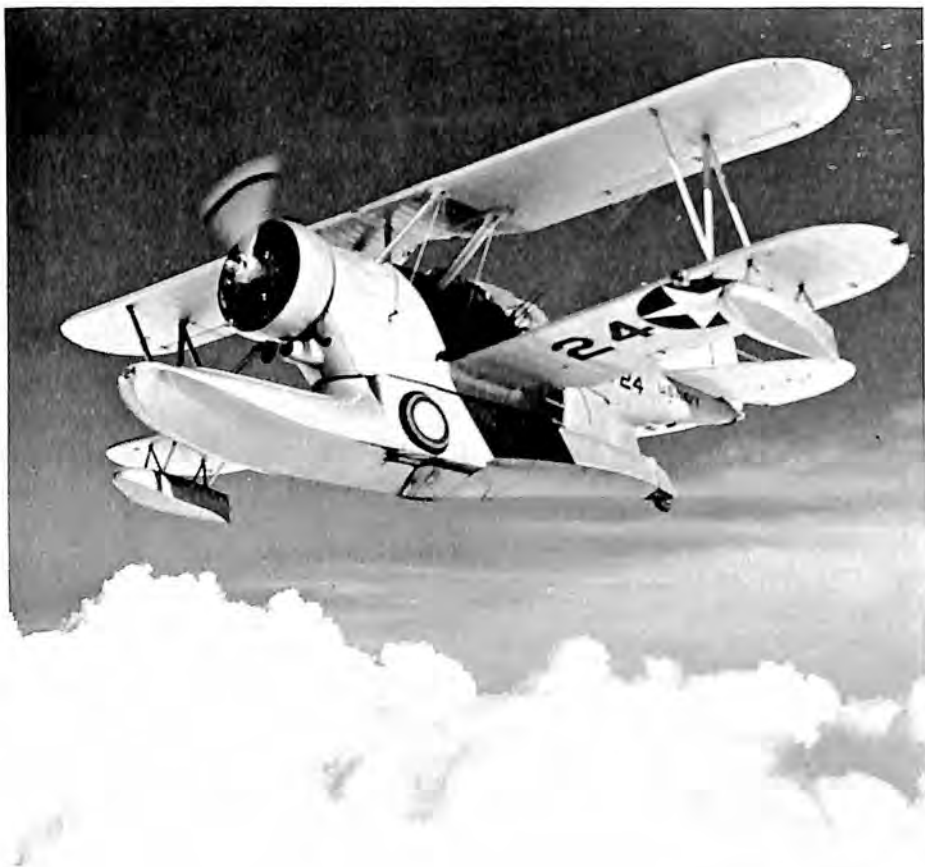
Production of four-engine Flying Fortresses and other bombers was to be stepped up rapidly with addition of this new plant, so large that the superintendent on cement construction had to ride a horse to cover the area.

## CHAPTER IV

### AIR FORCES OF THE U. S. NAVY

Acting Secretary Compton's Comment—The Navy's Principles of Aircraft Operation Proved Sound by European War—Rear Admiral Towers Makes Comprehensive Report—Operations With the Fleet—The Neutrality Patrol—Activities of the Squadrons—Improved Performance—Aviation Shore Stations—Naval Reserve on Active Duty—Appropriations—Increase in Flying Hours—How Manufacturers Improved Efficiency of Planes, Engines, Propellers and Accessories—Need for Continued Experimentation—Awards and Citations.

**I**N his annual report for the fiscal year 1940 the Acting Secretary of the Navy Lewis Compton made this comment:  
"Naval aviation has undergone extension of operations and acceleration of development as a result of the European war. The results of aircraft operations in Europe have been carefully studied and the lessons learned relative to construction, armament, and protection are being applied. It is gratifying to note that many of the major principles of aircraft operation, long ago adopted by the United States Navy, have been proven in the hostilities abroad. This has confirmed the opinion that United States naval aviation is organized on a sound basis and that the large expansion required can best proceed along the present well-established lines. The shore establishment development program was accelerated with emphasis placed on early completion of additional training facilities. The acquisition and training of large numbers of pilots are essential corollaries to the increased Navy and are being actively pursued. The Naval Reserve aviation bases throughout the country have been active in the procurement of civilian applicants for pilot training and the elimination training of those who meet other standards. These bases have also provided facilities for maintenance of flight proficiency of Naval Reservists on inactive duty."



U. S. Navy photo

**GRUMMAN J2F-2 IN FLIGHT**

One of the utility planes with the Navy air forces.

A most comprehensive report on the detailed activities of the Navy's air forces was given by Rear Admiral John H. Towers, Chief of the Bureau of Aeronautics, for the fiscal year 1940. Abstracts from his report follow.

"Procurement of aircraft to fulfill the requirements of the treaty navy, already well in hand, was largely confined under previous programs to replacement of aircraft on hand by improved models. With the passage of the act by Congress authorizing 10,000 airplanes for the Navy, plans have been drawn up to fulfill the increased aircraft needs of the Navy. Fortunately, the Navy was in an excellent position to undertake this expansion without reducing the quality of the aircraft to be procured.

"New and improved experimental models in all types were already under test or about to be delivered, development and experimental work long under way on the subjects of aircraft armor and self-sealing gasoline tanks was reaching the stage of fruition, and reports from abroad had indicated that the concepts as to aircraft material and aircraft tactical usage held in the Bureau were correct in their anticipated application to actual warfare. Examples of this lie in the effectiveness of dive bombing and dive-bombing aircraft which were pioneered, developed and perfected in the U. S. Navy, in the development of high performance carrier aircraft, particularly fighters which also possess long-range capabilities and the capabilities demonstrated by long-range patrol planes in protection of sea routes.

"Shore station development, one of the most pressing needs of naval aviation, has continued under the broad program laid down by the Hepburn Board.

"As in the past, aircraft squadrons and tactical units, including



#### FLY-AWAY DELIVERY OF STEARMANS

Navy N2S-1 trainers leaving the Stearman factory at Wichita, Kans., for the Navy training center at Pensacola, Fla.





U. S. Navy photo

**DOUGLAS TBD-1 TORPEDO-BOMBER**

One of the planes of Squadron 6 attached to the carrier "Enterprise."

Marine Corps squadrons, have been assigned to and operated with the fleet. Naval aircraft have also been based ashore for experimental, training and administrative activities. Certain squadrons of the fleet have operated with the Naval District Headquarters for much of the year in maintaining neutrality patrols. Cooperation with the Army forces by aircraft units of the Navy has developed as the result of local coastal defense exercises.

"A unit of the Neutrality Patrol was established in the Philippine Islands, two squadrons of patrol planes having flown across the Pacific from Hawaii without incident in providing the aircraft for this duty.

"During the fiscal year 1940, airplanes were purchased to replace those in service which became obsolete, or which had been lost due to crashes, as well as to increase the Naval Aeronautical Organization in accordance with the Naval Expansion Act. Aviation units were organized for the 'Helena' and 'Noa.' The squadrons for the 'Wasp' were organized, commissioned and outfitted. Aviation units were recommissioned for the 'New York,' 'Texas,' 'Arkansas,' 'Erie' and 'Charleston.' Contracts were let for planes for five new patrol squadrons and for the expansion of six other patrol squadrons from six planes to 12 planes.

"In connection with the expansion of the Naval Aeronautical

Organization in the near future, it was realized that the most urgent part of the program was the prompt initiation of the pilot training program. [See chapter on training.]

"Experimental aircraft are under construction or test in each of the service types. Increase in power and refinement of design have made possible marked advances in performances, particularly in speed, range and operating altitudes. At the same time aircraft will have greater striking power due to more and larger guns and more efficient installations, in addition to greater defensive power resulting from guns, armor and other forms of protection.

"Development has been pressed on improved engines in order to obtain greater power, better installations from an aerodynamic standpoint and more efficient performance with safer fuels. The necessary equipment is being actively developed to take full advantage of increasing ranges, altitudes and other aircraft performance, and to promote the general efficiency of naval aircraft.

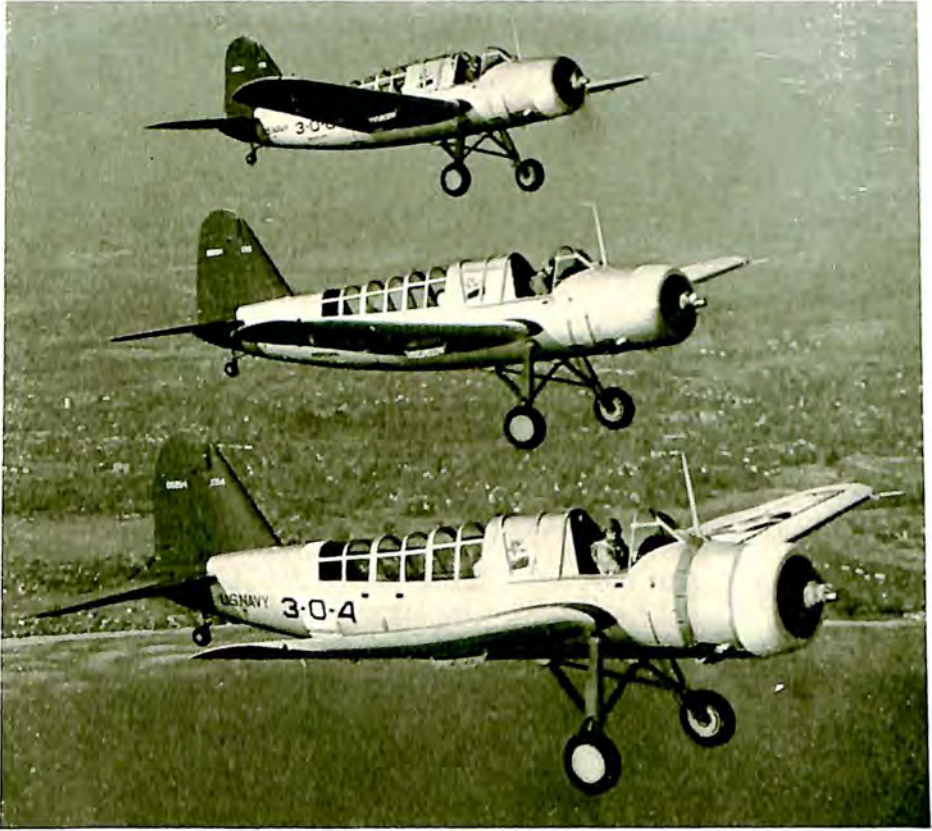
"Naval aircraft assigned to the Fleet participated in all Fleet problems and tactical exercises during the fiscal year 1940. The aircraft carrier 'Ranger' with her squadrons was transferred to the Atlantic Squadron on July 1, 1939. The air group for the 'Wasp,' was commissioned on July 1, 1939, and the 'Wasp' was commissioned in April 1940.

"The accident record of naval aviation during the year continued its decline. The fatality rate was the lowest on record and was only one-half of the rate for 1939. The Naval Aeronautic Organi-



CURTISS SB<sub>2</sub>C-1 DIVE BOMBER

New two-place dive bomber for the U. S. Navy air forces produced by the Curtiss-Wright Corporation's Curtiss Airplane Division at Buffalo, N. Y. It is powered by a 14-cylinder Wright Cyclone engine and a Curtiss electric propeller.



#### VOUGHT-SIKORSKY OS<sub>2</sub>U-1 SCOUTS

They are powered by Pratt & Whitney Wasp Junior engines.

zation suffered the same number of fatalities as it did 16 years ago in 1925. However, 10 times as much flying was accomplished during 1940.

“Shore station development of aviation facilities has increased more during this fiscal year than ever before. Funds from regular appropriations for use on existing stations have been larger; and to supplement this Congress appropriated funds to start the development of new aviation stations in accordance with the Hepburn Board recommendations. In addition to the above, eight new small operating bases were developed along the Atlantic seaboard for use of the neutrality patrol squadrons in accordance with the President’s limited emergency program. WPA funds have also been used to good advantage in places where labor has been available.

“There are shown the amounts of the appropriation “Aviation,

Navy" for the fiscal years 1938, 1939, and 1940. The sum of \$111,459,000 shown for 1940 consists of a regular appropriation of \$82,798,000, and a supplemental appropriation of \$28,661,000. The latter was provided to cover the cost of neutrality patrol operations and additional training planes for Pensacola.

	1940	1939	1938
Navigational, Photographic, Aerological & Radio Equip- ment .....	\$ 1,850,800	\$ 968,700	\$ 750,000
Maintenance and Operation Aircraft and Air Stations.	30,689,200	19,069,800	18,796,000
Experiments and Develop- ment .....	9,500,000	2,003,500	4,768,000
Aircraft Construction .....	69,419,000	24,633,000	27,186,000
Rigid Airship .....	—	500,000	—
Total, "Aviation, Navy"	\$111,459,000	\$48,075,000	\$51,500,000

"During the fiscal year 1940, as compared to 1939, the number of hours flown in the Fleet increased 24.4 per cent. The number of hours flown ashore increased 18.7 per cent. This increase was due mainly to the increase of student flying at Pensacola. This gives a combined increase in 1940 of 22.2 per cent over the hours flown in 1939.

"A project has recently been assigned to the Naval Aircraft Factory, to study the application of various plastic materials to air-plane structures. This undertaking is to be carried out in cooperation



U. S. Navy photo

THE AIRCRAFT CARRIER "WASP"



U. S. Navy photo

#### THE CONSOLIDATED PB<sub>2</sub>Y-2

Long-range four-engine patrol bombers in production for the U. S. Navy.

with several industrial concerns. Static test wing panels of prototype airplanes, and of wood-plastic construction, are being procured from a number of aircraft firms. These structural assemblies will be tested by the Naval Aircraft Factory and the results compared with those obtained on the equivalent metal structures.

"The improvement and development of equipment and accessories for use on naval vessels for the launching, arresting and operation of aircraft has shown marked progress in keeping with the increasing requirements.

"To augment the tender facilities for patrol planes, 11 additional destroyers are being converted to small seaplane tenders. Two large seaplane tenders, 'Curtiss' class, and four small seaplane tenders, 'Barnegat' class, are under construction. Authorization for 10 small and three large seaplane tenders is covered by recent legislation.

"The 'Wasp' was commissioned on April 25, 1940, and the 'Hornet' is under construction. Authorization for 11 additional aircraft carriers is covered by recent legislation. Aircraft equipment has been provided on the light cruiser 'Helena.' Aircraft equipment is under construction for eight new battleships and two light cruisers. Aircraft equipment will be required for two additional battleships, four heavy cruisers and 11 light cruisers in the new construction program.

"The last year has been especially productive in the standardization of Army-Navy aeronautical equipment and materials as a

result of the activities of the Permanent Working Committee of the Aeronautical Board, and this work continues to progress at a highly satisfactory rate. Under the direction of this committee, there have been issued as joint procurement documents a total of 60 specifications and 23 Army-Navy standard drawings. These specifications and drawings are being used as such for procurement purposes by both the Bureau of Aeronautics and the Army Air Corps, with the result that procurement and stocking problems of both services are being materially simplified as the scope of this work extends.

"Screw threads, parachute silk, steels and aluminum alloys of various types, aircraft fuels and engine accessories, are examples of some of the more important items which have been standardized today. An outstanding accomplishment has been the preparation and issue of joint documents in the form of general specifications for engines and model specifications for engines, as well as specifications covering the type and acceptance tests thereof.

"Satisfactory materials for sealing fuel and oil tanks against gunfire have been developed, various systems of camouflage have been devised, more efficient emergency rations have been developed, magnesium, because of its light weight, has been introduced to an increasing extent in naval aircraft for various applications, substitute materials have been given special attention, particularly materials



THE GLENN L. MARTIN PMB-1

These new 20-ton long-range flying boats are in production for the U. S. Navy. The PMB-1, designed to scout far in advance of the Fleet, has two Wright cyclone engines with Curtiss electric propellers, and carries seven in its crew.



U. S. Navy photo

#### NAVY GRUMMANS IN FLIGHT

They are fighters stationed in the West Coast area.

which could be used in lieu of silk for parachute purposes. As a result of excellent cooperation from the producers of synthetic silk, at least two materials will shortly be available in production quantities which appear at least equivalent and in some properties superior to those of imported silk. Corrosion control is still given every possible attention, and as a result of superior protective coatings, better design and manufacturing procedures and improved maintenance in service, problems of this nature have become less serious than they were heretofore, in spite of severe operating conditions. Improved wing de-icing equipment, light weight heaters for flying boat hulls and cockpits, electrically heated flight clothing, are some of the more important equipment projects of the nature under the cognizance of the Bureau. All are either in the service test stage or have been adopted for general use.

"The year has been marked by rapid advances in aircraft armament resulting from the activities of aircraft in the European war. While the Bureau of Ordnance has cognizance of all aircraft armament material with the exception of built-in equipment and minor accessory items, the Bureau of Aeronautics has, in cooperation with the Bureau of Ordnance, fostered the improvement of the armament of naval aircraft along the following lines:

"(a) Modernization and improvement of armament installations in existing fleet aircraft.

“(b) Incorporation in aircraft under construction of new designs in gun and bomb installations, a general increase in the caliber and number of guns carried, and improved new sighting methods.

“(c) Design and development of new and more effective aircraft weapons and accessories.

“The policy of obtaining production prototypes by inviting contractors informally to submit proposed designs in accordance with type specifications prepared by the Bureau has been continued. It has been possible in one case to place an order for two airplanes to a particularly promising design, thus providing a duplicate airplane with which to accelerate testing and insuring against total loss due to accident and loss of time while development work is under way. For the first time in recent years, contracts have been placed for step-by-step development of specially selected aircraft of great promise but of sufficiently unconventional nature to class them as other than production prototypes in their present stages of development. Many contracts have been placed for major assemblies intended for experimental use on service aircraft, such as wings of plastics, stainless steel and magnesium alloy, improved floats for



U. S. Navy photo

THE AIRCRAFT CARRIER "SARATOGA"





U. S. Navy photo

#### VOUGHT-SIKORSKY F4U-1 FIGHTER

A single-seat shipboard fighter with Pratt & Whitney Double Wasp and Hamilton Standard Hydromatic propeller.

seaplanes, folding wings for small carrier aircraft and wings incorporating special provisions for de-icing and special devices for increased lift, reduced drag and greater controllability at low speeds. During the year, two experimental VSO aircraft equipped with air-cooled in-line engines reached the stage of flight tests, as well as three experimental fighters, and various important modifications and improvements to existing models, particularly in the field of patrol-bombers.

"The outstanding feature of the last year has been the considerable increase in the number of new types of military and naval engines brought out during the year, and the entry of more manufacturers, giving a greater dispersion of manufacturing activities. The majority of these types were designed with the purpose of reducing the frontal area of the engines, making them more compact and reducing the weight per horsepower. The experimental designs give great promise both for sea level take-off and high altitude performance. With the funds available it has been possible to explore the possibilities of many attractive designs heretofore neglected. Development of service types has produced a substantial

increase in power output and reduction of fuel consumption at cruising powers and speeds with the same reliability and ruggedness that has been a feature of naval aircraft engines for years.

"The same activity and interest in the accessory field has resulted in many new and desirable items of equipment reaching a production status. Among these are auxiliary power plants, devices for easier starting in cold weather and better magnetos and carburetors which remove the hazard of icing in cold weather.

"The use of some dimensional and performance requirements in the procurement of material by both services under the common Army-Navy specification has resulted in definite economies in all phases of aircraft power plant work as well as stepping up production capacities. The specifications now include accessories, lubricants and fuels, as well as the power plant proper.

"The Naval Aircraft Factory has continued the production of the R-760 training plane engines and development work on other types. The Aeronautical Engine Laboratory, which is the activity concerned with calibration, type and endurance testing of aircraft engines and accessories, has continued to keep up its usual standards under considerable difficulty during the expansion of the laboratory.

"Considerable progress has been made in propellers since the recent introduction of hollow steel propeller blades, hydromatic propeller hubs, and other devices which will permit absorbing the large powers of future aircraft engines.

"The continuation of the long range fuels and lubricant research



U. S. Navy photo

#### CURTISS SO<sub>3</sub>C-1 SCOUT OBSERVATION

Designed to serve as the "eyes of the U. S. Battle Fleet," it is powered with a 12-cylinder Ranger inverted V-type engine.



U. S. Navy photo

#### BREWSTER FIGHTER-BOMBER

The SBA-1, Export Model 138, powered by a Wright Cyclone engine, and built for the Navy.

and development program has resulted in products more suitable for the aircraft engine, bearing definitely in mind the possible demands on production facilities in emergencies. This work has been done in collaboration with the representatives of the industry, with the cooperation of the Air Corps.

"The types of instruments which are powered, or in which the indication is transmitted electrically rather than hydraulically or pneumatically, continue to increase. Indications from four flight instruments have been combined on one dial experimentally. This arrangement is of marked assistance in instrument flying. The accuracy of drift sights has been materially increased by recording, averaging attachments. The general trend is toward automatic or semi-automatic instruments which reduce the work load on the flight crew.

"The small group of non-rigid airships at the Naval Air Station, Lakehurst, has been operated on a more ambitious level than heretofore, with gratifying results. Especially noteworthy have been the simulated patrol exercises and participation in various exercises with submarines, where the ability of airships to keep water areas under close scrutiny are proving valuable. Notable improvements in methods of mooring and re-fueling non-rigid airships, both on shore and on the water, have been effected."

Among Admiral Towers's recommendations were the following:  
 "The United States is entering a new period of intense competi-

tion in the aviation field, with emphasis on combatant aircraft. Important as is the necessity for accelerating production, we must not fail to realize that while we are catching up with foreign nations in productive capacity there is danger that lack of emphasis on development and experimentation may leave us with aircraft inferior to those of foreign countries which are able to concentrate on this phase. Funds allocated for experiments and development cover not only experimental airplanes and engines but also vital airplane accessories and aeronautical material of every category. It is essential that increases in facilities and funds for experiments and developments be provided, and that there be no diminution of effort in this important field.

"The situation with respect to patrol plane tenders has improved due to conversions completed and pending. Continue progress completely to offset the present deficiency and to ensure for patrol squadrons the mobility and flexibility of operation of which they are capable.

"Utilize training facilities existing and in prospect to maximum capacity in order to alleviate the existing shortage of naval aviators and to meet the demands of the expansion program.

"Continue close cooperation with the National Defense Council, the Army Air Corps, and the manufacturers of aircraft to ensure the rapid procurement of suitable aircraft.

"Accelerate and simplify the procurement of civilian personnel in both the Bureau and field services in order to proceed with the maximum efficiency in the Defense Program.



THE SPARTAN NS-1

A two-place trainer produced by the Spartan Aircraft Company at Tulsa, Okla., and powered by a 220 h.p. Lycoming engine.

"Actively pursue the shore station development program.

"Pursue a moderate airship building program and continue training personnel in non-rigid airships."

The Navy in 1940 made many awards and citations for meritorious achievements by aircraft personnel. Included were:

The Rear Admiral William A. Moffett Memorial Trophy to the aviation unit of the U.S.S. Phoenix for conducting its operations with the maximum of safety.

The trophy of the Daughters of the American Revolution to the aircraft carrier "Ranger" for excellence in anti-aircraft gunnery.

The Distinguished Flying Cross to Vernon O. Hatfield, aviation chief machinist's mate; Donald D. McKay, aviation chief machinist's mate; Otto R. Phelps, radioman, second class, and Ensign James H. Eoff (posthumous). The awards to Hatfield, McKay and Eoff were for unusual heroism in saving, or attempting to save, lives of others during flight or after accidents. The award to Phelps was for landing safely a bomber plane after the pilot was thrown out during a dive, even though Phelps was not a pilot.

Silver life saving medals were awarded to John C. Lafferty, aviation chief machinist's mate, and Wilfred F. Johansen, aviation machinist's mate, third class, for their efforts to rescue two comrades who crashed into Pensacola Bay.

Letters of commendation were sent to Captain Raymond E. Hopper and Sergeant Thomas W. Reynolds, both of the U. S. Marine Corps, for extinguishing a fire which broke out in their plane. A letter of commendation was also issued to Lieut. (J.G.) James S. Gray, Jr. for rescuing a comrade from drowning. Gray also assisted in saving another comrade at the same time.



N. A. C. A. 19-FOOT PRESSURE WIND TUNNEL

Used at Langley Field, Va., for testing airplane models at high speeds.

## CHAPTER V

### U. S. GOVERNMENT ACTIVITIES

Bureau of Foreign and Domestic Commerce—Civil Aeronautics Administration—Civil Aeronautics Board—Division of Aeronautics in Library of Congress—Division of Controls—Division of International Communications—Federal Communications Commission—National Advisory Committee for Aeronautics—National Bureau of Standards—Office of Production Management—U. S. Forest Service—U. S. Public Health Service—U. S. Weather Bureau

**N**EARLY all branches of the Federal Government dealing with aviation in one way or another found their work becoming more arduous and exacting under the impetus of the national defense program. Following are interesting details of their more important activities.

#### Bureau of Foreign and Domestic Commerce

All elements of the aeronautics industry are concerned with information from abroad. The functions of promoting the export trade in aeronautic products and the collection, preparation and dissemination of information on aeronautics abroad are charged to the Motive Products Division of the Bureau of Foreign and Domestic Commerce. In its foreign trade informational and promotive work, the Bureau uses the facilities of the Foreign Service of the United States with which the former Foreign Commerce Service was consolidated on July 1, 1939. At home the work is done in cooperation with the many district offices of the Bureau and cooperative offices (in chambers of commerce) in business centers; with the Aeronautical Chamber of Commerce of America, the Air Transport Association of America and other aeronautical organizations, public and private. Monthly figures on aeronautic exports are contained in Statistical Statement No. 2705 while general information on various phases of aeronautic activities abroad is contained in a weekly publication "Foreign Com-



ERCOUCPE MODEL 415C

The two-place private owner plane produced by Engineering and Research Corporation on a flight over Washington, D. C.

merce Weekly." Similar information is disseminated through the trade and daily press, other publications, the Aeronautical Chamber of Commerce of America, correspondence and otherwise. Much information is supplied regularly to other agencies of the Government, as well as to civilian organizations.

#### Civil Aeronautics Administration

Under the Civil Aeronautics Act of 1938, the Civil Aeronautics Authority was established as an independent agency composed of the Civil Aeronautics Authority of five members, the Administrator, and the Air Safety Board of three members. By Reorganization Plans No. III and IV, effective June 30, 1940, issued pursuant to the Reorganization Act of 1939, the name of the five-member Board was changed to the Civil Aeronautics Board and certain of its functions were transferred to the Administrator. The offices of the members of the Air Safety Board were abolished and the functions of the Air Safety Board were transferred to the Civil Aeronautics Board. The Civil Aeronautics Board, the Administrator, and their functions

were transferred to the Department of Commerce, with the proviso that the Board "shall exercise its functions of rule-making (including the prescription of rules, regulations, and standards), adjudication, and investigation, independently of the Secretary of Commerce." The plans further provided that the Administrator of Civil Aeronautics, whose functions would be administered under the direction and supervision of the Secretary of Commerce, and the Civil Aeronautics Board should constitute the Civil Aeronautics Authority.

The Administrator of Civil Aeronautics encourages and fosters the development of civil aeronautics and air commerce; encourages the establishment of civil airways, landing areas, and other air navigation aids and facilities; designates and establishes Federal airways; acquires, establishes, operates, and maintains air navigation facilities along civil airways and at landing areas; makes provision for the control and protection of air traffic moving in air commerce; undertakes or supervises technical developmental work in the field of aeronautics; and plans for the development of aeronautical facilities.

The Administrator also carries out civil aeronautics safety regulation (excepting the prescribing of safety standards, rules, and regulations and the suspension and revocation of certificates after hearing), including (a) effectuation of safety standards, rules, and regulations, (b) examination, inspection, or rating of airmen, aircraft, aircraft engines, propellers, appliances, air carriers, air navigation facilities and air agencies, (c) issuance of various types of safety certificates, (d) issuance of emergency suspension of safety certificates, and (e) compromise of civil penalties; provides for aircraft



THE GENERAL LIGHT PLANE

A two-place private owner machine with 75 h.p. Lycoming engine.





THE RYAN YO-51 DRAGONFLY

A short range observation plane built for the U. S. Army Air Corps to low-speed specifications.

registration and recordation of title; recommends to the Civil Aeronautics Board proposed standards, rules, and regulations designed to promote air safety; requires notice and issues orders with respect to hazards to air commerce; administers the Civilian Pilot Training Act of 1939; and administers the affairs of the Washington National Airport.

#### Civil Aeronautics Board

The Civil Aeronautics Board, while technically within the framework of the Department of Commerce, appoints and controls all its personnel and performs its work independently of the Secretary of Commerce and the Department. As a result of the reorganization, the Board's activities in 1941 were divided into the following three main categories:

1. Economic regulation, including issuance of certificates of public convenience and necessity, fixing of air mail rates, regulating of passenger and property rates, passing upon mergers and consolidations, and the performance of various other related economic regulatory duties.

2. The prescribing of safety standards, rules, and regulations, and the suspension and revocation of various safety certificates (including pilots' certificates) after notice and hearing.

3. The investigation and reporting of aircraft accidents, a function formerly performed by the Air Safety Board, whose duties were transferred under the reorganization to the Civil Aeronautics Board.

Other activities in connection with government regulation and supervision of civil aeronautics are performed by the Administrator of Civil Aeronautics independently of the Board.

The Safety Bureau of the Board, between its inception, July 1, 1940, and the end of the year, conducted 508 investigations. Nineteen public hearings on aircraft accidents were held, five of them for air carriers.

Shortly before the end of the year the analysis section of the Bureau added personnel to enable it to pursue special safety studies. Surveys dealt with collisions in non-air-carrier flying, propeller feathering incidents in air-carrier operation, propeller failures in non-air-carrier operations and accidents in which student pilots were carrying passengers.



THE GLENN L. MARTIN SELF-SEALING TANK

The metal covering shows the holes made by heavy machine gun fire, yet the rubber seals prevent leakage of gasoline, without a drop of seepage.



#### BREWSTER 339 FIGHTERS

Built for the Netherlands East Indies Air Force, they are powered by 1,200 h.p. Wright Cyclones and Curtiss electric propellers.

#### Library of Congress

When the Division of Aeronautics was started in 1930 there was in the Library of Congress an accumulation of aeronautic books, perhaps three thousand volumes. With money available from the Guggenheim fund several private aeronautical libraries were purchased from Maggs Brothers of London. One of these, the Tissandier Collection, brought together by the brothers Tissandier, noted French aeronauts, was recognized as the finest collection of its kind in existence. Others were the Hoernes and the Silberer collections, of Austrian origin. At the same time the Smithsonian Institution deposited in the Division of Aeronautics the Langley Aeronautic Library. Through these acquisitions the collection was at once made preeminent in material relative to the history of aeronautics. It now has about 25,000 books and pamphlets.

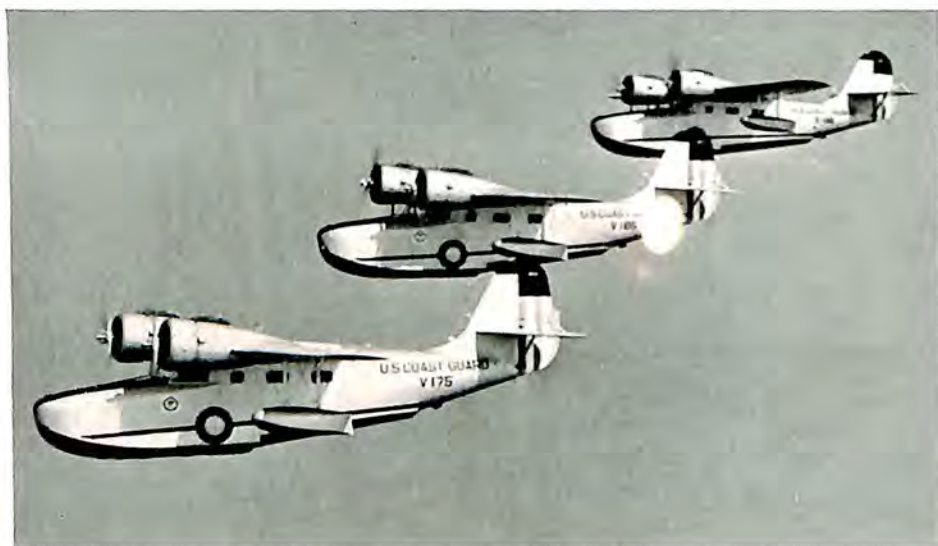
### Division of Controls

The Division of Controls of the Department of State continued to administer the registration and licensing provisions of the Neutrality Act approved November 4, 1939. These provisions require that all persons engaged in the business of manufacturing, exporting or importing any of the articles or materials enumerated in the President's proclamation of May 1, 1937, shall register with the Secretary of State. A separate license is required for each individual export and import shipment, and such licenses may be issued only to those persons who are duly registered with the Secretary of State in accordance with the provisions of the Neutrality Act. An additional provision of the Neutrality Act stipulates that each application for a license to export or import shall be accompanied by a statement of the terms of sale involved in the particular transaction. The articles listed in the proclamation of May 1, 1937, include aircraft of all kinds, aircraft engines, certain essential aircraft parts, such as wings, hulls, fuselages, propellers, under-carriage units, and tail units, and a number of items of aircraft armament. The Division also issues licenses under the provisions of the Export Control Act approved July 2, 1940. Many additional items of aircraft equipment and materials have been made subject to license by Presidential proclama-



**NORTHROP N-3PB PATROL BOMBER**

It is powered by a Wright Cyclone engine and equipped with Edo floats.



#### GRUMMAN JRF-2 AMPHIBIONS

On duty with the U. S. Coast Guard. They are powered by Pratt & Whitney Wasp Junior engines.

tions and regulations issued pursuant to the provisions of this act. Licenses will not be issued in any case in which it shall have been determined that the proposed shipment would be contrary to the interests of the national defense. Full information in regard to persons registered under the Neutrality Act and in regard to export and import licenses issued is found in the reports of the National Munitions Control Board, of which the Secretary of State is Chairman and Executive Officer. These reports are prepared by the Division of Controls and are presented to Congress on January 3 and July 3 of each year. The value of the aircraft and aircraft equipment licensed for export under the Neutrality Act during the year 1940 was \$672,433,103.11. No statistics have been published concerning the value of the additional items of aircraft equipment licensed under the provisions of the Export Control Act of July 2, 1940.

#### Division of International Communications

The Division of International Communications of the Department of State was created on August 19, 1938, in order to meet more effectively the steadily increasing problems which confront the United States in the field of international communications. The functions of the Aviation Section include the negotiation of international agreements on such subjects as air navigation, the operation of air trans-

port services, the reciprocal issuance of airman certificates and the reciprocal recognition of certificates of airworthiness for export, as well as agreements on various phases of international air law. The Aviation Section is in charge of the technical work connected with participation in international aviation conferences and in the activities of international aeronautical organizations such as the International Technical Committee of Aerial Legal Experts (CITEJA) and the Permanent American Aeronautical Commission (CAPA). The Aviation Section makes arrangements for flights of United States civil and military aircraft over foreign countries and for flights of foreign civil and military aircraft over the United States, and is charged with certain other miscellaneous duties pertaining to various phases of international aviation.

#### Federal Communications Commission

In connection with its specific duty to promote "safety of life and property," the Federal Communications Commission allocates frequencies for the use of aviation, and licenses radio-equipped aircraft. Assignment of all frequencies for Federal use is by means of Executive order of the President, upon the advice of the Interdepartment



THE GLENN L. MARTIN PMB-1 IN FLIGHT

One of the Wright Cyclone-powered U. S. Navy long-range patrol boats produced by The Glenn L. Martin Company at its Middle River plant near Baltimore, Md.



U. S. Army photo

#### AN AIR CORPS BEECHCRAFT

High altitude photographic ship built by the Beech Aircraft Corporation at Wichita, Kans. The plane is powered by two Wasp Junior engines.

Radio Advisory Committee. In addition to the Civil Aeronautics Administration and the Federal Communications Commission, at least five other Government units are interested in aviation—namely, the State Department, War Department, Navy Department, Treasury Department (Coast Guard) and Commerce Department.

The Federal Communications Commission exercises jurisdiction over all non-Federal aircraft radio, including international flights originating or terminating in this country. Regularly established transatlantic and transpacific flights are made possible by coordinated radio contact systems en route. Technical advances justified the Commission making available new frequencies in 1940, and licensing on a regular basis certain classes of aviation stations previously authorized for experimental purposes only. To facilitate communication between planes in flight and ground points, two new types of station were provided. Public service aircraft stations, located on planes, were licensed to handle two-way conversations with public service aeronautical stations, located on the ground along air routes. The nearest ground station feeds the conversation into the telephone wire system and back. Thus plane passengers while in flight may talk directly with ordinary telephone subscribers. The ultra-high frequencies are particularly useful for developing this type of service.

Public service aircraft stations on transport planes engaged in transoceanic service are authorized to operate on frequencies available to ship-telephone and ship-telegraph stations for the handling of public communications in the same manner that ships engage in such service. The effect is that ocean-crossing aircraft are in the same category as ocean-going vessels.

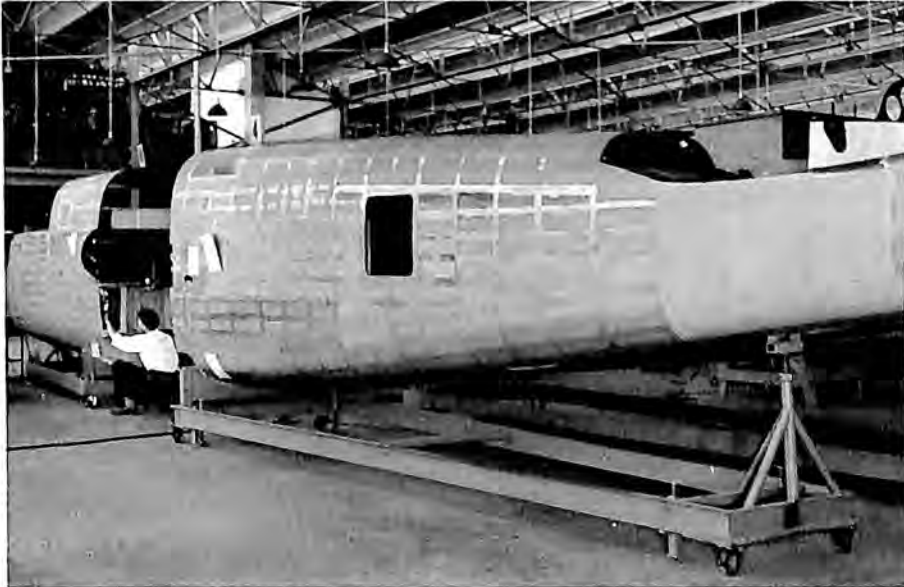
During 1940 the Commission amended its rules and regulations

in a number of instances to meet the convenience of the aviation industry. The two chief changes were the provision for the use of ship telephone frequencies for safety purposes by aircraft flying over the sea, and moving the expiration date of non-scheduled aircraft licenses from April 1 to August 1.

#### National Advisory Committee for Aeronautics

The National Advisory Committee for Aeronautics, through fundamental research, had in progress many investigations calculated to add something in speed, maneuverability, load capacity, range, safety or economy of American airplanes for the defense program. The main Committee had the assistance of strong technical subcommittees composed of specialists in their respective fields. For example, the aerodynamics subcommittee prepared the research programs and followed the work at the N.A.C.A. Langley Laboratory, Langley Field, Va., and at its Ames Aeronautical Laboratory at Moffett Field, Calif. At both laboratories wind tunnels of unusual characteristics had been developed for solving the problems incident to aeronautical research.

Flight research on the flying qualities of airplanes in 1941 was augmented by investigations carried out in a new 12-foot free-flight



#### NORTH AMERICAN BOMBER CONSTRUCTION

After leaving the master jig, fore and aft sections of the B-25 bomber move down the assembly line on mobile cradles.





#### N. A. C. A. 12-FOOT FREE FLIGHT WIND TUNNEL

At Langley Field, Va., it is in a steel sphere 60 ft. in diameter supplied with compressed air up to two or more atmospheres. The tunnel is mounted on a steel framework inside the sphere, and has a test section diameter of 12 ft. and length about 30 ft.

wind tunnel used for the study of the stability and control of airplane designs. In addition, a 15-foot free-spinning wind tunnel was being used in the investigation of spinning characteristics of new designs. Coordinated with the stability and control tests of these various wind tunnels, a flight-research laboratory checked the agreement of results with actual flying conditions.

Tests of military airplanes in the Committee's full-scale tunnel over the past several years demonstrated the extreme importance of

aerodynamic refinement as applied to even the smallest details. The gains due to the refinement of any one detail might not be large, but the over-all effect of applying the results of basic research to each detail in turn might, when taken together, produce surprising results.

One of the subcommittees reporting to the Aerodynamics Committee was that on propellers. Force tests were conducted on full-scale propellers, and analyses of propeller losses were made from data obtained in the N.A.C.A. 20-foot propeller research tunnel. As the compressibility effect on the propeller was beginning to appear as a serious obstacle to further gains in high-speed performance, improved blade sections were constantly being developed in the high-velocity jet-type wind tunnel of 24-inch throat diameter. Further study of this effect was carried on in the 11-inch high-speed tunnel, until in 1941 it became necessary to use the eight-foot 500-mile-per-hour wind tunnel to extend the investigation. A new 19-foot pres-



British Air Ministry photo

#### LOCKHEED HUDSON ON A RAID

This photo was taken during a raid of five Lockheed Hudsons over the Heligoland Bight area. Here the navigator peers at the island of Sylt, seven miles on the starboard bow.



British Air Ministry photo  
LOCKHEEDS AT DUNKIRK

The Lockheed Hudsons of the British Coastal Command participated in the evacuation of Dunkirk.

sure tunnel, which was put into operation during 1940, provided an excellent means of separating certain effects of Reynolds number and compressibility.

The subcommittee on seaplanes followed investigations in the 2,900-foot seaplane-towing tank at Langley Field which was used almost continuously for the study of specific models submitted either by the military services or by seaplane manufacturers. A second seaplane-towing tank and an impact basin were planned to provide additional research facilities. The scope of the work covered included the development of improved forms of hulls for flying boats.

Work also was carried on in extension of existing rotor theory in accordance with the program of the subcommittee on rotating-wing aircraft.

Although the greater part of the work under the cognizance of the subcommittee on vibration and flutter was in theoretical analysis, a large number of flutter tests were made on models in the eight-foot high-speed tunnel. These investigations included tests showing the

effect of compressibility upon flutter speed up to 500 miles per hour.

The investigations of the gust structure by an instrument known as the "V-G recorder" was extended to determine the variations both with altitude and with direction. An instrument called the "G-Altitude recorder" was devised to obtain data at the high altitudes being reached by new aircraft. Further investigation in gust structure was made possible by the procurement of an Army stratosphere airplane and the necessary radiosonde equipment for making high-altitude soundings.

The special subcommittee on lightning hazards to aircraft was organized under the subcommittee on meteorological problems. Data were being accumulated from air transport operators by means of a questionnaire on incidents of lightning strikes to airplanes with a view to obtaining more information as to the extent to which electrical phenomena constitute serious hazards to aircraft in flight.

A new special subcommittee on de-icing problems was formed to consider the problems incident to the operation of airplanes in regions where atmospheric conditions were conducive to the formation of ice on exposed surfaces. The most promising work on this problem was in the investigation in flight of the use of exhaust heat for ice prevention on wings. The facilities of the National Bureau of Standards for aerodynamic research were used effectively in advancing the N.A.C.A. research programs. Attention was given to practicable



ONE OF THE NEW WRIGHT ENGINE PLANTS

The magnesium section of Plant 3 of the Wright Aeronautical Corporation at Fairlawn, N. J.

STEARMAN NAVY TRAINERS—N<sub>2</sub>S-1

methods of reducing the turbulence in existing wind tunnels, principally by means of portable hot-wire equipment.

Research projects of the various subcommittees of the committee on aerodynamics might be prosecuted by means of the facilities already mentioned, or in additional equipment consisting of a five-foot variable-density wind tunnel, a refrigerated wind tunnel with a throat  $7\frac{1}{2}$  feet by three feet and a new two-dimensional-flow wind tunnel. Under construction at Langley Field in 1941 were a stability wind tunnel, a 16-foot high-speed wind tunnel, and a 20-foot free-spinning wind tunnel. At the Ames Aeronautical Laboratory several structures were completed, and others were under construction.

To remedy the deficiency in national engine-research facilities, the construction of a third major research station for the Committee was authorized. The site adjoined the municipal airport at Cleveland, O., and there the Committee was constructing an aircraft engine research laboratory. The staff at Langley Field concerned with power-plant research was to be moved to the Cleveland laboratory.

A special subcommittee on welding problems was authorized.

Structural research was conducted under the supervision of the committee on aircraft structures, fourth of the main technical committees. It was concerned with both the theoretical and the experi-

mental approach. A new structures-research laboratory was erected at Langley Field, where provision was made for large-scale testing equipment to be employed on research work. Examples of the type of theoretical problems taken up were rib design, design of diagonal-tension beams, stress distribution in monocoque structures and instability in various types of structural members.

An extended study on structural loads on airplanes was instituted in cooperation with the Civil Aeronautics Administration, through a program of installing N.A.C.A. "V-G Recorders" in many large airplanes and in some types of smaller airplanes as they were produced and put into service. The gust tunnel at Langley Field was particularly useful for measuring loads on airplane structures, and research was conducted on a gust-alleviating flap to examine the possibilities of decreasing vertical accelerations of the airplane. An airplane model with a flexible wing was used to investigate wing stress according to the damping obtained. Impact loads on seaplane hulls when landing in rough water were evaluated for large flying boats.

In 1940 a coordination office was set up in the Committee's headquarters in Washington, and provisions made for a resident coordination representative on the West Coast. In order to maintain close contact with manufacturers and to keep in touch with organizations,



#### LYCOMING ELECTRIC "BREAK IN" STAND

Battery of electrical running stands for breaking in 65 and 75 h.p. engines on a "cold run in" period of six hours—at the plant of Lycoming Division, Aviation Manufacturing Corporation, Williamsport, Pa.



#### A CONSOLIDATED FLYING BOAT FOR BRITAIN

These Twin Wasp-powered PBY patrol boats were going to England in increasing numbers.

Governmental and private, that operate research facilities, the coordination staff visited manufacturers and universities in all parts of the country where anything of significance in aeronautical progress was under way. Reports coming to the N.A.C.A. laboratories from the coordination staff in the field were extremely valuable in providing closer contact between the research personnel of the National Advisory Committee for Aeronautics, scientific and educational institutions and the aircraft and allied industries.

#### National Bureau of Standards

The National Bureau of Standards continued its studies of wind-tunnel turbulence and of flow in boundary layers in cooperation with the National Advisory Committee for Aeronautics. With the development by the N.A.C.A. of new airfoils of extremely low drag the question of wind-tunnel turbulence assumed even greater importance than before. Accordingly, much attention was given to practicable

methods of reducing the turbulence in existing wind tunnels. In cooperation with the Langley Field staff of the N.A.C.A. measurements were made of the longitudinal and transverse components of turbulence in a number of wind tunnels and in flight by means of portable hot-wire equipment. The flight results indicated that the small-scale turbulence of the atmosphere was substantially zero and hence that wind tunnels should have as low a turbulence as possible.

A study of boundary-layer phenomena at low turbulence levels on a thin, flat plate, parallel to the wind direction, was continued. Particular attention was given to the detailed study of the transition region under conditions of the lowest turbulence in an effort to obtain a more fundamental understanding of the process. Measurements and photographic records were obtained of the longitudinal and transverse components of the turbulent fluctuations parallel to the plate. There was a steady development of improved equipment for use in turbulence measurement. As a result, mountings were made available for making measurements within boundary layers that are free from spurious results due to vibration.

The following investigations on aircraft structures were in progress early in 1941: (a) The development of the pack test led to the accumulation of a large amount of data on compressive, as well as tensile, properties of thin sheet metal for aircraft; (b) the program on static tests of flush-riveted joints was extended to include single-rivet and multiple-rivet joints fabricated by the principal aircraft manufacturers, each manufacturer using his own type of joint and



STEARMAN ARMY TRAINER

One of the PT-13-B trainers for the Air Corps. It is powered by a Lycoming R-680-11 engine.





VULTEE VANGUARD 48

An interceptor pursuit with Pratt & Whitney Twin Wasp engine.

riveting technique; (c) data on the increase in strength with aging up to two and one-half years of riveted joints and rivet wire were acquired as a byproduct of the investigation of riveted joints; (d) the second portion of the program on high-strength chromium molybdenum steel tubing of the type used in landing gears was completed by tests of 15 tubes with D/t ratios from 12 to 34 under combined axial and bending loads; (e) the program of normal pressure tests of flat plates was completed with a report of rectangular plates. All results for rectangular plates with clamped edges could be plotted on a dimensionless basis to give an empirical relation between the washboarding pressure (the pressure at which yielding begins), the dimensions of the plate, and the tensile properties of the material; (f) end compression tests were carried out on six spot-welded aluminum-alloy sheet-stringer panels, identical except for variation in spot-weld spacing from one-half to four inches between centers. Three panels failed by stringer instability at the predicted stress; (g) the second and third portions of the program of tests on monocoque boxes were completed with a stress survey of a monocoque box specimen under pure bending loads and cantilever bending loads; (h) axial fatigue tests of wing beams by the resonance method were continued with tests on additional specimens.

Exposure tests of aircraft metals in sheet form were continued. The tests covered commercial aluminum and magnesium alloys and various chromium-nickel ("stainless") steels under conditions of continuous exposure in a marine atmosphere, and in atmospheric exposure with intermittent wetting with sea water at high tide. A general report summarizing results of exposure tests covering a period of 10 years was published in the Bureau's Journal of Research. That por-

tion of the current exposure tests covering welded and riveted joints in the light alloys yielded very definite and useful information as to the combination of metals which must be avoided in assembly work, both in the regular assembly joints and in the attachment of auxiliary parts to the main structure.

In the exposure tests of sheet stainless steel, an exact rating was obtained by flexural fatigue tests of specimens of the material in its initial state, and of companion specimens taken from the exposed sheet material. By that means it was possible to evaluate quite accurately the relative corrosion damage on different stainless steel compositions and also to differentiate between the corrosive effects in different environments.

The second report in this investigation, summarizing the data on the effect of plastic deformation (cold working) and of heat treatment on the tensile elastic properties was in preparation. The beneficial effect of heat treatment on stainless steel, especially with respect to its elastic properties, was especially noteworthy.

The effect of subzero temperatures (down to  $-78^{\circ}$  C.) upon the tensile properties, hardness and impact resistance of metals commonly used in aircraft construction was determined. The materials were divided into three general groups: (1) Ferritic steels, (2) austenitic stainless steels and nickel alloys, and (3) light metal alloys having an aluminum or magnesium base. None of these properties of any of the materials tested was adversely affected by low temperatures, with the exception of the impact resistance of the ferritic steels, a decrease in resistance as the test temperature was lowered being characteristic of these alloys.

The experimental work on the development of reinforced plastics for aircraft construction proceeded along three main lines.



THE INTERSTATE CADET

Model S-1A, a tandem trainer with 65 h.p. Continental engine.



#### BOMBER PRODUCTION SPEEDS UP

This is a view of a corner of the Consolidated plant at San Diego where about 30 per cent of manufacturing operations were carried on outdoors. Here an increasing number of long-range, four-engine B-24 bombers are in various stages of construction.

The first involved the synthesis of phenolic resins from various raw materials, such as phenol, cresols and xylenols on the one hand, and formaldehyde, acetaldehyde and furfural on the other, and determining the relationship which exists between the composition and the properties of those resins. It was observed in the Bureau's work with birch veneers that the maximum strengths were obtained when the modulus of elasticity of the resin binder was similar to that of the wood. Because that also should be true of other types of laminated products, this work on the properties of pure synthetic resins should make possible the selection of resins suitable for use with whatever type of reinforcing agent was found to be desirable in molding aircraft structures.

The second phase of the program was the further investigation of reinforcing materials. Various types of paper, cloth, wood veneers, fibers and thin metal wires and sheets were made up into laminated panels, the properties of which were determined. Optimum arrangement of the elements in a composite structure and determination of the minimum temperatures and pressures to obtain proper bonding together of the reinforcing agents were the ultimate objectives of this work. Commercial resins and resins synthesized in the Bureau's laboratory were being used.

The third phase involved the determination of the pertinent physical properties of reinforced plastics which seemed promising as materials for aircraft construction. Materials from commercial sources as well as those prepared in the Bureau's laboratory were examined. The properties measured included tensile, compressive and flexural

strength; moduli of elasticity in tension, compression and flexure; shear strength; impact strength; bearing strength; water absorption; and specific gravity. Particular attention was given to determining the moduli of elasticity and the coefficients of thermal expansion of the resins and reinforcing agents, in order that these materials might be matched up as closely as possible with respect to these properties.

#### Office of Production Management

The Office of Production Management grew out of advisory agencies set up for the defense program. On May 28, 1940, under powers allotted by a 1916 statute, President Franklin D. Roosevelt appointed the National Defense Advisory Commission (N.D.A.C.) to supervise the defense program. As the name implied, N.D.A.C. was advisory in character. It carried weight but, as time went on, need for an administrative mechanism developed. So the President, early in 1941, acting under an administrative order of May 25, 1940, created the Office of Emergency Management (O.E.M.) To this office were delegated certain executive powers of the President, and on Feb-



#### DOUGLAS PRODUCTION FOR DEFENSE

A corner of the Douglas plant at Santa Monica, Calif., showing work on some of the fuselages of bombers for the U. S. Army Air Corps and British Royal Air Force.



#### FUSELAGE ASSEMBLY AT BELL PLANT

Work on the increasing output of Bell Airacobra pursuit planes is an important activity in the defense program.

ruary 28, 1941, President Roosevelt reallocated to O.E.M. funds which had been made available to N.D.A.C. for administrative and operating expenses. Thus, legal authority and funds were given to the guiding body of the country's mammoth defense program.

As the O.E.M. gradually took over the functions of the N.D.A.C., need for the latter agency decreased. By late Spring in 1941, virtually all of N.D.A.C.'s divisions had been transferred to O.E.M. Thus O.E.M. stood watch, directly under President Roosevelt, over the national defense effort.

The membership of the original N.D.A.C., with functions assigned, were: Ralph Budd, Transportation; Chester Davis, Agriculture; Dean Harriet Elliot, Consumer Protection; Leon Henderson, Price Stabilization; Sidney Hillman, Labor; William S. Knudsen, Industrial Production; Edward R. Stettinius, Jr., Industrial Materials.

As O.E.M. took over N.D.A.C. functions most of the members were transferred to the new agency. Heads of several collateral N.D.A.C. divisions, created as the need developed, also transferred their units to O.E.M.

From the beginning of N.D.A.C., and through the transition of O.E.M., the division headed by William S. Knudsen had one of the heaviest immediate jobs, that of planning and stimulating actual output of war weapons.

Simultaneously with the creation of O.E.M., the Office of Production Management (O.P.M.) was established to take over all the problems connected with production. Mr. Knudsen was appointed Director General. Mr. Hillman, N.D.A.C. Labor Division chief, was named Associate Director General. In addition to Messrs. Knudsen and Hillman, the Secretaries of War and Navy, Henry L. Stimson and Frank Knox were named to O.P.M. as ex officio members.

In the O.P.M. there were set up three main divisions—Division

of Production with John D. Biggers as director; Division of Purchases with Donald M. Nelson as director, and Division of Priorities with Edward R. Stettinius, Jr. as director.

In the Production Division of O.P.M. several sections were set up. To each was given the task of getting production rolling in an assigned field toward the goals set up by the Administration.

Among the most important was the Aircraft Section. Named to head this unit was Merrill C. Meigs, with T. P. Wright as assistant.

The duties of the Aircraft Section were to see that airplanes ordered were produced on schedule; to coordinate British and other foreign orders with those of the U. S. air services and to standardize on types of planes in order to obtain maximum production.

Among the many units in the Aircraft Section were: Engineering, handling engineering and standardization; Production Planning, handling surveys and schedules of production of aircraft, engines, parts and accessories; Manufacturing Unit, handling speeding of production output by anticipating shortages, preventing delays and coordinating activities of prime contractors and subcontractors, passing on approvals of aircraft emergency plant facilities contracts with the War and Navy Departments; and the Facilities Group, handling acquisition of plant facilities for prime contractors and recording available facilities.

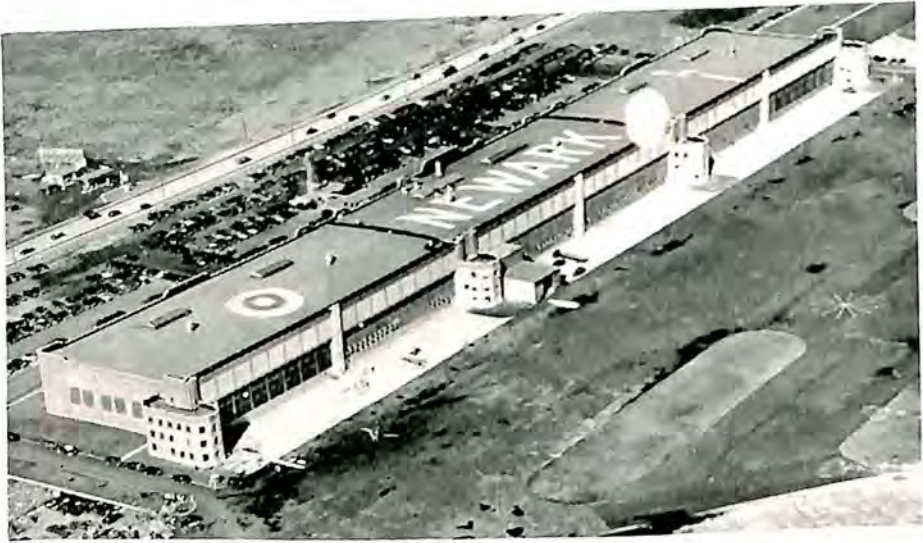
#### U. S. Forest Service

During 1940 the U. S. Forest Service found airplanes not only a practical but a profitable aid in protecting the national forests from fire. Planes turned days into hours and hours into minutes to enable



#### LOCKHEED FINAL ASSEMBLY

Rapidly increasing "production for defense" features the effort at this huge plant in Burbank, Calif.



BREWSTER PLANT AT NEWARK, N. J., AIRPORT

One of the manufacturing units which the company established to play its part in the defense program.

firefighters to reach fires in back country while they were still small and easily controlled. In a series of tests during 1939 the Forest Service developed the equipment, jumping techniques, recruitment standards, and training plans which it used for the first time during 1940 to parachute firefighters from airplanes to actual forest fires. The "smoke jumpers" reached the hard-to-get-at fires and had them under control before a regular crew on horseback or afoot could have made a good start. Savings of time and money resulted from this use of airplanes and parachutes. In a dozen or so fires the average time taken by parachuters was one hour and 41 minutes as compared with the 28 hours which ground crews would have needed to reach the same fire. It cost, on an average, \$247 to control each of these fires—whereas competent fire control men, familiar with the history of similar fires in the past, estimated that the average cost with ground crews would have been \$3,500. This did not include the timber, wildlife, recreation, watershed and other forest values that would have been lost without quick control by the aerial jumpers. Of course, aerial fire control was less economic in forest areas where the road system permitted easy access by truck or pack train.

Here are some specific instances in which smoke jumpers kept down forest fire control costs during 1940: In the Bitterroot National Forest of Montana, four parachutists quickly put out two potentially

large forest fires and the total cost of control was only \$320. On the same day and under comparable conditions, crews which had to travel on foot attacked eight forest fires, also in the Bitterroot National Forest—but it cost from two to seventeen thousand dollars each to put out these fires. Parachute fighters saved \$20,000 that day.

In the Nezperce National Forest of Idaho two parachutists dropped down on a fire that looked bad from above. They held it to two acres—until a 25-man ground crew arrived to smother it. This fire was comparable to the 1934 Packer Creek fire which burned 1,000 acres in the very same area—and cost twelve thousand dollars to control. Compare twelve thousand dollars with five hundred, the cost of control 1940 aerial style.

During the summer of 1940 fire fighters jumped to a fire blazing away in the Chelan National Forest of Washington and had it out in two hours. Unfortunately there were no smoke jumpers available when a lightning fire started in this same country the year before. Fifty of the best men, some on saddle horse and some afoot, had set out immediately on a 12-mile uphill trip to fight the fire. But they didn't get there fast enough and before the last spark was out 800



INTERIOR OF NORTHROP AIRCRAFT PLANT

Showing progress in construction of Northrop N-3PB patrol bombers.





#### RYAN TRAINERS FOR DEFENSE

A corner of the Ryan Aeronautical Company's plant at San Diego, Calif., showing construction of Ryan S-T trainers.

acres were burned, in spite of additional reinforcements of 400 men and several strings of pack horses. That fire cost \$10,000 to control. In 1940, parachutists saved \$7,000 in control costs and much valuable timberland besides.

The 14 smoke jumpers employed in 1940 were all regular forest guards, some having worked for the Forest Service for 15 years. None had previous experience in parachute jumping; yet all were volunteers in this new field. Between jumps they performed their regular duties as forest guards. After the 1940 training they were qualified to serve as parachute jumping instructors on their home forests during 1941. Thus within a couple of years, if funds were made available for this work, the Forest Service hoped to have a force of highly skilled aerial fire fighters, ready for any emergency. Foresters believed the great savings and reduction of losses that would result from this work justified a considerable expansion of the smoke-jumper force.

#### U. S. Public Health Service

The U. S. Public Health Service was most intimately concerned with aircraft and airplane travel in connection with its quarantine functions, designed to keep away from our borders the quarantinable diseases and dangerous insect stowaways, especially mosquitoes, which transmit disease. The rapid development of travel by aircraft

had so reduced distances in time of travel from areas infected by yellow fever and Asiatic cholera that persons might arrive in an American port in the incubation stage of the disease. This was especially true with respect to yellow fever. Unless appropriate meas-



U. S. Public Health Service photo  
**FIGHTING AN AERIAL INVADER**

Before passengers disembark, all mosquitos on board a plane at a port of entry must be killed by a complete spraying. Here an official of the U. S. Public Health Service is using a new sprayer operated by compressed air.



U. S. Public Health Service photo

#### BACK FROM AN ATLANTIC CROSSING

Pan American Airways' Boeing Clipper arrives at Baltimore where a U. S. Public Health quarantine launch comes alongside for inspection similar to that given surface vessels.

ures were taken, airplanes also might bring infected mosquitoes into ports of the United States or mosquito carriers of malaria into Hawaii where malaria did exist.

A few years ago yellow fever was believed to have been practically eliminated; but in 1936 a reservoir of the jungle type of the disease was discovered in Brazil, and in 1940 the infection was present over practically the entire area of South America north of 30° south latitude. Control measures applied to aircraft traffic between North and South America included vaccination of all aircraft personnel against yellow fever, the disinsectization of aircraft at points en route from South American ports and just prior to landing at a United States port, the securing of information regarding the localities visited by passengers before embarkation, and a system of surveillance of passengers, after arrival, for a period to complete nine days from the date of their departure from infected areas.

Those measures were 100 per cent successful. Two or three suspicious cases of illness among aircraft passengers were discovered through the follow-up system, but in no instance was the illness yellow fever.

Mosquitoes very rarely were found on aircraft arriving in this country from South America. During 1940, the spraying, with an insecticide, of planes from the east coast of South America on the water at Port-of-Spain, Trinidad, was initiated, using the new compressed-air operated sprayer in place of the hand sprayer. This improved sprayer, designed by Public Health Service engineers, permitted accurate measurement of the insecticide and provided a finer spray that did not deposit on walls and fabrics. Since the spraying of planes at the Port-of-Spain was put into effect, no live mosquitoes

were found on planes on arrival at San Juan, P. R. Inspection and disinsectizing of planes were carried out on the West Coast and in Hawaii, especially for the purpose of preventing the introduction of malaria mosquitoes into the latter territory. Precautions also were observed with respect to the introduction of Asiatic cholera from the Orient.

During the fiscal year 1940, a total of 5,233 planes, carrying 82,693 persons, arrived at continental and territorial airports of entry from foreign ports. Of these, 2,184 planes and 35,667 persons were inspected by medical officers of the Public Health Service. Of the persons inspected, 11,171 were aliens, and 123 of these were certified as having a disease. The remainder entered under circumstances rendering quarantine inspection unnecessary. Although the number of arriving planes decreased in 1940 (as compared with 5,363 in 1939), the number of persons carried increased from 65,568 to 82,693.

#### U. S. Weather Bureau

The rapid development and expansion of meteorological service to aid air navigation during recent years continued in 1940, being given added impetus in the closing months of the year by the vital necessities of national defense, and plans were made for further expansion and improvement during 1941. On July 1, 1940, there were 864 stations in the Weather Bureau system, rendering meteorological reports for air navigation over approximately 40,000 miles of airways within the United States and its territories. During the latter part of 1940, 24 additional weather reporting stations were established. Also, 25 off-airway stations were changed from six-hourly to three-hourly re-



PRODUCTION OF FAIRCHILD PT-19

Assembly line of Air Corps trainers at the Fairchild plant in Hagerstown, Md.



#### GRUMMANS FOR BRITAIN

The G-36A single-seat fighter produced in quantity for the Royal Air Force. It is powered by a Wright Cyclone engine and Hamilton Standard Hydromatic propeller.

porting stations to provide forecasters with weather trend information necessary in the preparation of special forecasts and warnings in event of sudden changes in weather conditions.

Steps were taken at 14 strategic points to consolidate all Weather Bureau activities at the airport, thereby meeting the increased demands for meteorological service in those areas.

A new airway and general forecast center was established at Boston, Mass., to provide more adequate meteorological service for the New England States and at the same time to permit the forecast and general supervising center at LaGuardia Field, New York, to improve its service to oceanic and inland airways by providing a smaller inland district to be served. In order to provide more adequate meteorological service for the region in which many of the country's aircraft manufacturing industries were concentrated, the airway forecast center at Burbank, Calif., was transferred to Los Angeles, and the district served by the latter limited to Southern California. Expansion and improvement of service rendered in aid of aeronautical operations in Alaska were accomplished by establishing a forecast center at Fairbanks and by increasing from four to seven the number of Weather Bureau stations in Alaska manned by Civil Service commissioned personnel. All seven stations took one radiosonde observation and two pilot balloon observations daily in addition to rendering frequent surface weather observations and providing other necessary services.

Tentative arrangements were made to establish transoceanic forecast centers at Oakland, Calif., and Honolulu, T. H. In cooperation with the Civil Aeronautics Administration plans were laid and instrumental equipment furnished for making pilot balloon observations at Palmyra and Johnston Islands and at French Frigate Shoals in the Pacific Ocean south and west, respectively, of the Hawaiian Islands. To provide increased meteorological service in aid of air navigation over the Pacific Ocean, the number of ships rendering weather reports was materially increased, and plans were made for equipping additional ships to make surface weather observations. Plans were formulated also to equip seven ships in the Pacific for rendering four pilot balloon observations a day. Additional ship supervising centers were to be established at San Pedro, Calif., Seattle, Wash., Portland, Ore., Honolulu, T. H., and in the Canal Zone, to service and equip with meteorological instruments the increasing number of ship reporting stations.

Ship supervisors operating in the Canal Zone were to board ships at either end of the Canal, and utilize the time required to traverse the Isthmus for making necessary repairs and installations of instruments and in training ship personnel to take weather observations. This would permit the servicing of a large number of ships heretofore impossible because their ports of call seldom included points where this service was available.

Ship weather reports from the Atlantic Ocean west of the 35th meridian were increased from two to four a day from each ship, and the number of ships reporting was increased to provide meteorological protection for flights to and from the United States and Europe. In-



U. S. Army photo

#### THE DOUGLAS B-23

A development of the Air Corps B-18 bomber. It was powered with two 1,500 h.p. Wright Cyclone engines.



CURTISS P-40 PURSUIT

It is powered by an Allison liquid-cooled engine and a Curtiss electric propeller.

creased meteorological aid to flights conducted over the Gulf of Mexico and the Caribbean Sea was made possible by the establishment of a first order station at Swan Island, situated in the Caribbean Sea between Cuba and Honduras, to render four synoptic weather reports, two pilot balloon observations, and one radiosonde observation daily. This considerably augmented the service, formerly limited to the hurricane season, at that point. The number of weather reports from vessels plying the shipping lanes in the Gulf of Mexico and the Caribbean Sea also was increased materially in 1940.

The number of pilot balloon observations made to determine wind direction and velocity in the free atmosphere was increased, and at the beginning of 1941 this work had been added to the activities of 29 additional stations in the United States and three new stations in Alaska, making a total of 137 stations making upper air wind observations. At certain selected stations 100-gram balloons, which permitted observations at greater heights, were used instead of the smaller 30-gram balloons. The number of stations using this larger type balloon was increased from 39 to 41. Radiosonde observations, by means of which humidity, temperature and pressure in the free atmosphere were obtained, were inaugurated at five additional stations, making a total of 37 radiosonde stations. Plans were made for the inauguration of pilot balloon observations at Tanacross, Alaska, and, through cooperation with the Civil Aeronautics Administration,

at Ruby and Summit, Alaska. Three synoptic reports were received daily from 25 additional stations, 24 "on-call" stations were changed to hourly or more frequent reporting stations, and 14 additional three-hourly reporting stations were added to the Alaskan network through cooperation with the U. S. Coast Guard, Civil Aeronautics Administration and the Office of Indian Affairs.



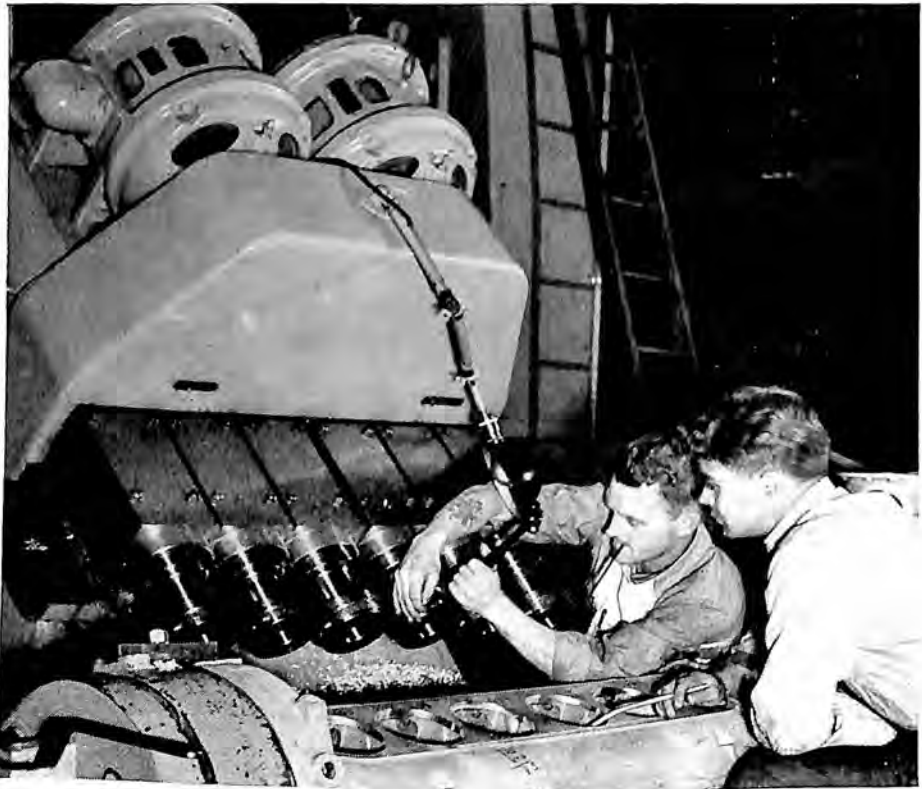
U. S. Army photo

THE RYAN PT-20

One of the Air Corps trainers built by Ryan Aeronautical Company at San Diego, Calif.



During 1940 the majority of airway terminal stations were equipped with two ceiling light projectors for measuring accurately the height of clouds at night. By the use of two ceiling projectors such measurements could be obtained to all heights within the usual range of aircraft operation. The more powerful projectors, 12-volt type, were installed on 1,000-foot base lines for measuring heights of intermediate and high clouds, while the old style 110-volt projectors were utilized on a 500-foot base line to determine accurately the height of low clouds under certain conditions of low visibility.



#### TRAINING A NEW HAND

Virtually every aircraft manufacturing company in the United States spends much time and money training new employees in the exacting work of quantity production for defense. Here one of the thousands of "trainees" at the Allison engine plant in Indianapolis takes a lesson from a veteran workman as he sets a machine which bores six holes simultaneously for a cylinder bank in an engine crankcase.

## CHAPTER VI

### TRAINING AND EDUCATION

Thousands of Americans Volunteer for Air Force Training—  
Program of the Army Air Corps and the Navy Bureau of  
Aeronautics—Magnitude of the Civilian Pilot Training  
Program—Achievement of the Industry in Train-  
ing New Employees—Vocational Training—  
The Three Programs of the U. S. Office  
of Education—Work of the Schools.

**T**HE vast defense program made necessary the training of scores of thousands of new workers to build warplanes; of mechanics to maintain them, and of pilots to fly them.

The Army, the Navy and the Civil Aeronautics Administration were training the pilots; the Army, the Navy and other Government agencies were training the mechanics and some aircraft factory hands. The aircraft industry was training the large majority of its factory workers.

In June, 1940, as the full import of President Roosevelt's call for a 50,000-plane air force was realized, the U. S. Army Air Corps had 3,322 flying officers and 1,894 flying cadets—pilots working for their wings.

About seven months later—in January, 1941—the number of flying officers had been increased to 6,180; the number of cadets in training to 7,000. The Air Corps in March, 1941, was aiming at an immediate annual pilot training rate of 12,000; beginning on March 22 cadets were being inducted at a rate designed to turn out these 12,000 flying officers a year. But at that moment, new increases in the rate were being planned. Early in April, Congress was asked for, and granted, funds to bring the annual rate of output of trained army pilots to 30,000 by November, 1942.

A tremendous organizational expansion and speeding up in pilot training was effected by the Air Corps to make possible the vitally



U. S. Army photo

#### THE CESSNA AT-8

With two Jacobs engines, it was one of a fleet used by the U. S. Army Air Corps in multi-engine training.

necessary increases in flying personnel. In brief, the new routine took a fledgling pilot to a reception center where for four weeks he was "processed"—fitted for his uniforms and taught regular drilling. New classes entered these centers every five weeks. Next, the neophyte went to an elementary flying school for six weeks. There were 28 schools privately operated and under contract with the Air Corps. The next step comprised basic flight instruction for 10 weeks at one of the 21 Air Corps-operated flying schools. Finally, the pilot, nearing his commission, went to an advanced flight school for 10 more weeks. The advanced schools also were Air Corps-operated. That intensification of training so shortened the course that one could become an Air Corps pilot in slightly more than six months, instead of the former full year. Employment of private flying schools to handle the elementary stages of flight training aided greatly in increasing the volume of pilot output, because two classes a year, instead of one, could be handled in the regular Air Corps training centers.

The Air Corps training program was split geographically into three areas; the Gulf of Mexico area (headquarters, Randolph Field, Tex.); the Southeastern area (headquarters, Maxwell Field, Ala.), and the West Coast area (headquarters, Moffett Field, Calif.). The headquarters handled all training activities in its area, including operation of the reception centers and basic and advanced training centers, and supervision of the privately-operated elementary flying schools.

Training courses also were run by the three area commands for bombardiers and navigators (output 3,600 a year) and for squadron engineers, communications personnel, flying photographers, meteorol-

ogists and aerial observers. This activity also was sponsored by the Air Corps at a number of civilian universities.

Further, the Army was training an air infantry and a body of parachute troops. The two groups would be used in conjunction, for instance, in desert warfare, to seize and hold water sources, to destroy vital communications, or to harass or impede an enemy moving up to attack.

Extent and procedure of Naval pilot training was recommended by the Bureau of Aeronautics, U. S. Navy, and was set up and administered by the Navy Bureau of Navigation.

The Navy, on February 1, 1941, had 3,703 pilots on active duty. It was an increase of 644 over July 1, 1940. Of that increase, 120 were reserves called to active service, and 524 were graduates from training courses. On February 1, 1941, the Navy had 3,000 pilots in training. That was double the number in training two months earlier. The Navy's training program, however, contemplated even larger increases. By July 1, 1941, when enlargements at the Navy's three main training stations were to be completed, an annual entry rate of 9,600 potential pilots was to be reached. As the rate of attrition—students disqualified—in Naval pilot training was about 30 per cent, an annual entry rate of 9,600 would result in an actual output of about 7,000 pilots a year. New programs were being drafted, however, to increase that rate of output.

Naval pilot training differed from that of the Army Air Corps in that the trainee received his entire course at two stations, instead of four. The main Naval pilot training stations were at Pensacola, Fla. (entering 100 students monthly in June, 1940; contemplated 300 monthly by July 1, 1941); Jacksonville, Florida (75 monthly on Feb. 1, 1941; 200 monthly by July 1, 1941), and Corpus Christi, Tex.



THE AERONCA TANDEM TRAINER



THE FLEETWINGS XBT-12

A stainless steel basic trainer.

(to begin training in April, 1941; with 300 monthly entry rate by July 1, 1941). All of these stations were to be on a daylight-to-dark, six days-a-week training syllabus.

Naval pilot training also was intensified to meet the need for pilots to man the thousands of new airplanes the Navy was receiving under the all-out defense program. Only about half a year was required to make a Naval pilot in 1941, as compared to the full year consumed prior to the emergency.

Naval cadets, selected by Navy boards to which they had applied and by which they had been physically examined, first were sent to one of the 15 Naval Reserve bases, where a month of elimination training, both flying and ground, was received.

Then the successful cadets moved on to either Pensacola, Jacksonville or Corpus Christi. There they received flying and ground courses for six months and were finally selected for duty in one of the three specialized branches into which the training program was divided—patrol plane, seaplane (operating from cruisers and battleships) and carrier-type plane. Carrier-type pilots went to a specialized school at Miami, Fla., for their final training.

In their six months at one of the three main training stations. Naval cadets, in addition to learning to pilot aircraft, received instruction in engine construction, radio operation, celestial and dead reckoning navigation, gunnery, naval warfare, tactics and aerodynamics.

One of the most significant programs in the United States was carried on by the Civil Aeronautics Administration of the Department of Commerce. It was the Civilian Pilot Training Program. From its inception in February, 1939, until January 1, 1941, the program gave flight training courses to 41,188 young men and women. By June, 1941, 19,000 additional courses were to be given. At that

time, due chiefly to the program, there were to be nearly 100,000 certified pilots in the United States.

CPTP graduates, comprising a vast reservoir of military pilot material and promising a halcyon new era for private flying, were trained in 907 program centers—707 college and 200 non-college. The military worth of CPTP was attested by U. S. Army Air Corps studies showing that, while 39 per cent of its cadets having no previous flight training were disqualified in the primary stage, only 16 per cent of those taken after CPTP training were so disqualified. A survey in March showed that 4,800 CPTP trainees had entered the air services.

Cost of the CPTP was low. A private pilot was produced for \$375; a "secondary" (advanced) pilot was trained for \$870 additional. The Government bought no airplanes, rented no class rooms, hired no instructors. They were acquired and paid for by the colleges and flight contractors. The student paid a small entrance fee. In April, 1941, Congress was planning to appropriate about \$25,000,000 for operation of the CPTP in the fiscal year beginning July 1, 1941.

In addition to being economical, CPTP set a new safety record for flying. CAA Administrator Donald H. Connally reported that during 1940, CPTP students flew 96,000,000 miles with only 31 fatalities—3,160,000 miles per fatality, the highest figure ever established in private flying.



FAIRCHILD AIR CORPS TRAINER IN FLIGHT  
The PT-19, powered with a Ranger or a Warner engine.



U. S. Army photo

## TRAINING FOR DEFENSE

North American BT-9 trainers on the line at the U. S. Army Air Corps "West Point of the Air"—Randolph Field, Tex.

The CPTP was not limited to turning out new pilots. It (1) produced qualified flight instructors, supplying the military flying schools, the air lines, and other phases of the national defense effort with nearly 1,000 trained personnel; (2) trained 73 CPTP graduates in meteorology to meet the need for expert weather forecasters; (3) trained 35 selected Latin-American youths to further the "good neighbor" policy and stimulate private flying in the republics to the South; (4) gave advanced flight training courses to thousands of CPTP graduates; (5) introduced courses in daytime and night time cross-country flying in the spring of 1941.

With the United States arming against possible aggression in a world at war, qualified authorities—many of them officers in the Army and Navy—rated highly the military value of CPTP as a pilot reservoir and instructor incubator. The Navy asked CPTP for 100 instructors, and allowed CPTP graduates to skip the usual elimination training. The Army, as noted, found a low attrition rate among CPTP graduates inducted into the Air Corps. In short, CPTP meant to the military more instructors, more students and hundreds of thousands of hours of time saved in training.

In years to come, with the return of peaceful skies, CPTP un-

doubtedly will attain even greater significance in another field—private flying. The 100,000 pilots of 1941 should become, in the view of aviation experts, the 1,000,000—or more—pilots of tomorrow, bringing with them a new era in aviation, an era in which the small plane and its pilot will be important factors in the broad field of transportation.

By the spring of 1941, as the program to step up training of Army pilots to 30,000 a year was completed, it was believed that the Civilian Pilot Training Program would become a more integral part of the military pilot training plan under the new expansion. Officials were discussing turning over to CPTP a portion of the basic military training activities, thereby relieving Army fields of overcrowding.

A complete list of civil primary and advanced flying schools approved by the Civil Aeronautics Administration will be found in the Appendix.

The demand created by the defense program for hundreds of thousands of new aircraft factory employees, airplane mechanics and other artisans placed an additional load on an already overburdened Government and aircraft industry. Major portion of the load fell on the industry, which increased shop employees from 60,000 at the end of 1939 to 165,000 at the end of 1940. The increases have continued, with a total of 380,000 shop employees to be employed in the industry by the Fall of 1941.

The task of adding so many shop employees was extremely difficult. The building of aircraft equipment being a different art,



THE HARLOW PC<sub>5</sub>A BASIC TRAINER





THE PIPER CUB TRAINER

A light plane with engines from 40 to 65 h.p.

virtually all new employees had to be trained for their work. Established schools offering training courses were pitifully few. The industry, while it was doubling 1939 plane output in 1940, and while it was pressing a vast plant expansion program, also had to institute a mammoth vocational training system.

The Government also instituted programs to train shop employees for both the industry and the air services. Here is how both jobs were done.

While individual aircraft manufacturing companies set up their own vocational training systems, all fell nearly enough into a nationwide pattern to allow general treatment.

The aircraft industry, at the outset of the emergency, and up to this writing, found the labor supply relatively plentiful, but almost completely lacking in the skills requisite for aircraft building. So the industry first called on the few specialized trade schools to undertake training programs. Then the industry asked other educational institutions to install vocational training courses. In both cases, but particularly the latter, the industry furnished instructors, material and all other necessary aid, including financial. In most cases trainees, after preliminary courses in these schools, courses devoted to the teaching of a single, simple operation, moved into the factories and began performing this single simple task. At this point, a new industrial departure, called up-grading, entered the picture. As an employee became proficient in his most simple skill, he was up-graded one step to the next most simple skill. As this process went on, the employee acquired new skills, and in many cases he achieved an all-around proficiency. Then he was moved up into a supervisory position, such as a sub-foremanship.

The introduction of up-grading was an outgrowth of the lack of a sufficient number of persons with any semblance of all-around mechanical skill. This problem cried for a solution, if the defense effort was to succeed. Hence up-grading which, boiled down, amounted to splitting up the many skills of a veteran artisan among that many individuals, was introduced. A big bottleneck was broken.

In 1941, every airframe, engine and propeller company building for defense had in operation its own training program, involving the induction, training and setting at real work thousands of raw labor recruits every month.

Government vocational training programs fell into three categories—Army, Navy and U. S. Office of Education.

The U. S. Army Air Corps operated an extensive vocational training program to produce the thousands of mechanics and other hands needed to maintain the warplanes which the aircraft industry was building in such great numbers. Recruits were sent to the reception center at Jefferson Barracks, Mo., whence they were channeled to one of the five Air Corps Technical Schools at Chanute Field, Ill.; Scott Field, Ill.; Lowry Field, Colo.; Wichita Falls, Tex.; and Biloxi, Miss., or to one of 15 schools privately operated under contract with the Air Corps. The Air Corps vocational training program was geared to produce 53,000 mechanics annually. It operated at this tempo for nearly a year. By April, 1941, it had turned out nearly 50,000 mechanics, and plans were approved to raise the annual output of trained mechanics to 100,000. The courses varied in length between four and 24 weeks, and covered all phases of maintenance—planes, engines, instruments, parachutes and other accessories.

Vocational training in the Navy having to do with aircraft was



PORTERFIELD COLLEGIATE TRAINER

A two-place plane with a 75 h.p. Continental or Lycoming engine.



ST. LOUIS AIRCRAFT PT-1 TRAINER

One of an order delivered to the U. S. Army Air Corps.

under the Navy's Bureau of Navigation. In peacetime, training of airplane mechanics and other aviation maintenance personnel was carried out through an apprentice system in the Naval Aircraft Factory and in other Naval manufacturing establishments. Advent of the 1940 emergency, however, forced an immediate expansion of that program. As of March, 1941, the bulk of Naval aircraft vocational training was carried on in the Naval Trade Schools at Jacksonville, Fla., Norfolk, Va., and San Diego, Calif. Vocational training activities were expanded at other air stations, and the Navy planned to start courses in civilian universities and trade schools. The numbers to be trained had not been decided, but Naval officials declared "as many as possible will be trained with facilities available and planned."

Facilities of one privately-operated trade school, were extensively utilized. Plans called for selection of 300 enlisted men each month for 30 days' training at the Great Lakes Naval Station, to be followed by 90 days intensive instruction at the Ford Trade School. When the program was in full operation, 900 enlisted men were to be under instruction in the Ford School at all times. Aviation vocational courses given by the Navy were designed to produce mechanics, metalsmiths, ordnance men and radiomen.

Other Government labor training was headed up in the Office of Production Management, Labor Supply Section. Most of the actual operations fall to the U. S. Office of Education. Other Government agencies cooperated with this bureau.

The U. S. Office of Education participated in three vocational training programs. Two were set up under acts of Congress. The third was a WPA project.

The day-trade part-time and evening vocational school courses were set in operation by the Smith-Hughes and George-Deen Acts. At the end of the 1940 school year there were in Federally-aided day trade schools 10,976 enrollees, as compared with 5,814 at the end of the 1939 school year. In part-time classes there were 8,438 as against 1,120; in evening schools 15,448 as against 5,551. Some of the courses included blueprint reading and drafting, mechanics, tool and diemaking, hydraulic design, and construction and maintenance.

Training of workers for "Industries Essential to National Defense" was provided by the 76th Congress, 3rd Session (Public No. 812). On October 15, 1940, more than 7,000 persons were enrolled in aircraft courses. In December, a total of 30,914 persons were enrolled in the courses, which for the most part were set up for short, intensive periods leading to training of specialized workers, rather than the training of all-around skilled mechanics. This type of training lends itself to up-grading when the student actually begins working in aircraft factories.

A program to "furnish trainees and train needy persons in the manual occupations of aviation ground servicemen and provide the necessary and appurtenant services and facilities incidental thereto" was organized, and courses were started in Washington, D. C., Baltimore, Md., Richmond, Va., and Lock Haven, Pa. Training of 4,000 persons was anticipated by the end of the first year of operation.

A complete list of aircraft mechanic schools approved by the Civil Aeronautics Administration will be found in the Appendix.

While the rapidly expanding defense program found in existence



SOUTHERN AIRCRAFT BM-10

A two-place trainer with a 225 h.p. engine.



STEARMAN MODEL 91 TRAINER

Powered by a 450 h.p. engine. A similar ship, Model 90, is powered by a 225 h.p. engine.

an insufficient number of schools to train enough pilots, maintenance crews and aircraft shop employees, those institutions which were operating plunged immediately and enthusiastically into the task of increasing existing facilities. A number of new schools were founded.

Flight and vocational training schools which were notably successful in their efforts to help meet the needs of the defense program, included the following:

Aero Industries Technical Institute, Los Angeles, Calif., increased its facilities and activities 100 per cent with an average enrollment of 1,000 students. The staff of 61 employees was doubled. The 25,000 sq. ft. of shop, laboratory and class room space was increased to 50,000 sq. ft. Three new buildings were erected. Emphasis was placed on courses in master mechanics and aeronautical engineering. Courses in armament design were instituted to help meet the acute need for engineers. In addition to its training program the Institute carried out a program of private research and development.

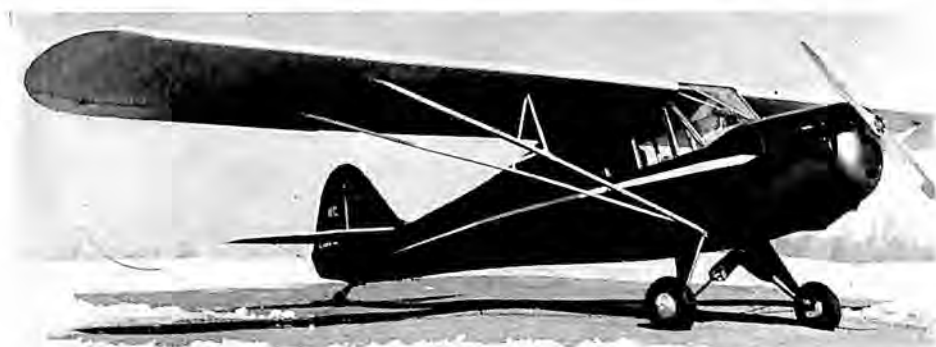
The Aeronautical University, Inc., Chicago, Ill., offered courses in engineering, mechanical training and aircraftsmanship, and awarded the degree of Bachelor of Science to aeronautical engineering graduates. It reported an enrollment of 785 students. A new building for the engineering school was purchased and equipped, and several thousand feet of hangar space was secured at the Chicago Municipal Airport. The university continued to train enlisted personnel of the Army Air Corps.

American School of Aircraft Instruments, Glendale, Calif., tripled its floor space, quadrupled its training equipment, and expanded

its training program. A special Sperry instrument department was established. Added instruction was instituted in the maintenance, repair, overhaul, and testing of autosyn, and telegon instruments, fuel-air ration indicators, and electrical tachometers. To supply trained men to aircraft plants a special course in instrument installation and aircraft electricity was added.

The Aviation Institute of Technology, Long Island City, N. Y., specializing in training aircraft mechanics, had an enrollment of 400 students, and reported that it was successful in placing its graduates in the industry. The school, which had a capacity for turning out 1,400 students gave courses in sheet metal work, welding, radio, and aircraft drafting and design. A post graduate course was also offered those desiring to specialize in any particular branch of the aviation industry. The school building was a four-story concrete, fire-proof, structure, lighted on all sides, with a floor area of 52,000 sq. ft.

Boeing School of Aeronautics, a division of United Air Lines, where average enrollment was 300 students, included eight career courses in its program, with instruction in 35 major subjects. Graduation from high school, with emphasis on mathematics and physics, was a prerequisite for the mechanical, operations and engineering courses and for the air line pilot and engineering course. A special air line pilot course was offered students with two years or more of college work. The meteorology and air line technician courses required graduation from an accredited college of engineering. Length of the courses varied from one year for the air line mechanic course to two years for the aeronautical engineering and the air line pilot and engineering courses. Flight training and instrument instruction was given in eight different types of planes, including a twin-engine Boeing 247 transport. Instruction was given in Link



TAYLORCRAFT MODEL D  
A tandem trainer.



THE VEGA MODEL 35 TRAINER

Trainers. A 12-week sheet metal course was offered. The school had 35 instructors, and reported graduate placement at 100 per cent.

Cal-Aero Academy, Glendale, Calif., affiliated with Curtiss-Wright Technical Institute, which originally contracted to train classes of 35 Army flying cadets when the Air Corps expansion program began in July, 1939, expanded during 1940 into three large plants. One of these was reported to be the largest primary training center in the nation. This unit had over 600 cadets under instruction at the end of the year. Construction of the 400-acre training center at Ontario, Calif., drew much favorable comment. From a field of waving grain, the area was turned into a complete training center in 40 days. After completion, the plant was twice enlarged, until it had 25 large permanent buildings and 3,000,000 sq. ft. of paved runways. In the barracks there was a room for every two cadets, with bath between each pair of rooms. Walls were double, with sawdust solidly packed between to a thickness of four inches, insuring coolness in summer and warmth in winter. Thermostats controlled heating facilities. A mess hall, seating 700 cadets, and a huge recreation building with a lounge, entertainment facilities and other features were also incorporated in the 25-building set-up. The plant, capable of handling 700 cadets, was planned to permit material expansion.

Cal-Aero also built and put into operation a smaller training center at Oxnard, Calif., and enlarged its original center at Glendale. Each was capable of handling 100 cadets with present facilities, and each was capable of material expansion to fit defense needs.

Curtiss-Wright Technical Institute, Glendale, Los Angeles, Calif., began 1941 with an enrollment of more than 2,000 students—approximately 1,500 civilians learning to be aeronautical engineers and master aviation mechanics, the balance being Army Air Corps enlisted men in training to become part of the future maintenance force of the Army's thousands of new fighting airplanes. Preparations were made to expand to 5,000 students if national defense so required. During the year, Curtiss-Wright Tech's shops and classrooms were more than doubled in size, with eight new buildings added to the already vast facilities. In addition, barracks and headquarters of the Air Corps Training Detachment were tripled, to provide housing and eating accommodations for the increased quotas of Army men sent to Curtiss-Wright Tech as students.



WACO UPF-7 TRAINERS

A week's production of trainers sold to flying schools under the CPT program, outside the factory of The Waco Aircraft Company, Troy, O.





#### ALABAMA INSTITUTE OF AERONAUTICS

Showing Air Corps training ships.

Civilian students came from every State and a score of foreign countries. The American graduates were absorbed in West Coast factories. Curtiss-Wright Tech adhered to its policy of career training only, no short-term, "job" courses being given. During the year, the aeronautical engineering course was broadened to 2,100 hours of instruction; master aviation mechanics to 1,920 hours; and two new courses, airplane manufacture and maintenance, and engine repair and maintenance, each of 1,280 hours, were added. An aircraft sheet metal course of 13 weeks also was added.

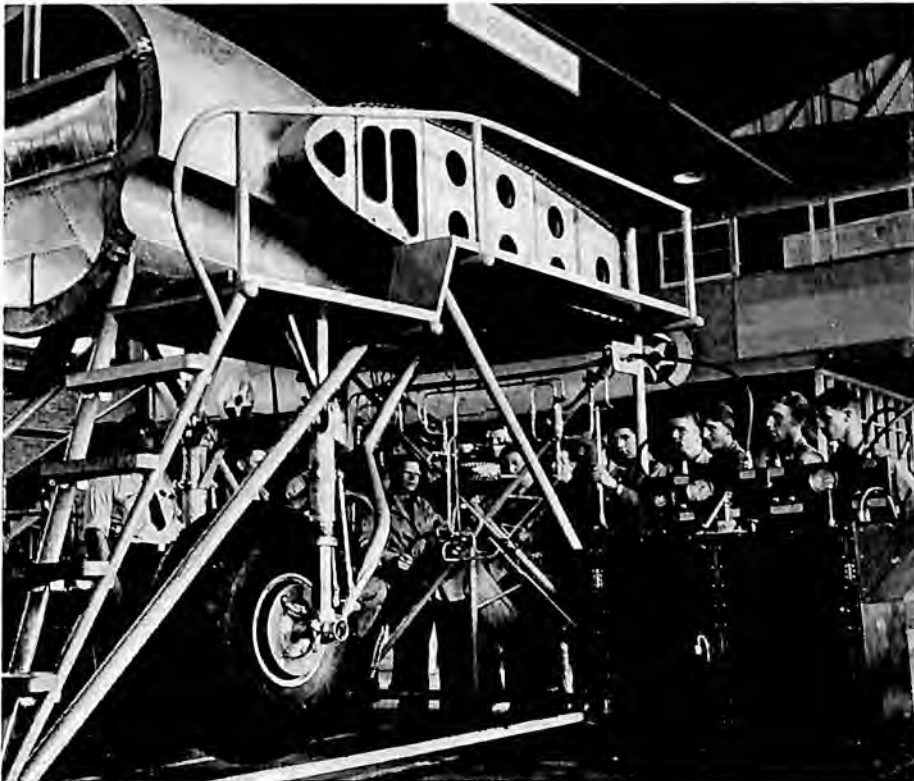


#### CAL-AERO ACADEMY

New training center at Ontario, Calif., with 25 huge permanent buildings on a 400-acre tract.

Dallas Aviation School & Air College, Dallas, Tex., started a large-scale expansion program early in 1940 to accommodate greatly increased enrollment in all its branches—military flight and mechanical training, CPTP flight training, and civilian flight and vocational training. About 850 Army Air Corps cadets were trained, 250 students were enrolled in the civilian school, 40 CPTP students were trained, and courses in aircraft mechanics (for the Army Air Corps) were taken by 150 enlisted men. The expansion program included new barracks, enlargement of the school cafe, and erection of a canteen and new administrative offices. Approximately \$200,000 was spent.

Of the 731 flying cadets accepted for training at Dallas, 364 successfully completed primary flight training, and went on to Randolph Field for advanced instruction. Training of 120 flying cadets was allotted to Hicks Field, where low-winged training planes, replacing bi-winged PT-3's, were provided.



AT CURTISS-WRIGHT TECHNICAL INSTITUTE

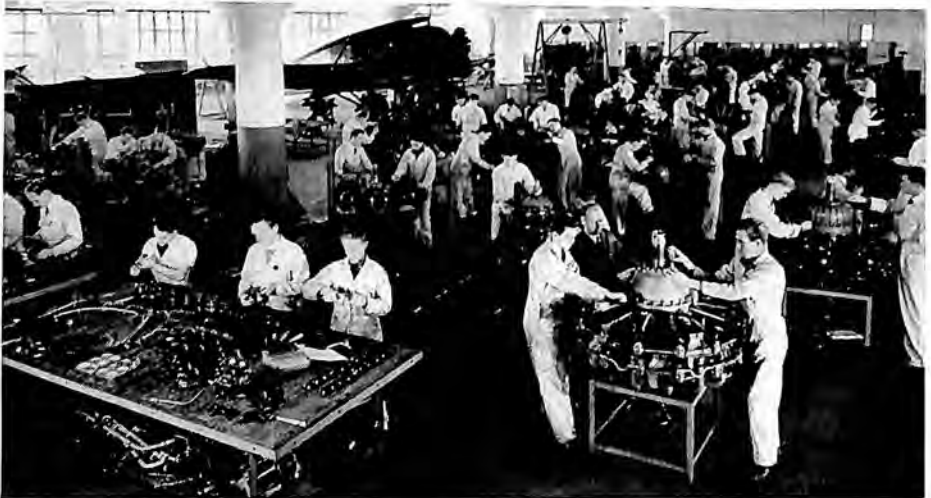
Mechanics students at the school in Glendale, Calif., learning the operation of hydraulic landing gear.



### CASEY JONES SCHOOL OF AERONAUTICS

The aircraft design department at the school in Newark, N. J.

American-born pilots who applied for jobs in Canada, as instructors or ferry pilots, were trained. The students allotted the Dallas school were required to have a minimum of 150 hours before they were accepted for the "refresher" training course. An aircraft factory worker's training program to fill vacancies in aircraft factories was offered as a special course. Blueprint reading, arc welding, aircraft wiring, drilling, riveting and aircraft metal work were included in the course. Construction of barracks, administrative offices and



### CASEY JONES SCHOOL OF AERONAUTICS

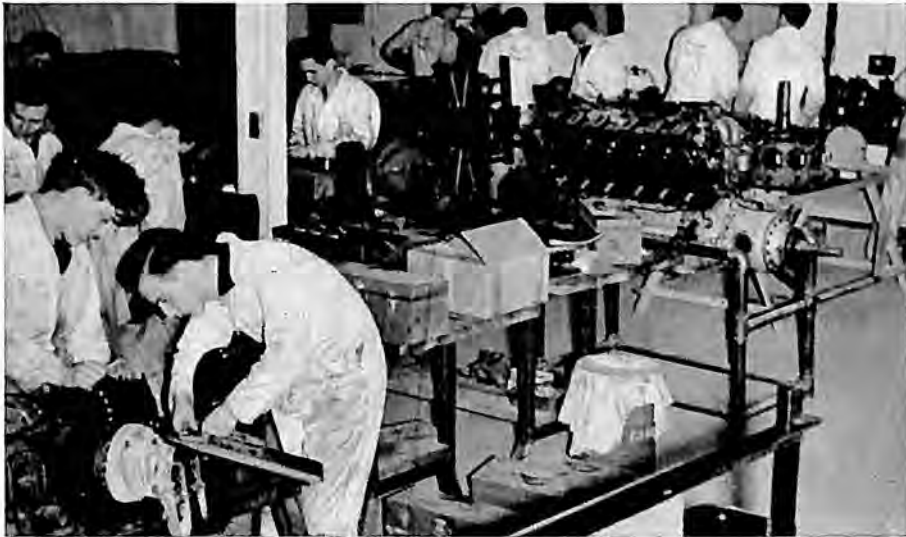
View of the Engine Department.

mess halls was started at Brady, Tex., where the Dallas school was to begin operation of a new U.S. Army Air Corps training detachment for primary flight instruction in April, 1941. Approximately 120 flying cadets were to be allotted to the new detachment every 10 weeks.

Edwards' Flying Service, Inc., Flushing Airport, New York, conducted CPTP flight training and increased private activities 300 per cent. Office facilities, personnel, and new training equipment were increased. Ten airplanes were used. CPTP flight training was to be continued in 1941 with 20 Columbia University students and 10 non-college students, the latter group sponsored by the Young Men's Board of Trade of Flushing.

Frye Aircraft Company, Kansas City, Mo., opened a school to train aircraft workers. Later other schools were established at Omaha, Neb., Dallas, Tex., and St. Louis, Mo. The schools graduated more than 1,500 persons, most of whom acquired positions in the aircraft industry. Under its own system of training, classes were limited in size to assure students adequate personal attention.

Graham Aviation, at the Pittsburgh-Butler Airport, Pa., opened branches at Meadville, Oil City, Pittsburgh-Allegheny County Airport and Pittsburgh Seaplane Base, Waynesburg, Pa., and Americus, Ga. The company instructed CPTP students from Carnegie Tech, Washington and Jefferson College, Geneva College, Allegheny College, and Duquesne University. Non-college groups from Pittsburgh and Oil City also were given training during the



LUSCOMBE SCHOOL OF AERONAUTICS AT WEST TRENTON, N. J.



#### AT PARKS AIR COLLEGE

It is located at East St. Louis, Ill.

year. In conjunction with the Pittsburgh Aero Club and the Pittsburgh Press, Graham Aviation offered a ground school course with over 1,000 students enrolled.

Graham Aviation brought flight instruction into the heart of Pittsburgh's metropolitan district when it established a seaplane base on the Allegheny River.

Casey Jones School of Aeronautics, Newark, N. J., in response



#### AT RYAN SCHOOL OF AERONAUTICS

Flying cadets of the Army Air Corps in training on Ryan PT-20 low-wing trainers at the company's school in San Diego, Calif.

to the tremendous demand for skilled workers by the aviation manufacturing industry and the air forces, leased two floors of the Center Market Building, with a total floor space of more than 140,000 sq. ft., and converted it into classrooms and laboratories, with sufficient space and facilities for training 1,700 students. A contract was made with the Air Corps to train 600 enlisted mechanics, and commercial enrollment was increased to 1,100 students. The old school building was converted into a barracks and mess hall, and additional housing facilities were secured by taking over the five story Progress Club. Other space was secured on the river front and nine motor test stands, together with classrooms, were built. Additional equipment included 35 airplanes, both military and commercial, and more than 100 engines, 50 propellers, 200 carburetors and 200 magnetos. The faculty was expanded to more than 100 persons.

During the year a contract was made with the City of New York, which constructed a modern fire-proof school building, especially designed as a mechanics school, at LaGuardia Airport. Civilian enrollments in this school were limited to 300 in order to accommodate an additional 300 enlisted men from the Army Air Corps. A two-story barracks, complete with restaurant facilities, was put up for the Army contingent. This institution, known as the Academy of



AT ROOSEVELT AVIATION SCHOOL

One of the "classrooms" at the school on Roosevelt Field, Mineola, N. Y.



"UNDER THE HOOD" IN A RYAN

Instrument flight instruction in a Ryan S-T training plane is an important phase of advanced flight training for prospective air line pilots at the Ryan School of Aeronautics.

Aeronautics, rented the City hangar to handle field service and part of the Army instruction. The Academy of Aeronautics offered only advanced courses, the shortest being of two years duration. During the year the Casey Jones School graduated more than 1,000 men, all of whom, school officials said, were absorbed by the industry as quickly as they had completed their training. It was believed that during 1941 the total enrollment of the two schools would exceed 2,500 men, with an instructional staff of some 125 persons.

The Lakeland School of Aeronautics, Lakeland, Fla., operated the Lincoln Flying School, which was engaged solely in the primary training of Army Air Corps cadets under contract from the War Department. The school was situated on the old Lakeland Municipal Airport, and the barracks and mess hall were on the shores of Lake Parker, adjacent to the airport. All barracks and hangars were permanent buildings. Approximately 200 cadets were undergoing primary training on PT-17 training planes. Approximately 150 persons were employed by the school and considerable expansion was planned.

Lewis School of Aeronautics, Lockport, Ill. contracted to train 240 CPTP students and expanded its facilities. Special all-weather runways were built, as was a large hangar. Both of these projects gave students the opportunity of acquiring practical experience in airport construction. Total enrollment increased over 300 per cent, with the largest percentage of increase in the airplane engine mechanical courses. A new building, housing cafeteria, general store and storerooms, was added. Flying equipment worth about \$50,000 was

acquired, including 11 Piper Cubs, 3 Wacos and a Howard. The school's Stinson was converted into a full blind flying ship. Plans for 1941 called for an expansion of the mechanics school and the aeronautical engineering school. A course in gliding and soaring was to be added.

The Luscombe School of Aeronautics, Trenton, N.J., training men in all-metal airplane construction and offering Government-approved courses in airplane mechanics and airplane engine mechanics, underwent an expansion in 1940 which brought its total floor space up to 18,620 sq. ft. New equipment was procured and, early in 1941, opening of a branch school in Dallas, Tex., was announced.

Missouri Aviation Institute, Kansas City, Mo., concentrated in 1940 on courses in aircraft engine mechanics and aircraft mechanics. On October 27, it began receiving increments of 25 Army enlisted men each month to train in aircraft engine mechanics. The school had a capacity for 200 commercial students in addition to the Army men.

Mountain States Aviation, Denver, Colo., turned out two groups of CPTP pilots and added 150 students to its commercial flying rolls. A branch field was established at Trinidad, Colo. Operating in a high altitude, a great deal of the school's training was done in the snow, with Aeronca and Waco training planes equipped with skis.

New England Aircraft School, Inc., East Boston, Mass., with 43 instructors, trained over 500 students as aviation mechanics, among them Air Corps enlisted men as crew chiefs. Air Corps officers were assigned to the school to take direct charge of Air Corps students.

Parks Air College, East St. Louis, Ill., increased its student body to more than 550. Three hundred were in the commercial school, 200 were Army Air Corps flying cadets, and 50 were Air Corps mechanics. Faculty personnel reached 86, three new buildings were erected including two dormitories housing 60 men each, and one classroom building with four lecture rooms. The college received continued recognition as an Institution of Higher Learning from the U. S.



SAFAIR FLYING SCHOOL

It is located on Roosevelt Field, Mineola, N. Y.





#### FAIRCHILDS TRAIN AIR CORPS PILOTS

Group of U. S. Air Corps flying cadets at Spartan School, Tulsa, Okla., ready for instruction flight in the Fairchild PT-19

Office of Education, and operated under the approval of the Superintendent of Public Instruction of Illinois. In addition, the Army and Navy accepted Parks graduates for appointment to the Army Air Corps and the Naval Reserve for flight training. The college cooperated in the expansion of the Army Air Corps by leasing the 568-acre Curtiss-Steinberg Field and an auxiliary 96-acre field for the use of the 200 flying cadets. Commercial students receiving flight training used the airport immediately adjacent to the college. Expansion plans for 1941 included projected addition of four new Stearman planes to the fleet of 18 school-owned ships, and further improvement and enlargement of equipment, faculty, personnel and curricula of the Civilian Pilot Training Program.

In December, 1938, Oliver L. Parks, president of Parks Air College, was approached by members of the City Commission of Tuscaloosa, Ala., and representatives of the University of Alabama to establish a school so that the University might take advantage of the Civil Pilot Training Program offered by the C.A.A. Soon thereafter Mr. Parks leased the Municipal Airport. The school opened February 1, 1939, as the Alabama Institute of Aeronautics, and on March

1, 1939, received official approval as a commercial flight and ground school. The University was given a quota of 30 students to be trained by the Alabama Institute of Aeronautics and this training was started in March. On June 1 every student received his private pilot's license. On July 1, 1939, the Institute was among the first nine civilian schools to start training pilots for the Army Air Corps.

Rising Sun School of Aeronautics, Philadelphia, Pa., trained commercial and military aviation mechanics, and added equipment. Air Corps mechanical training at the school made necessary the hiring of more instructors, adoption of a schedule of instruction to meet Army standards, and the purchasing and setting up of equipment, including the construction of a large test house capable of handling seven engines.

Robertson Aircraft Corporation, Robertson, Mo., enrolled 155 students in its mechanical school at the St. Louis Municipal Airport, where day and night classes were conducted. The corporation also operated an advanced flying school in St. Louis and a primary flying school at Jefferson City and Boonesville, Mo.

Roosevelt Aviation School, located on Roosevelt Field, Mineola, N. Y., after 14 years of teaching young men and women both flying and mechanics, reported that every member of the graduating class of September, 1940, had been employed in some branch of aviation, and that the demand for Roosevelt graduates was steadily increasing. Early in 1941 the school had more than 600 students in the Civil School and a corps of 200 men from the Army Air Corps was main-



AT STEWART TECHNICAL TRADE SCHOOL  
The Drafting and Design Department.



#### AT SPARTAN SCHOOL OF AERONAUTICS

Maintenance engineering department at the school in Tulsa, Okla.

tained and being trained in mechanics as part of the defense program. In 1940, some \$75,000 was spent in improving and enlarging buildings and in adding new equipment.

Complete courses were offered under the following classifications: private pilot; commercial pilot; combination flight-mechanic; (special) aircraft sheet metal, and master airplane and engine mechanic.

Ryan School of Aeronautics, Military Division, Lindbergh Field, San Diego, Calif., with the accelerated pilot training program of the Air Corps getting into high gear, announced plans for a new expansion of training facilities at its base school at San Diego and at its branch school at Hemet, Calif. Its schedule called for the training of 65 cadets each five weeks, and in addition, its branch training school at Hemet had a schedule of 70 cadets every five weeks. This was to be increased to 120 cadets per class sometime in 1941.

To accommodate the enlarged number of flying cadets at the San Diego school, the cadet barracks were increased in size to take care of 128 men instead of 72. Many additional pilots, ground school instructors and mechanics were added each week. A new hangar, 100 ft. by 200 ft., provided needed storage space for the enlarged number of training planes assigned to the San Diego training detachment.

The Ryan School maintained its operating base at Lindbergh Field, San Diego's municipal airport, but all training work was done at outlying airports. At Hemet, a huge building program was com-

pleted, and the actual lay-out of the school was such as to provide for immediate expansion of facilities should such a request come from the Air Corps. Buildings included three hangars, maintenance shops, 10 administration and classroom buildings, 28 barracks units and a large dining hall, canteen and kitchen. Three million square feet of the half-mile by mile field were oiled and a paved ramp, 236 ft. by 600 ft. adjacent to the hangars, was provided. Thirty-seven days after construction began, the new training school was in operation. The hangars were in use three weeks after construction began and the barracks and mess hall served the first cadets 18 days after work started.

Marking a departure in Air Corps pilot-training policies, low-wing monoplanes were used for the first time in the 30-year history of Army aviation, for primary training of flying cadets at the San Diego training detachment. Heretofore, biplanes were used exclusively. Selected to carry out this new move in pilot training procedure were the Army's Ryan PT-20 low-wing metal-fuselage trainers. The Ryan Aeronautical Company delivered a fleet of the new monoplane trainers to the Army. They were then assigned to the San Diego Training Detachment. The Ryan commercial school had used similar S-T trainers for primary instruction for four years.

Ryan School of Aeronautics, Commercial Division, Lindbergh Field, San Diego, Calif., operated both flight training and mechanical training schools.

To meet the need of the aircraft manufacturing industry for



ST. LOUIS AIRCRAFT PT-LM-4

An acrobatic training plane, with a Ranger engine.



U. S. Army photo

#### TRAINING PARACHUTE TROOPS

A cable from each trooper's parachute is clipped to the parachute static line attachment cable installed in this troop transport. When a trooper jumps, the cable rips the top off the pack after he has fallen about five feet and has been whipped back eight feet by the air stream.

shop employees, Ryan instituted a short-term training course early in 1941. The aim was to provide maximum training in the shortest time consistent with proper instruction. This course was turning out production mechanics at the rate of from 35 to 50 per week, with an acceleration of the rate expected, due to continuing expansion of the aircraft industry.

The Engineering Department was expanded in 1940 to accommodate an ever-increasing number of students. A new Engineering Building was projected. Because Ryan Aeronautical Company, parent of the Ryan School, was engaged in volume manufacture of airplanes, practical instruction geared directly to industry needs was possible in the Engineering Department of the school.

School officials reported they were unable to train men fast

enough to meet the employment demands of the industry, the air lines and other fields of aviation business.

The flight training division of the school operated at the highest level in its 18-year history, due to the demand for trained pilots. School officials reported that graduates from the nine-month flight training course found little difficulty in obtaining employment.

The Ryan School was selected by the Government to train students of San Diego Junior College under the Civilian Pilot Training Program.

Construction of a new 100 x 200-foot hangar was completed to house 25 additional training planes and to provide additional space for the vocational school.

The Safair Flying School, Roosevelt Field, Mineola, N. Y., pre-



U. S. Army photo

#### AIR CORPS CADETS AT RANDOLPH FIELD

Future pilots of the air forces ready to take off on a training flight at the "West Point of the Air" in Texas.



pared students for all pilot courses, including the highest grade of licenses on land or sea planes. It contracted with the government to train students from five New York universities and colleges under the CPTP. Safair also was designated to train Government apprentice instructors and give instructors' refresher courses. An expansion program saw the school's activities carried on also at Nassau airport, Hicksville, N.Y. and at Floyd Bennett Airport, Brooklyn. Ground school courses were held in New York City, as well as at Roosevelt Field.

Spartan School of Aeronautics, Division of Spartan Aircraft Company, Tulsa, Okla., enrolled 870 students in 1940. Of these, 250 were civilian students taking courses in air transport, aeronautical engineering, air line maintenance engineering, air line service mechanic, aircraft or engine mechanic, air transport radio communication, commercial pilot, weather forecasting, instrument technician, aircraft factory mechanic, private pilot or aircraft welding. Of the total, 420 were cadets receiving Air Corps training. Spartan School was being geared up to train 2,100 Air Corps pilots a year. Air Corps enlisted men in the mechanical courses numbered 200.

During the year the school built 10 new buildings, including classrooms, shop, cafeteria and dormitories at Tulsa and at its branch in Muskogee. A total investment of more than \$600,000 was represented. Fifteen new training planes were added to the civilian school fleet. The flying cadet school operated a fleet of 120 Fairchild PT-19 and Stearman PT-13 trainers. Personnel numbered 540, including 110 flight instructors.

Stengel Flying Service, Gainesville, Fla., trained 125 Civilian Pilot Training Program students and a large number of private students. The school increased the number of airplanes it operated from five to seventeen during the year, and flight instructors were increased from three to eight.

Stewart Technical School, New York, N. Y., offered courses in construction and maintenance of aircraft, while acquiring a large amount of new equipment and training facilities. The school strove to maintain high standards, accepting chiefly students of the "leader" type. It offered day and evening courses in aeronautical design and drafting; aircraft and aircraft engine mechanics; sheet metal and assembly. The "A" and "E" mechanic courses were approved by the Government. Applicants for admission had to be high school graduates and also meet other requirements of the Council of Admissions.

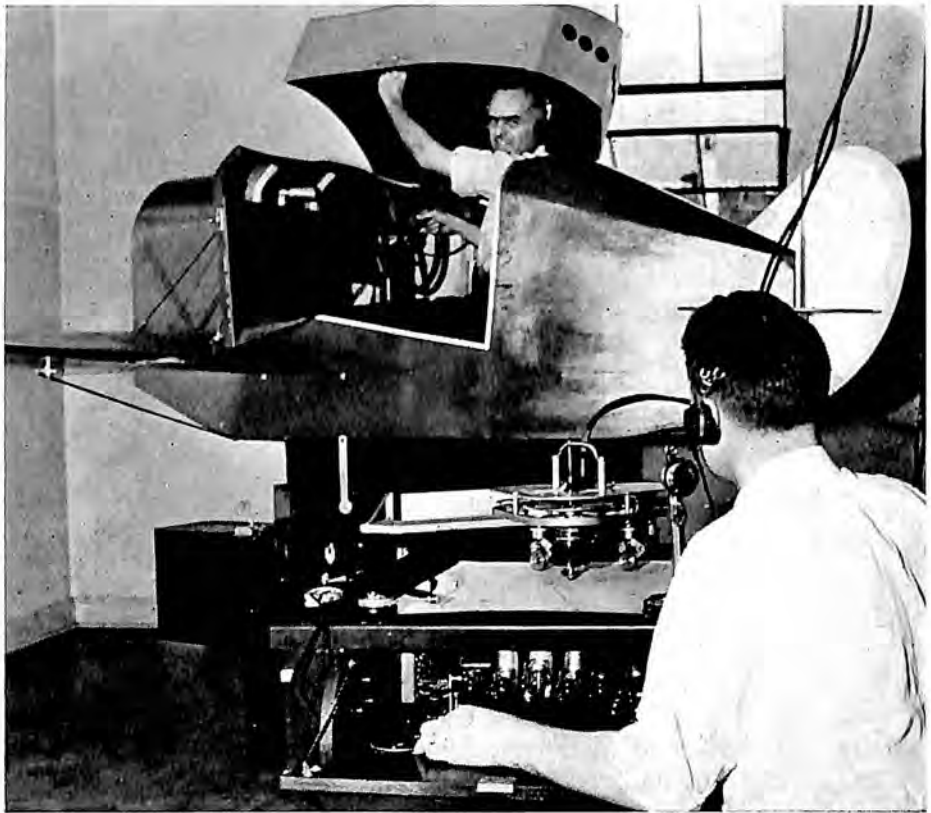
The University of Georgia School of Aviation at Athens, Ga., offered solo, private and commercial courses as an advanced flying school, and operated two CPTP courses, including 50 primary and 20



advanced flying students. Piper Cubs were used for primary and Waco UPF-7 planes for advanced flight training.

Western Air College, Alhambra, Calif., trained more than 600 students as aircraft workers, and instituted evening classes to help meet the demand for such workers from the large Southern California segment of the aircraft manufacturing industry.

E. W. Wiggins Airways, East Boston, Mass., operating five land bases and two seaplane bases, taught CPTP students to fly, and operated a training division, offering engine and airplane repair and maintenance courses and courses to prepare shop employees for the aircraft manufacturing industry.



TWA'S LINK TRAINER



THE FEDERAL AIR  
U. S. Civil Aeronautics



WAYS SYSTEM  
Administration Map.



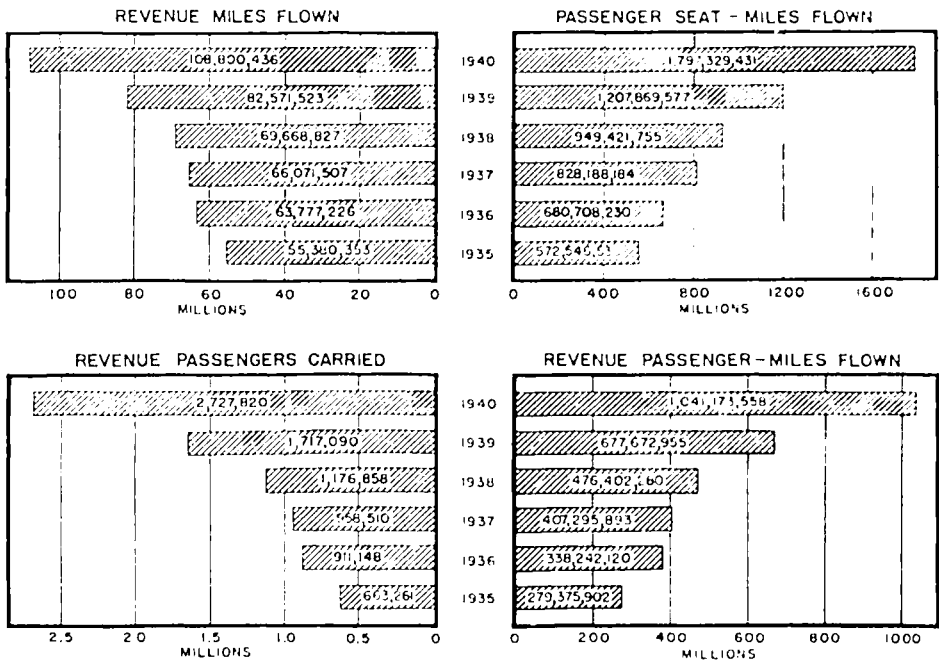
## CHAPTER VII

### AIR LINES OF THE UNITED STATES

Record Growth of Traffic—Increase in Personnel—The Lines Demonstrate Their Value in National Defense—A Million Shipments by Air Express—Pan American Airways Expands Its Services—Plans of American Export Airlines—Development of Air Pick-up Service—Transcontinental and Western Air Starts Stratoliner Operations—Activities of Other Lines.

**A**T the beginning of 1941 the air transport system of the United States had reached a record stage of development. The domestic carriers alone had flown 108,800,436 revenue miles in 1940. They had carried 2,727,820 revenue passengers as compared to 1,717,090 the previous year. Seat miles had jumped to 1,797,329,431 and revenue passenger miles to 1,041,173,558. The revenue passenger load factor was 57.93 per cent, the average pay passenger load 9.57 persons as compared to 16.52 average number of seats per plane in the 358 transports in service on the domestic lines. Passenger revenues totalled nearly \$55,000,000, according to the Air Transport Association. The Civil Aeronautics Authority reported a total of 6,253 tons of express flown by the domestic lines in 1940, aggregating 3,469,485 express ton-miles. The mail ton-miles amounted to 10,500,000. To handle all that traffic the domestic lines employed 15,800 persons of whom 1,017 were first pilots and 893 co-pilots. They operated over 39,746 miles of airways. Including foreign operations, the air lines of the United States used more than 66,000,000 gallons of gasoline.

Importance of the air line system in the national defense program was demonstrated daily. A large part of the increasing traffic could be traced to transport of Government officials and civilians working on defense and the urgent need for the delivery of official and civilian mail, as well as emergency supplies, in the shortest possible time.



C. A. A. graph

## AIR TRANSPORT IN THE UNITED STATES

Six-year progress graph by calendar years.

## Growth of Air Express

Started in 1927, air express gradually matured from an experiment into a \$3,000,000 business. Progressively, year by year, air express shipments increased from 9,074 in 1931 to an all-time high of 1,078,189 in 1940. Regularly scheduled airplanes of 17 domestic lines and one international line transported 1,078,189 shipments in 1940, compared with 870,806 in 1939, an increase of 23.81 per cent. Tonnage was up to 3,850 tons in 1940 from 2,925 in 1939, an increase of 31.61 per cent. Gross revenue increased 27.59 per cent, or an average of eight cents for each air express shipment.

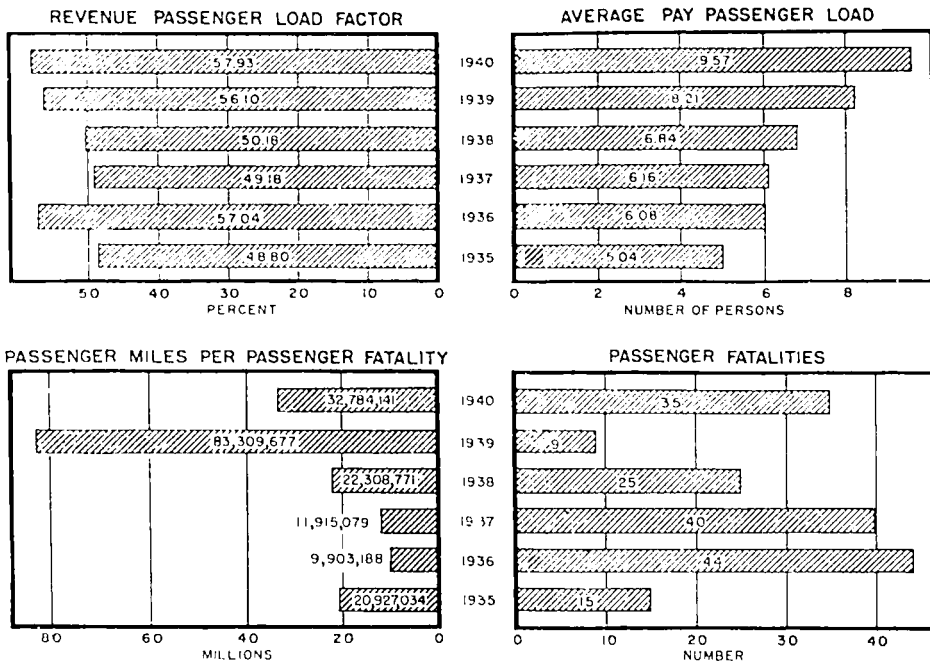
Payments to the air lines by the Railway Express Agency, which handled everything other than flying the shipments between airport cities, were up 27.2 per cent in 1940 over 1939. Air-rail shipments, which either started or finished or both started and finished by rail, totaled 192,429 in 1940, an increase of 33.3 per cent over 1939. Gross revenue of air-rail shipments advanced 40.2 per cent in 1940, with an average revenue 73 cents higher than the shipments moving entirely by air between the 269 airport cities in the United States.

Increased mileage of domestic airways and frequency of service

and increased use of air express to speed national defense preparations were among the factors, contributing to the all-time high totals. In all, domestic air lines flew a daily average of 319,000 miles over 44,399 miles of airways.

In addition to its domestic service, Railway Express Agency extended air express to and from 47 countries and colonies in the West Indies, Central and South America, Alaska, the Pacific Islands and the Orient because of its contract with Pan American Airways. There were 109,396 international air express shipments in 1940 compared to 79,338 in 1939, an increase of 37.9 per cent. Gross revenue for international air express was up 45.7 per cent in 1940, due in part to new air routes and improved business with Latin-America.

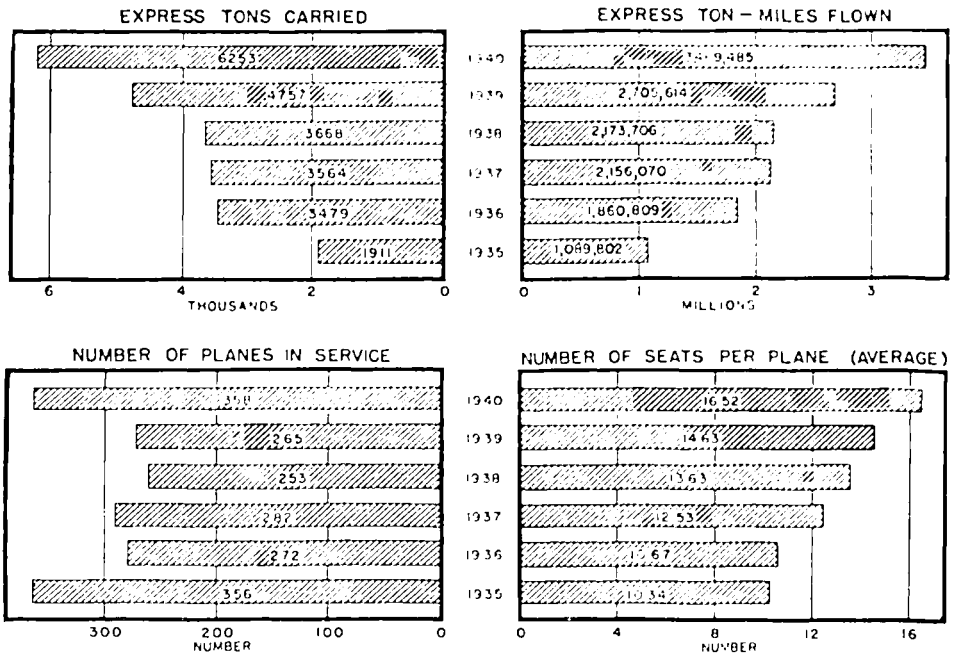
Frequency of plane departures and coordination of air and rail services, together with lower rates and higher speed, contributed to the increased utilization of air express in the first decade of service. Between New York and Chicago at the end of 1940 there were 82 regularly scheduled flights daily by three major air lines. This afforded the company a wide range of routes over which to forward its shipments, as well as a huge carrying capacity. Coordination



C. A. A. graph

AIR TRANSPORT IN THE UNITED STATES

Six-year progress graph by calendar years.



C. A. A. graph

## AIR TRANSPORT IN THE UNITED STATES

Six-year progress graph by calendar years.

of services between planes to airport cities and trains to off-airline points extended the 44,399 miles of airway service to 230,000 miles of rail service through the 23,000 offices of Railway Express. About 30 per cent of all air express shipments either started or finished or both started and finished by rail or were carried part way by rail to expedite their movement. In its coordinated air-rail service Railway Express in 1940 utilized the services of 57,000 employees. Night and day and holiday pick-up and delivery were accelerated by 11,300 motor vehicles. As a further concession to speed, Railway Express had an agreement with Western Union whereby hurry calls to any Western Union office brought boys—without extra charge to the shipper—to pick up air express packages.

Profits due to speed were an important incentive to the increased use of air express. Thousands of dollars in depreciation, rents and taxes were saved by manufacturers and merchants in 1940 by reducing inventories and depending upon air express to make overnight deliveries of goods from distant points.

New air express service included an all-cargo plane daily by one line from New York to Chicago and the inauguration by Railway

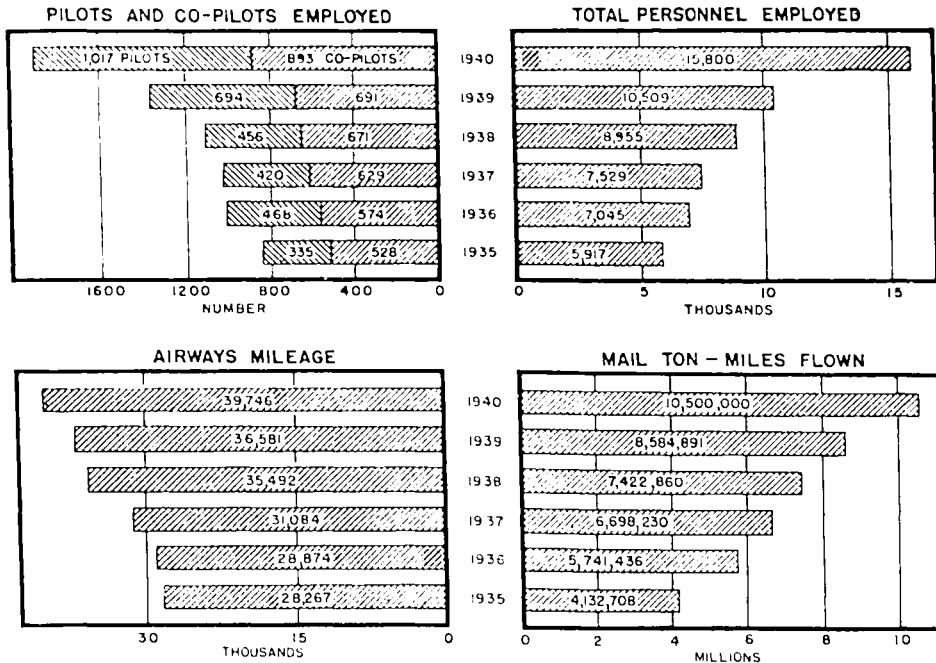


Express of a daily air cargo service on January 6, 1941, over the 205-mile pick-up feeder route of All American Aviation between Pittsburgh and Williamsport, Pa. By that hook-up, 14 Pennsylvania towns were geared into the nation-wide express service.

Air express was important to national defense. Rush shipments of machinery prevented bottlenecks in production.

**Pan American Airways**

Pan American Airways operated the main line of communication between the United States and war-torn Europe in 1940, started a second great aerial highway across the Pacific to Australasia, linking the United States with its fourth most important commercial market; and also established the first year-round regularly operated airway joining the United States with Alaska. Air travel time between the aerial gateway of Miami and Buenos Aires was equalized by way of both coasts of South America and reduced to three and a half days. Into operation went one of the most important overland airways ever established in the history of aviation; the "Cut-off" to Rio, across the heart of Brazil, by which the airway flight mileage be-



C. A. A. graph

**AIR TRANSPORT IN THE UNITED STATES**

Six-year progress graph by calendar years.

tween the United States and Rio de Janeiro was shortened by nearly 1,000 miles, thereby reducing the advantage of European lines in reaching important South American markets.

Pan American Airways during 1940, over the 69,464 route miles of its international airways system, flew 17,100,000 miles, carried 275,000 revenue passengers a total of 140,000,000 miles, attaining new highs in all traffic categories—mail, passengers and express. Highlights of the vital transatlantic service were the stepping up of schedules by 50 per cent; completion without incident of 175 additional ocean crossings and a similar number of Bermuda shuttle trips.

In addition to other difficulties, Pan American had to operate at the beginning of 1940 under new neutrality rules, and carry on its operations under wartime conditions with no precedents to act as a guide. The winter passed without incident and the Clippers carried capacity transatlantic loads. Operating under the pressure of the war, and without the customary aids for gathering information on weather, the meteorological department was able to make forecasts which necessitated no mid-flight turn-arounds, and contributed to the record of allowing all Clipper crossings to be made "without incident."

With the coming of spring 1940, the transatlantic service got down to "normal operations"; the base was transferred from its winter location in Baltimore to the new International Air Terminal at La Guardia Field, New York, on March 31, 1940. With their new base established and the approach of favorable flying weather, the Clippers were able to settle down to a routine of shuttling back and forth across the Atlantic with their wartime loads of passengers and mail. By May, 1940, with a year of experience in transatlantic operation behind it and improved methods of overhaul and maintenance, the line was able to increase its schedules by half by adding another weekly round trip. All three trips were flown on the so-called "Southern" route, terminating at Lisbon. The "Northern" route had been discontinued in the Fall of 1939 because of freezing weather in that area. When the Neutrality Act became effective during the winter, Foynes, Eire, was placed within the barred zone and operations on the "Northern" route were moved to the "Southern" route via Bermuda and Horta.

In addition to important persons and refugees of all sorts, the Clippers carried to the war zone substantial cargoes of Red Cross supplies and serum. Mail loads had consistently mounted, and by the end of the year 3,000 to 4,000 pounds per trip were being carried in each direction, as compared to pre-war estimates of only a few

hundred pounds. A record load of mail was carried on December 18 when the "Yankee Clipper" set out for Europe with 13,402 pounds, the biggest mail load ever carried by an airplane.

In 1940 almost a half million pounds of mail were carried across the Atlantic by the Clippers and almost 2,000 passengers made the shore-to-shore crossing, apart from those who used the big Boeing flying boats for a trip to Bermuda. Passenger miles amounted to more than 13,000,000 and the Clippers flew more than a half million plane miles in 1940 to bring their total mileage on the transatlantic route past a million.

On the basis of experience gained through the 1939-1940 season, Pan American began preparations late in the Fall for the forthcoming winter by reconditioning the Clippers to give them more load-carrying capacity. Engines were changed to give 50 additional horsepower each, giving the Clippers a total of 6,200 horsepower for take-off. More efficient gas-consumption characteristics were incorporated in the engine change-over. Larger propellers, 14 feet, 10 inches in diameter, were installed. The "step" on the hull was lengthened by 23 inches, to give improved take-off performance. Gasoline capacity was increased from 4,200 to 5,400 gallons. With these innovations completed in the fleet, it was planned to omit Horta, the Azores, as a refueling stop on eastbound trips, the Clipper being prepared to fly the 3,119-mile trip non-stop between Bermuda and Lisbon on east-bound flights.

Meanwhile, out on the Pacific the giant Clippers winging their way to Honolulu and to the Orient completed their fifth year of operation, and in 1940 flew 844,344 route miles, 319,967 mail ton miles and 179,526 express ton miles. The 2,846 passengers on the Orient route flew 9,510,467 passenger miles.

Noteworthy among the new services started by Pan American in 1940 was that between the United States and Australasia. The Australasian area ranks fourth in foreign trade with the United States, and, being so far removed from both the United States and Europe geographically, the "down under" nations gain a proportionately large time-advantage through the speed of air transportation. It applies to the whole area, for although the Clipper route does not extend to Australia, it does connect at Auckland, New Zealand, with a British air route to Sydney. (Trans-Tasman Empire Airways).

A New Zealand route was surveyed as early as 1937 via Honolulu, Kingman Reef, and Pago Pago. That route, however, was not placed in operation, and with the advent of the larger Boeing 314 flying boats in 1939, a route by way of Honolulu, Canton Island and New

Caledonia was laid out and surveys flown. The first flight with air mail on the latter route was from July 12 to 24, 1940, for the round trip. Service with passengers began on September 11.

Over this newly established four and a half day, 8,000-mile air route to New Zealand, the Clippers flew 193,155 route miles in the six months that this twice-monthly service was in operation; and flew 57,389 mail ton miles, and 20,727 express ton miles. Passenger service on this route began in September—the total for the rest of the year was 356 passengers carried and 1,450,057 passenger miles flown.

The unusual conditions in the Orient affected all Pan American operations on the Pacific, especially the North Pacific operation to Hong Kong. A new route beginning at Manila to bring Singapore into the network was planned. The North Pacific Clippers would proceed from Manila to Hong Kong one week and from Manila to Singapore the next, maintaining weekly transpacific service, but with the alternate flights west of Manila.

Since 1932, Pan American Airways, through its subsidiary, Pacific Alaska Airways, maintained and increased its aerial network throughout interior Alaska, and the connecting link with the capital city of Juneau, 950 miles from the nearest United States point. Survey flights for a connecting route between Juneau and Seattle, Wash., had been made.

On July 12, 1940, the "Alaskan Clipper," a Sikorsky S-42B, made the first commercial flight providing the long desired link. Regular service on a twice weekly basis was maintained throughout the summer months and, when, with the advent of winter weather, flying boat operations were deemed impracticable, Douglas DC-3 equipment was placed in operation to provide all-year-round service between Juneau and Seattle, pending early delivery of Lockheed Lodestar transports to take over the service early in 1941.

Still another striking innovation during the year was the inauguration of new high-speed, over-the-weather air express services from Miami across the Caribbean to Panama and through the West Indies to Port of Spain and Belem, Brazil. Giant Boeing stratoliners cleared another 2,500 passengers at Miami's municipal airport. On July 1, the Pan American Airways System made a major move toward increased solidarity on the commercial air front of the Americas by adding 50 per cent to its services between the United States and Buenos Aires by way of both the eastern and western coasts of South America.

Into Pan American's inter-American service went the new fleet of over-the-weather ships, three of the world's largest type of com-

mercial land transports, the Boeing stratoliners. For the first time in a decade land planes were again operated over the Gulf Stream and across the waters of the West Indies. The big, 22-1/2 ton, four-engine Boeings were tested, pilots and flight crews were trained and survey flights made across the Caribbean.

For the first time in history the Americas were joined in half a day's travel time, when on the fourth of July the Caribbean was spanned non-stop in six hours from Miami to Barranquilla. It was necessary to train five complete flight crews to man the high-altitude Clippers and to establish the new services across the Caribbean to Panama, via Barranquilla, and connecting with Pan American-Grace Airways' new third schedule down the South American Pacific coast to Chile and over the Andes to Argentina; and over the West Indies to Puerto Rico, down to Trinidad and Belem, Brazil. That was done in order to provide the new thrice weekly schedule from Miami down South America's long east coast to Rio de Janeiro and Buenos Aires.

After years of survey and preparation, the famed new short route to Rio was inaugurated on September 1. This route leaves the long coastal course around the great eastern hump of Brazil (which extends to a point 2,700 miles east of New York and only 1,600 miles from western Africa) and plunges straight across the



NEW BOEING CLIPPER 314-A

First of a new fleet of Boeing transoceanic air liners scheduled for delivery to Pan American Airways in 1941, this 42-ton flying boat is shown on its delivery flight. Among the passengers were officials of the British Overseas Airways who had announced plans to use the famous Boeings in their own service.

little-known interior of Brazil 1,500 miles from Belem to Rio, cutting off a thousand miles from the former course. That cross-country route brought the Brazilian capital from five days to less than three days travel time from the United States, made Buenos Aires accessible in less than four days by either coast. The long schedules swung into permanent action, three times weekly in both directions, week in and week out. On December 12, 1940, an additional schedule was instituted between Rio and Buenos Aires, by way of Porto Alegre, trade center on Brazil's South Atlantic coast, making four schedules a week to the United States from Buenos Aires by way of Rio de Janeiro.

The fleet of flying boats and land planes of the Eastern sector were then flying an average of 360,000 miles a month—equal to 15 round-the-world flights every 30 days. Total mileage flown during 1940 topped almost 4,000,000, which was 660,000 more than 1939. Scheduled operations were carried on over 17,225 miles of fully equipped airways, which include five different routes spanning the Caribbean; the South American East Coast routes to Rio and Buenos Aires; a West Indian local line; non-stop, express services from Miami to the Canal Zone and Puerto Rico, and Trinidad to Belem, Brazil; a branch route between Havana and Merida, Mexico.

Rio de Janeiro and Santiago de Chile were only three days of daylight flying from the United States. From Lima, from Guayaquil, Ecuador, or from Belem, the air liners made the trip to the United States in two days, while from Colombia or Venezuela, from the West Indies, Guatemala or Mexico, the trip to the United States was made between breakfast and dinnertime.

Greatest recent advance in equipment and in providing passenger comfort and remarkably swift service was the inauguration of high-speed, through, express service with the Clippers "Comet," "Rainbow" and "Flying Cloud" [Boeing Stratoliners] which Pan American operated between the Panama Canal Zone and Miami to meet connections with the South American West Coast and between Belem and Miami to meet planes of the South American East Coast. These ultra-modern four-motored land planes, weighing 22-1/2 tons, cruised at nearly 200 miles an hour at levels avoiding the turbulence of surface weather.

Scheduled for delivery early in 1941 were six new super-Clippers designated as Boeing 314A flying boats. The new Clippers were of the same basic design as those in service, but they were to have increased horsepower and greater fuel capacity, with improvements brought about by the 15,000 hours of service experience in two years with the six Boeing 314 Clippers. The new Boeings had a maximum

gross weight of 84,000 pounds, and were equipped with four 1,600 h.p. (for take-off) Wright Cyclone engines and propellers 14 feet, 10 inches in diameter. The fuel tanks built into the hydro-stabilizers were increased in size for an additional 1,200 gallons of fuel to give the new Clippers a greater non-stop cruising range, bringing the total fuel capacity to 5,400 gallons per ship.

Other plans for 1941 contemplated a two day service from the United States to Rio de Janeiro and increasing schedule frequencies throughout the West Indies and Latin America to provide for growing traffic. Pan American Airways also looked forward to a transatlantic service to Europe in both directions on every business day, with faster schedules throughout the 69,464-mile system.

#### American Export Airlines

American Export Airlines had its efforts to establish overseas service under the American flag materially strengthened when in July, 1940, it received two certificates from the Civil Aeronautics Board to operate transatlantic service. One authorized passenger, mail and express service on the New York-Lisbon route, with four-engine Vought-Sikorsky S-44 flying boats. The second authorized temporary service for mail and express on the New York-Lisbon route, using the twin-engine Consolidated PBV flying boat, similar to the U. S. Navy PBV long-range patrol bomber, to operate only until the Vought-Sikorsky ships were put into operation.

Construction was being rushed for late 1941 delivery of the fleet of three Vought-Sikorsky flying boats, being built at Bridgeport, Conn., at a cost in excess of \$2,000,000. They were designed to carry 16 sleeping passengers, heavy mail loads and a crew of 11, non-stop between New York and Lisbon in approximately 20 hours. Patterned after the Navy Vought-Sikorsky super-dreadnaughts, the ships had



BEECHCRAFT 18S

A twin-engine transport with 450 h.p. Pratt & Whitney Wasp Junior engines.

a non-stop range above that required for the 3,400-mile New York-Lisbon flight. It was upon that range that American Export based its plans for non-stop operation, thus avoiding the Azores, where weather conditions might cause delay.

Flight crews were in training for many months, using the twin-engine Consolidated on survey flights, and coordinating in flight activities the work of the company's own communications staff and weather bureau. As the New York-Lisbon air line route paralleled the route of the parent company's steamship service, American Export Lines, an air lines meteorologist was assigned aboard each of the company's four transatlantic steamships to take frequent daily observations of weather aloft. Soundings obtained were radioed to the United States Weather Bureau, and correlated for operations guidance by the company's weather bureau maintained at Floyd Bennett Field.

In October, 1940, after months of careful studies and planning, American Export Airlines filed an application with C.A.B. to establish service from New Orleans over a short-cut route to Cristobal, Panama Canal Zone, via Central America and via Cuba. Survey flights over the routes were started immediately with a nine-man crew in the company's twin-engine Consolidated flying boat. The flights were conducted each month. Upper air flying weather conditions, observed at half-hourly intervals on the flights were relayed to the company's base at New Orleans Airport. The flight between New Orleans and Havana was of particular interest in that two old and famous cities were linked together for the first time by air and were only three and one-half hours apart.

Prior to filing the application for the short-cut routes between New Orleans and Panama, American Export Airlines negotiated for the purchase of the network of local air lines throughout Central America, Transportes Aereos Centro Americanos (T.A.C.A.). These negotiations involved 100 per cent ownership of T.A.C.A. by American Export Airlines, subject to the approval of the Civil Aeronautics Board. Under this plan T.A.C.A.'s complete network of airports and radio facilities, with 54 airplanes, maintenance bases, fueling stations and personnel would come under the American flag, the idea being to benefit national defense as well as American commerce by direct connections with the proposed short-cut route into New Orleans. American Export Airlines made a fast demonstration flight from Guatemala to New Orleans and return, using a T.A.C.A. plane. This flight was made in approximately five and one-half hours each way, and brought New Orleans a full business day closer to Central American countries than by existing routes.



### All American Aviation

All American Aviation operated its Air Pick-up Systems on five routes radiating from Pittsburgh to 108 cities and towns in the six States of Pennsylvania, West Virginia, Kentucky, Delaware, New York and Ohio. The routes averaged 275 miles in length and each served about 20 communities an average distance of 18 miles apart, although some were less than 10 miles from each other. Service to all points was provided by two flights a day, one in the morning and one in the evening, both being timed to give each community trunk-line connections for overnight service to and from other air line points.

Communities along the pick-up routes ranged in population from 800 to 120,000. Many had no airports and at those places the Air Pick-up stations were located on hilltops, meadows and in public parks. The Pick-up station could be established wherever the approaches were reasonably clear of obstacles for a distance of 500 or 1,000 feet in opposite directions. A number of the towns with airports had the local air Pick-up stations located on the landing fields. Schedules were maintained at an average speed of 110 miles an hour.

Introduction of new equipment produced by the development division of All American simplified the pick-up operations, increased speed and flying accuracy in making station contacts, and made it



VOUGHT-SIKORSKY S-43 AMPHIBION

A fleet of these transports was delivered to Netherlands East Indies Airways.

possible to handle heavier loads. The portable ground station was a distinct improvement, especially in facilitating operations from airports, as it was not a flying hazard.

The Air Pick-up operations conducted by All American attracted attention throughout the world. Other companies were planning the establishment of similar service in different parts of the United States, and inquiries were received from several foreign countries. Early in 1941 All American announced plans for seven new routes in New England and adjacent areas in New York, New Jersey and Pennsylvania.

#### American Airlines

American Airlines in 1940 carried its 3,000,000th passenger. The rapid growth of air transportation is reflected in the fact that it took American Airlines approximately ten years to carry its first million passengers, two years and seven months to carry its second million, and a little more than a year to carry its third million. The company, operating from coast to coast, carried 870,930 revenue passengers in 1940, compared with 541,757 the previous year. This means that 311,746,689 revenue passenger miles were flown by American in 1940, whereas in 1939 the figure was 207,360,215. The 1940 statistics marked a new record for travel over an air transport system in a single year. Part of the increase in passengers carried in 1940 was due to a record-breaking winter vacation season in the Sun Country and California. Because of conditions abroad and other reasons, "See America First" became the travel slogan. American Airlines inaugurated its fifth transcontinental round-trip flight in September. It increased to five the number of Flagship flights daily each way over the Southern Transcontinental Route between Los Angeles and New York. Figures compiled in December showed that American Airlines flew 77,005 scheduled miles every 24 hours, of which 35,044 or 45.6 per cent were night flying. During 1940 American accepted delivery on 32 new Flagships of the Douglas DC-3 21-passenger day ships and DST (Skysleeper) types. By the end of the year the company operated 86 ships, including 61 DC-3's, 15 DST's, 5 DC-2's, and 5 Stinson Reliant route survey and pilot training planes.

#### Canadian Colonial Airways

Canadian Colonial Airways in 1940 established a new base at LaGuardia Field, New York, and spent \$300,000 on line expansion. The regular equipment included six Douglas DC-3 transports. The routes provided service for New York, Albany, Burlington and Montreal, with additional seasonal service to St. Jovite, famous resort,

known the world over for its skiing, hunting, fishing and many other sports. A complete merchandising plan for the tourist traffic was introduced. Sky cruises were offered for summer vacations, and ski planes attracted winter sports fans.

#### Catalina Air Transport

WCA in 1940 completed nearly ten years of operating a scheduled passenger and express service between Avalon, Santa Catalina and Wilmington, Calif., the mainland terminal, a distance of 30 miles over the Pacific, without mishap to a revenue passenger. During 1940, 30,342 passengers were carried on 4,873 flights, having given transportation to as many as 6,474 persons in one month and 304 in a single day. On January 2, 1941, the air line name was changed to "Catalina Air Transport", preparatory to a new service to start about May 1, 1941, and supplanting the old marine operation. Under construction was a new \$150,000 land airport on Catalina, and a high-speed road to Avalon. The new airport was to be the base for two new Lockheed Lodestars, specially built to accommodate 17 passengers and having ultra-modernistic streamlined interiors to simulate a 25th Century Rocket ship.

#### Eastern Air Lines

Eastern Air Lines early in 1941 was operating frequent round-trip flights between New York and Washington, D. C., offering the most frequent air passenger service between any two cities in the world. Extensions during 1940 brought the route total to 5,647 miles, a 5.9 per cent increase. At the beginning of 1941, company person-



THE LOCKHEED LODESTAR

One of the air liners in United Air Lines service.

nel totalled 1,946, representing an increase of 41 per cent over 1939. Average age of personnel was 30 years. Company payroll for 1940 was \$4,014,170, an increase of 45 per cent over 1939. Revenue passenger miles flown in 1940 totalled 158,132,350, an increase of 54 per cent. Plane miles totalled 16,171,801, an increase of 43 per cent. Revenue passengers carried were 346,593, an increase of 50 per cent over passenger volume of 1939. The company operated 39 Douglas transports and three Stinson Reliant instrument-training planes.

#### Mid-Continent Airlines

Mid-Continent Airlines in 1940 expanded personnel more than 100 per cent, brought about by new routes. Revenue passenger miles for 1940 increased to almost six and a half million and the year ended with 1,741,614 miles flown. Passenger traffic increased to 23,821. Air express stood at the record high of 54,884 pounds. A new fleet of Lockheed Lodestar 14-passenger transports was purchased to supplement the 10-passenger Lockheed Electra aircraft already in service. A Civil Aeronautics Board examiner's report recommended that Mid-Continent Airlines be awarded a new route from St. Louis to Minneapolis via Ottumwa, Ia., Des Moines, Ia., and Rochester, Minn., with an extension from Des Moines, Ia., to Kansas City, Mo. On May 3, 1940, the first night operations over the northern division of the Great Plains route were started. The company was granted a certificate of convenience and necessity to operate the new Bismarck to Minot, N. D., extension, a 105-mile airway north to North Dakota's leading trade center, a gateway to Canada.

#### Northwest Airlines

Northwest Airlines in 1940 placed 21-passenger Douglas planes in service on all flights over its transcontinental line and on the run between Spokane and Portland. A new line was opened to Duluth, Minn. Passenger revenues increased 62.41 per cent over 1939. A total of 37,089 more passengers were carried during the year, making a total of 111,608 revenue passengers in 1940. The increase in passengers carried was more than 50 per cent for the year. Passenger revenue miles totalled 59,787,646 as compared to 34,749,246 in 1939. The line carried 2,293,121 pounds of air mail and 515,211 pounds of air express in 1940.

#### Pennsylvania-Central Airlines

Pennsylvania-Central Airlines reported a 100 per cent increase in net income for the first eleven months of 1940 over the corresponding period for 1939, a 72 per cent gain in revenue passenger traffic in 1940

over 1939, the replacement of older equipment with the most modern type of luxurious aircraft, and the inauguration of a new 500-mile air route through the South. A total of 210,436 revenue passengers flew with PCA's Capital Fleet in 1940. In the same period 37,579,164 revenue passenger miles were flown by PCA as against the 21,192,745 revenue passenger miles flown in 1939, a gain of 77 per cent. The



#### TWA BOEING STRATOLINER

Interior of one of the 33-passenger, high altitude transports in transcontinental service.

company had 725 persons on its payroll. Air hostess service was introduced. Over 60 young ladies graduated from PCA's Air Hostess School at Detroit, and 36 hostesses were on the line early in 1941. On November 1, 1940, Pennsylvania-Central started a new 500-mile air route through the south from Norfolk, Va., to Knoxville, Tenn., opening up a vital new artery in the nation's air line network. Serving Rocky Mount, Raleigh, Greensboro-High Point, Hickory and Asheville-Hendersonville, all of North Carolina, as intermediate points, the new route was at once a tremendous improvement in transportation facilities and an important agency for handling air mail and air express for the area. Another new route was the Grand Rapids-Traverse City link, providing a through air service from Chicago to upper Michigan.

#### Transcontinental & Western Air

Transcontinental and Western Air in 1940 recorded the most remarkable growth in its history. Passengers, air mail and air express reached all-time highs. One of the important contributing factors was the inauguration of service by four-engine Boeing Stratoliner schedules. Five of the 33-passenger ships were purchased. They opened a new era in domestic air line transportation by innovating a system of flying "above the weather". The transports were equipped with "pressurized" cabins so that passengers could enjoy low level comforts of breathing while flying three and four miles above the earth. The Boeing Stratoliners were the only ships of this size and type operated by any domestic line, and they were designed to provide the fastest transcontinental schedules, as well as the swiftest Chicago-New York service.

To handle the many additional schedules instituted in 1940, TWA increased personnel from 1,500 to 2,800. Passengers carried advanced 59 per cent over 1939. Express and mail showed a 67 per cent and 46 per cent increase, respectively. Emphasis on personalized passenger service was intensified. TWA installed its own kitchens at New York, Chicago and Pittsburgh, and these food units, together with caterers at other online points, served approximately 400,000 hot meals.

An improved reservation and communication system was set up. A center for one of the largest air line teletype systems in the world was established in Dayton, O., to speed the transmission of nearly 3,000,000 words a month. As many as 800 messages an hour were handled.

New schedules were added to take care of passenger demands, and Marquette Airlines, which operated from St. Louis to Detroit, via Cincinnati and Dayton, was purchased and absorbed into the

TWA system with the approval of the Civil Aeronautics Board. It marked the first entrance of the air line into Detroit and Cincinnati.

To assist in research activities, a twin-engine Lockheed 12 was purchased. It supplanted the well-known Northrop Gamma which had been used for the past several years for high altitude experiments leading to the development of the Stratoliners. New engineering developments were installed on the Lockheed for thorough test under every possible flight condition before being approved or disapproved for installation on the passenger planes. TWA had 42 planes in operation at the beginning of 1941, including 22 Douglas DC-3's and DST's, 13 DC-2's and five four-engine Boeings. Additional equipment was on order for 1941, with delivery subject to the priorities requirements of the defense program.

#### United Air Lines

United Air Lines in 1940 flew 222,331,118 revenue passenger miles, a gain of approximately 50 per cent over 1939; flew 23,174,931 revenue airplane miles, an increase of almost 32 per cent; flew 5,834,395,067 air mail pound miles, a gain of eight per cent; and 2,190,378,085 express pound miles, or more than 22 per cent over 1939. By the peak of the season, United was flying 2,270,000 miles a month, exclusive of extra sections and charters. Of the total, 1,734,000 miles were scheduled on United's coast-to-coast "Main Line" airway and 535,700 miles on its Pacific Coast route. Included were 13 daily round trips between New York and Chicago, of which five were non-stop; seven daily round trips between New York and the Pacific Coast, twelve daily round trips between San Francisco and Los Angeles, and four daily round trips the length of the Pacific Coast, in addition to numerous other inter-city schedules. New equipment in-



THE CURTISS TRANSPORT



#### DOUGLAS DC-3

Interior of Chicago & Southern Air Line transport.

cluded 18 Douglas DC-3 Mainliners, both of the sleeper and day plane types, and four Lockheed Lodestars. Ordered for future delivery were 10 more DC-3 Mainliners and 20 Douglas DC-4 transports, 40-passenger, four-engine Super Mainliners to cruise at 228 miles an hour and make possible coast-to-coast travel time of 13½ hours, including stops.

In September, 1940, United observed the 20th anniversary of the New York-San Francisco airway. Contrasted were the three-day air-rail schedules of 1920 and United's 15½-hour coast-to-coast flights of 1940; the single-engine open-cockpit 90-mile-an-hour planes of 20 years ago and the twin-engine 200-mile-an-hour cabin Mainliners of 1940; the lack of flying aids in 1920 and the numerous devices employed for scientific, dependable and safe operation in 1940. United carried on three projects for improved radio telephone communication between planes and ground stations. One was the development of a 5,000-watt transmitter for ground stations. As a



second project, United brought out a new combination transmitter and receiver for planes. This unit, weighing only 75 pounds, operated on 10 frequencies, any one of which could be selected automatically by the pilot. A third project was the development of a gigantic new antenna, 1,200 feet long, 500 feet wide and 100 feet high, with directional characteristics which were said to reduce static and other interference by at least 100 times as compared with any antenna previously in use. The total number of employees reached 3,065 as compared with 2,191 in 1939.

#### Western Air Lines

Early in 1941, Western Air Express celebrated its 15th anniversary and changed its name to Western Air Lines. In 1940 the line extended its service to Lethbridge, Canada, completing its system as an international carrier from the Mexican border to Canada. Revenue



WACO INTERIOR

Rear seat detail of the Model E.

passengers increased 55.37 per cent, from 30,075 in 1939 to 46,728 in 1940. Revenue passenger miles flown jumped 42.54 per cent from 11,035,541 to 15,730,164. The Civil Aeronautics Board denied a merger with United Air Lines on June 19, 1940, which had been proposed July 8, 1939. The company immediately went ahead with plans for expansion which were held in abeyance during merger proceedings. At the same time the merger was denied, the C.A.B. granted Western and United the right to interchange equipment at Salt Lake City, thus giving through sleeper service for the first time without change of planes. On August 20, interchange was inaugurated, setting a precedent for air transportation.



#### IGOR SIKORSKY AND HIS HELICOPTER

The Vought-Sikorsky VS-300, with 90 h.p. Franklin engine making its officially observed record flight of one hr. five min. on April 15, 1941.

## CHAPTER VIII

### PRIVATE FLYING

Increase in Pilots and Planes—Problems Incident to the Defense Program—New Uses for Civil Aircraft—New Record for Safety—Development of Cross-country Flying by Private Owners—Sales Promotion Efforts by Light Plane Manufacturers.

**P**RIVATE flying enjoyed a new surge of popularity in 1940 and even World War II, which in early 1941 beclouded with uncertainty the future of almost all normal human endeavor, had a silver lining for this important branch of aviation. The silver lining was the assurance that out of the holocaust there was certain to rise a full, new generation of airmen, trained as military pilots during the emergency, who, with the coming of peace, were foreseen as eager to continue flying—for business or pleasure. Some authorities predicted that the new flyers would number hundreds of thousands; Government figures showed there would be more than 100,000 rated pilots in the United States by July 1941. Aviation experts forecast that, as the functions of private flying multiplied, those 100,000 pilots, and the thousands expected to follow them through flight training courses, would lift private flying to a new, proud status in the general transportation scheme.

Full scope of private flying's potentialities became evident in 1940 as scores of new functions were successfully performed in light and medium weight planes. This newly-discovered utility, plus a generally-heightened interest in the art of flying on the part of the public, was convincingly reflected in Government statistics relating to numbers of new pilots and aircraft.

Licensed pilots increased by 31,849 during the year, rising from 31,264 on January 1, 1940, to 63,113 on January 1, 1941, a percentage increase of 101.9. Of the January 1, 1941, total, about 75 per cent were termed private pilots and about six per cent solo pilots. It was



GRUMMAN WIDGEON

A four-five passenger amphibion powered by two Ranger 200 h.p. engines.

those two classes which were responsible for most of the private flying done during the year. The number of women who held licenses increased from 902 in 1939 to 2,145 in 1940.

The number of certificated aircraft, exclusive of all types of military airplanes, also rose sharply. There were 17,351 certificated planes on January 1, 1941, as compared to 12,829 the previous year, an increase of 35.2 per cent.

California again held the lead in the number of licensed pilots, with 8,285, followed by New York, with 4,863, and Texas, with 3,918. California also had the largest number of certificated aircraft, 1,753. Pennsylvania was second, with 1,438, and New York was third, with 1,323.

There were about 60 licensed models—with about 20 others in an experimental stage—from which customers could choose in 1940 in buying a plane made in the United States for private flying operations. This was about 10 more models than were available for purchase during 1939.

Official records showed that 4,455 "Class I" planes weighing less than 1,300 pounds were manufactured in 1940 as against 3,029 in 1939; that 2,019 planes in the 1,300-4,000 pound weight class were built in 1940, compared with 529 in 1939. These were the two classes of planes in which most of the year's private flying operations were conducted. The growing popularity of the 1,300-4,000 pound plane, as evidenced by the almost 300 per cent increase in 1940 manufacture of that weight class over 1939, was partially explained by the fact that the public grew increasingly cognizant of the many functions such craft would perform cheaper, faster and more safely than they had

ever been performed before. Among these new duties taken on by the private flyer and his plane—sometimes commercially, sometimes simply through a spirit of cooperation—were ambulance work, fighting forest fires, police work, transport of executives on national defense missions, and other similar functions.

In addition to making possible such services, the private plane lent itself to scores of new personal services. Salesmen, such as the milking machine vendor who flew his product direct to cow pastures for demonstrations, adopted the airplane in ever-growing enthusiasm to increase their efficiency. Mining prospectors, ranchers and oil drilling contractors were able to make their rounds more often in the air. The private plane found numerous other uses, not the least pleasant of which was fishing from seaplanes.

Increasingly important in the aviation scheme was the Civilian Pilot Training Program which created thousands of new private flyers, who formed a reservoir of potential military pilots ready for any call to the colors.

Outstanding refinements in the planes built for the private flyer were made during the year. One of these, development of a radio for installation in all planes of a certain model put out by a prominent light plane concern, was significant in that it marked a step toward inclusion as standard equipment in private planes of devices heretofore obtainable only as "extras," at added expense to the purchaser. Another advance was the installation of self-starters on light planes;



1941 STINSON VOYAGER

A three-place private owner plane with 90 h.p. Franklin engine.



#### THE WACO MODEL E

A private owner plane available with five different engines. The Waco is manufactured by Waco Aircraft Company, Troy, O.

still another was installation of mufflers, which sharply reduced annoying motor noises. Designs were further streamlined; upholstery became more attractive; new, glossy outside finishes were added. All in all, the private plane moved rapidly out of the ungainly, dirt-encrusted "jalopy" class into the category of bright, modern adjuncts to better living.

A substantial factor in the increased popularity of private flying was the growth in number of airports and seaplane bases (see Chapter VII, Airports and Airways). Authorities were agreed, however, that additional large numbers of new airports were necessary to permit the volume of private flying envisioned for the future. On this subject, William T. Piper, president of the Piper company, said:

"I believe that it is just as much the duty of the Government to



INTERIOR OF TAYLORCRAFT PLANT



#### REARWIN SPORTSTER

It is powered by a 70 h.p. Ken-Royce or 90 h.p. Warner engine.

furnish adequate landing fields for those who wish to fly as it is to furnish roads for those who wish to drive automobiles."

A number of non-profit groups worked to advance private flying during the year. Among these was the Private Fliers Association, of New York, a national organization. Through the efforts of these groups, and those of scores of local groups throughout the country, many flying clubs were formed, in which a number of persons banded together to purchase one or more airplanes for their own use. Well-based plans were formulated, whereby small monthly payments by each member made possible ownership, storage and maintenance of flying equipment and, in many cases, flight training to participants.

The defense program posed a number of production problems for manufacturers of light planes. The Aeronautical Chamber of Com-



#### PORTERFIELD TWO-PLACE CABIN



THE CESSNA AIRMASTER

It is powered by either a 145 h.p. or 165 h.p. Warner engine.

merce of America, trade association for the aircraft manufacturing industry, coordinated efforts by the light plane builders to solve these problems, and many of the difficulties were ironed out. The central point at issue in most of these negotiations was the value of the light plane to the national defense program, particularly in connection with the Civilian Pilot Training Program. By the end of 1940, most defense officials were of the view that the light plane was playing a valuable role in the pre-military stage of Army and Navy pilot training.

An all-time U. S. record for private flying was set in 1940. Nearly 1,000,000 miles were flown per fatal accident, according to statistics prepared by the Civil Aeronautics Administration. The year marked the fifth in succession in which a gain in the safety record of private flying was recorded.

Pilots of 16,500 private planes, with and without passengers, flew 220,000,000 miles during the year, the C.A.A. reported. There were only 231 fatal accidents, responsible for the death of a total of 356 persons. This was 1,168,367 miles per pilot fatality and 1,651,420 miles per passenger fatality.

The 1940 safety record was reflected in a decrease in insurance premiums for CPTP students. In 1939 the rate was \$20 for \$3,000 in the event of death or \$1,000 in event of injury. The 1940 rate was only \$9. In addition hospitalization and medical benefits were doubled as of January 1, 1941, with no increase in the insurance premium.

One of the outstanding chapters in the year's history of private flying was written by 1,400 pilot enthusiasts who flew their planes, all powered by 80 horsepower or less, from hundreds of points through-



out the entire country to Florida, between December 25, 1940 and January 25, 1941. Most of the cross country flyers arranged their itineraries to be in Florida in time for the big Miami Air Maneuvers January 10, 11, and 12. The Gulf Oil Corporation, which sponsored the air tour along with private flying organizations and light plane manufacturers, estimated that the 1,400 planes flew more than 3,000,000 miles. There were no casualties. Observers declared that these statistics demonstrated impressively the progress of private cross country flying. The 1940 air tour was conducted somewhat differently than it was in 1939. At that time, the planes moved as a group from key points of departure. In 1940, however, with military flying training operations multiplying under the defense program, it was realized that a mass cavalcade of hundreds of aircraft would be undesirable, as it would cause congestion at training centers where civil and military air programs were in their important formative stages.

So the tour was arranged to cover 30 days, with the flyers leaving their home fields any time that they wanted to during that period. As a result, there was no congestion or unusually heavy concentration of aircraft along the way. The Gulf Corporation furnished gasoline and oil to all private flyers who made the journey along specified airways.

The year witnessed the introduction of many new promotion activities. Among those employed by some of the light plane manufac-



NEW BEECHCRAFT F17D

It is powered by a 330 h.p. Jacobs engine.



#### THE PIPER CUB CRUISER

A three-place utility light plane, with Continental or Lycoming engine, produced by Piper Aircraft Corporation, Lock Haven, Pa.

turers were: The Piper company placed large two-color advertisements of an institutional nature, seeking to promote private flying on behalf of the entire industry, in magazines of wide national circulation, such as the Saturday Evening Post and Collier's. These advertisements were followed by more than 75,000 inquiries regarding private flying and light planes directed by the public to the Piper concern. Piper continued to offer free flying courses to all purchasers of their product. Piper's most unique promotion of the year was participation in the "Wings of Destiny" radio program over a 92-station hookup. Each week on this program a Piper Cub Trainer airplane was given away in a contest which drew over 40,000 entries weekly. This program was to continue through most of 1941.

In the line of improvements, Piper installed mufflers on all planes, reducing the noise to a point where it compared with an automobile traveling at 60 m.p.h. Sound proofing was also built into Piper planes. A self-starter was added to Piper aircraft as standard equipment, as was radio. Experimental projects included the Cub Clipper, a two-place amphibion with 120 h.p. The company expected to have this new type ready for the market by the middle of 1941.

The Fairchild company conducted a campaign to secure distribu-

tors throughout the country who confined their activities to selling, rather than merely including sales activities along with charter operation and flight training. Fairchild continued its policy of introducing improvements as they became available, rather than awaiting early model changes. The company's familiar "24" Model found favor in the Hollywood movie colony, where it was purchased by such cinema luminaries as Charles (Buddy) Rogers, Robert Taylor, Brian Aherne and Barton MacLane.

The Luscombe company offered free flying instruction to all purchasers. Luscombe also added several new traveling representatives to assist dealers and distributors. Two women were added as Luscombe dealers.

The Aeronca company instituted a district manager-distributor-dealer setup whereby the district manager had under his direct control the distributors, who in turn had under their control the dealers. Advertising of the newspaper, direct mail, magazine and radio types was employed. Free flight instruction was offered to all purchasers of Aeronca planes. Stressed safety features gave additional comfort and improved appearance.

Porterfield installed a questionnaire system, through which private owners were asked periodically for suggestions that might help the company to improve its products.

The Engineering and Research Corporation introduced a light plane for private flying which it named "Ercoupe" following motor car practice.

Gillies Aviation Corporation played a novel part in popularizing private flying in 1940. This company, basically an aircraft sales organization, differed from the normal conception of such an organization because of the variety and scope of its activities. In addition to selling many types of American-built airplanes, the company main-



WARNER-POWERED FAIRCHILD 24

tained an all-inclusive aviation service. In many instances it handled the entire aviation interests of a client, including the hiring of personnel. The company was active in a consultant capacity.

In the field of record breaking achievements, the private flyer held his share of the spotlight. Three new records—two national and one world—were established by private flyers in light planes.

On January 30, Edward J. Walz, at Brooklyn, N. Y., set a new national speed record for light planes over a 100-kilometer course when he flew his Luscombe, powered by a 65 h.p. Continental engine, at an average rate of speed of 118.746 m.p.h. On September 12, at Burbank, Calif., Grace Huntington of Modesto, Calif., established a new light plane national altitude record when she took her Taylorcraft, powered also by a 65 h.p. Continental, to a height of 24,311 feet.



LUSCOMBE PRIVATE OWNER PLANES

Outside the factory in West Trenton, N. J.

## CHAPTER IX

### MISCELLANEOUS ACTIVITIES

Aeronautical Chamber of Commerce of America—Air Transport Association of America—Aircraft Owners and Pilots Association—Institute of the Aeronautical Sciences—Manufacturers Aircraft Association—National Aeronautic Association—National Intercollegiate Flying Club—The Soaring Society of America—Society of Automotive Engineers.

**A**CTIVITIES of the more important national aviation associations were aimed at two objectives as the national defense program claimed increasing attention in 1940. The first objective was to contribute to the defense program in every way possible; and the second was to conserve the great gains made in private and commercial flying against the day when a world once again at peace should find itself more than ever before in need of the flying machine for peaceful uses.

#### **Aeronautical Chamber of Commerce of America**

As the 21-year old trade association for the aircraft manufacturing industry in the United States, the Aeronautical Chamber of Commerce of America was the industry's spokesman and its intermediary in bringing about either a definite solution or, at least, clarification of the rapidly increasing number of problems cast up by the national defense program. The Chamber membership at the beginning of 1941 included the airplane and aircraft engine companies as well as the major accessories manufacturers. Representing the group opinion and conclusions of the industry as developed by committee meetings on all important matters, the Chamber followed closely the legislative developments in Congress, which remained in almost continuous session after the developments in Europe made apparent the fact that the United States was confronted with an emergency which required the utmost in preparedness for defense. On request of the various



U. S. Army photo

**NORTH AMERICAN BASIC COMBAT**

The Air Corps BC-2, with Pratt & Whitney Wasp engine.

Congressional Committees, the Chamber, either by written brief or personal appearance of the management, presented the views of the industry as well as the voluminous factual data in connection with the expanding production of aircraft. A thorough analysis of all pending aviation measures was made and reported to the membership. A total of 28 such bills became law in 1940, including 17 general and 11 appropriation, and a number of other bills were introduced. The Chamber prepared and sent to members a total of 74 legislative bulletins, and distributed a complete legislative digest.

Under the impact of the emergency defense program and consequent manifold expansion of productive facilities, the Chamber broadened its activities and added to its staff in order to cooperate more



U. S. Army photo

**VULTEE BASIC COMBAT**

The Wasp-powered BC-3 built for the Army Air Corps.

effectively with the regular Government bureaus, which were being enlarged, and also the new bureaus created for the period of the emergency, such as the Office of Production Management. The executive staff of the Chamber maintained constant contact with all bureaus; and on all matters affecting the manufacturing groups as a whole, Government officials designated the Chamber as the clearing house for information between themselves and members of the industry. The conference boards and advisory committees on which Chamber executives were invited to serve increased rapidly as the defense program got well under way early in 1941. For example, the president of the Chamber represented the aircraft manufacturers on the Priorities Advisory Committee.

Rules and regulations promulgated by the Federal bureaus received a great deal of attention from the Chamber staff and committees. Examples were found in the work of the Accounting Committee in its cooperation with the Treasury Department which many times led to clarification of existing problems and revisions of Treasury Decisions. The Chamber's work with the Interdepartmental Committee on Federal Apprenticeship won official recognition of the principle of vocational training conducted by the respective companies according to



**STREAMLINED NOSE OF BELL AIRACOBRA**

An unusual view of the highly streamlined nose of the Airacobra pursuit plane showing its three blade Curtiss electric propeller.



#### REPUBLIC EP-1 PURSUIT

It is powered by a Pratt & Whitney Twin Wasp engine.

conditions prevailing in the different localities in which the plants were situated.

Another notable example was the work of the Export Committee which through its departmental executive in the Chamber succeeded on countless occasions in clarifying regulations and solving other problems brought about by wartime conditions and current neutrality legislation. The rapidly expanding regime of Government instituted export control measures required prompt official interpretation, and the Chamber in 1940 issued upward of 100 bulletins dealing with export problems.

Still another notable example of the manner in which the industry assisted the Government in the unprecedented national defense pro-



#### LOCKHEED P-38 INTERCEPTOR-PURSUIT

Powered with two Allison 12-cylinder engines and Curtiss electric full feathering propellers, this fast single-seat combat plane was in quantity production at the plant of the Lockheed Aircraft Corporation, Burbank, Calif.



gram was its work, through the Chamber, in explaining to the public through all news media the various intricate and complex steps by which the United States was producing air force equipment. So important had this work become late in 1940 that the Chamber's public relations department was expanded, its public relations committee reorganized and a special aviation news committee created for the rapid dissemination of all permissible facts about the record production of aircraft. At the same time the committee and the public relations personnel of the Chamber staff maintained the closest liaison with the various defense bureaus of the Government, the press, radio, motion picture news organizations and other channels of public information. An important function of the Chamber for 20 years had been the compiling of production statistics; and early in 1941 that activity was reorganized and expanded to render even greater service both to the Government bureaus and the industry. The Chamber also continued to publish the Aircraft Year Book, the Aeronautical Export Directory and the aircraft and pilot license lists.

Notable among the Chamber's activities was the work of the technical department, which maintained close cooperation with the various Government bureaus as liaison for the engineering departments of member companies. In 1941 the technical department was serving in a liaison capacity for the National Aircraft Standards Committee which was allocated airframe and power plant installation activities by the Office of Production Management. It collaborated with the Army-Navy Aeronautical Board in revising specifications. It also surveyed and correlated the research and development needs of mem-



PITCAIRN-LARSEN AUTOGIRO PA-36



#### VOUGHT-SIKORSKY F4U-1 IN FLIGHT

This inverted gull wing shipboard fighter is powered by an 1,850 h.p. Pratt & Whitney Double Wasp engine and a Hamilton Standard Hydromatic propeller.

ber companies for discussion with personnel of the National Advisory Committee for Aeronautics and the Technical Development Division of the Civil Aeronautics Administration.

An outstanding example of the value of group effort through a trade association was the Chamber's successful presentation, early in 1941, of the appeal of the light plane manufacturers that they be allowed to secure a reasonable amount of essential raw materials to enable them to continue in production. The Chamber also was active in securing interpretations of the regulations of the Priorities Division of the Office of Production Management and advising members as to how they should proceed in covering their requirements.

#### Air Transport Association of America

The air transport industry, through the Air Transport Association of America, which it formed in January, 1936, as a clearing house for safety, legislative and business matters of interest to all air lines, made marked progress in 1940. Safety continued to be one of the major functions of the Association as evidenced by the following compilation of the meetings held on this subject: Chief Pilot's Committee had four meetings in 1940. (Six memoranda on 20 major subjects were exchanged in 1940.); the Meteorologists had three meetings in 1940. (Twelve memoranda covering separately over 30 subjects were exchanged during 1940.); Operations Committee had six meetings in 1940. (Fifty-five memoranda were exchanged covering over 200 subjects having a direct application to safety.); Engineering and Maintenance Committee met twice in 1940 with two additional special

meetings. (15 memoranda were exchanged in 1940, the majority of which went to the Army, Navy, National Advisory Committee for Aeronautics and manufacturers.)

Miscellaneous activities of the Association during the year included work on the following subjects: Air Mail Rates, Intrastate Operations, Air Express, Air Mail Field Post Offices, Airports, Airport Leases, Omnibus Transportation Bill, Regulation of Forwarders, Excess Profits Tax Legislation, Consolidated Tariff (published by the Association), Personnel Agreements, Personnel Problems Created by National Defense Measures, Joint National Advertising Campaign in cooperation with manufacturers, Air Navigational Facilities, Purchasing and general public relations subjects.

An Airline Finance and Accounting Conference was formed during the year as a division of the Association with E. I. Whyatt, secretary and treasurer of Northwest Airlines, its first president and E. Lee Talman, vice president and treasurer of Transcontinental and Western Air, and Amos Culbert of Chicago and Southern Air Lines, as vice presidents. This Conference had active committees working during the year on the cooperative purchase of insurance, revising the standard chart of accounts and making an audit of charges for handling express.

The Air Traffic Conference Division of the Association elected Laigh Parker, vice president of Delta Air Corporation as its president. Accomplishments during the year included the following: Air Travel on Credit, Plane-Auto service, and work with steamships, railroads and bus lines on promotion of inter-carrier relationships.

The "It Pays to Fly" advertising campaign of the air lines and



**THE REARWIN CLOUDSTER**

A two-place plane with 90 h.p. Ken-Royce engine.



#### CONSOLIDATED PBY-5A AMPHIBION

Consolidated Aircraft Corporation Model 28 flying boat with wing tip floats was the basic design to which the 3-wheel landing gear was added to make this long range amphibion.

manufacturers received the 1940 award of the magazine "Advertising and Selling" for the best campaign conducted by a trade association.

Herschel Snodgrass, a graduate student of the University of New Mexico, was awarded the Association's research fellowship in 1940 for his work in investigating the charge centers of cumulo-nimbus clouds.

#### Aircraft Owners and Pilots Association

Devoting itself exclusively to the interests of all civilian fliers other than air line pilots, the Aircraft Owners and Pilots Association



U. S. Navy photo

#### VOUGHT-SIKORSKY SB<sub>2</sub>U-3

A Navy scout bomber on Edo floats.

early in 1941 claimed 7,000 members. Because all nonessential flying activity was bound to be greatly restricted throughout the emergency, the Association endeavored to determine the place its members would occupy in the defense picture during the period of the emergency. It organized a system of training for civilian fliers, designed not only to improve their knowledge of aviation, but also of the military sciences. A body called the "Air Guard" was formed and sponsored by the Association. Shortly after the announcement of the project more than 500 of the Association's members had commenced work on Air Guard courses. Air Guard continued to flourish, and it became apparent that the demand for these courses would be great. Meanwhile, the United States continued to become more and more involved in the international situation and A.O.P.A. determined that its duty was not to dissipate any energy, but to suggest and sponsor the formation by the Government of a civil air reserve. This was the chief project of the Association throughout the winter of 1939-40. Plans were developed whereby the civil air reserve could be formed of all available non-scheduled fliers, their equipment, their bases and their staffs. Civil air reserve, in A.O.P.A.'s opinion, would "represent the best means to convert the civilian asset, represented by non-scheduled aviation, in this country into a group admirably adapted to make a great contribution to the national defense." A.O.P.A. also continued its civic and service work. There were some 180 units servicing that many localities, and they were at the forefront of the continual battle for more and better airports in their own communities. Over 300,000 miles were flown by 6,200 pilots partaking in various air activities. Discriminatory taxes against non-scheduled fliers were prevented in several cities during 1940. The Association performed pioneer service in conducting survey flights, and routing its members on long trips with a view to efficiency and comfort. It was successful in reducing



CULVER CADETS

Produced at the Culver plant in Wichita, Kans.



TAYLORCRAFT'S NEW PLANT AT ALLIANCE, O.

the cost to members of certain equipment which it desired to have used more generally, such as radio and fire prevention apparatus.

#### Institute of the Aeronautical Sciences

The Institute of the Aeronautical Sciences in 1940 announced a gift of \$50,000 by Paul Kollsman and F. W. Magin of the Square D Company, providing for the establishment of a lending library and two publications, the "Aeronautical Reader's Guide" and the "Aeronautical Review." The Archives of the Institute maintained a service to provide bibliographical data on aeronautical subjects.

In addition to 630 student members the former figure of 2,000 Institute members in other grades for the previous year had been increased to 3,045 by the end of 1940, making a total of 3,675.

In aeronautical schools, where there is an Institute member on the faculty who will sponsor a Student Branch conforming to the requirements, such branches are formed by Student Members of the Insti-



U. S. Army photo

#### STEARMAN PT-18 TRAINER

It is powered by a Jacobs engine.

tute. Over 100 meetings were held during the year by the Institute's 34 Student Branches and the six local Sections of members and affiliates in various aviation centers.

The Institute participated in the technical sessions of the Eleventh Annual Convention of the Greater New York Safety Council and the summer meeting of the American Association for the Advancement of Science in Seattle. In connection with the latter meeting, the Seattle Branch held a banquet at which the Musick Memorial Trophy was presented to Robert J. Minshall. The Second Annual Summer Meeting of the Institute was held in Pasadena, Calif., in June, 1940. The Wright Brothers Lecture was presented in New York on December 17, 1940, by Dr. Sverre Pettersen on the subject "Recent Fog Investigations."

At the Honors Night Dinner in New York on January 28, 1941, Griffith Brewer, President of the Royal Aeronautical Society of Great Britain, was the principal speaker. The Daniel Guggenheim Medal was presented to Glenn L. Martin, President of the Glenn L. Martin Company, "for contributions to aeronautical development and the production of many types of aircraft of high performance." The Sylvanus Albert Reed Award was presented to Dr. Hugh L. Dryden of the National Bureau of Standards "for his contributions to the mechanics of boundary layer flow and to the interpretation of wind tunnel experiments." Howard Hughes received the Octave Chanute Award



U. S. Army photo

#### THE BRITISH NAMED IT "HAVOC"

This is the U. S. Army Air Corps A-20-A Douglas twin-engine bomber. These ships have gone to Britain in rapidly increasing numbers as the DB-7A. They won their new name when they consistently wrought great havoc among the German raiders.



#### BREWSTER FIGHTER FOR BRITAIN

The "Buffalo" with which several R. A. F. squadrons are equipped.

presented annually for a notable contribution made by a pilot "for his skillful use of high speed, long range aircraft and advanced methods of aerial navigation". The Lawrence Sperry Award, conferred in recognition of work done by young men, was presented to Dr. W. Bailey Oswald of the Douglas Aircraft Company "for analytical studies in aerodynamics which have greatly facilitated the accurate design and economical operation of airplanes."

Two new awards were established by the Institute in 1940, and presented for the first time at the dinner. The John Jeffries Award, named after an American physician who made the first aerial voyage across the English Channel in 1785 with the balloonist Blanchard and was one of the first Americans to take an interest in aeronautics, was given for outstanding contributions to the advancement of aeronautics through medical research. Louis H. Bauer, M.D., Consultant in Aviation Medicine to the Civil Aeronautics Administration and the founder of the Aero Medical Association and editor of its journal, received the Jeffries Award "for his pioneering work and continuing activity in advancing the interests of aviation medicine through 21 years of teaching, research, organization, editing and contributions to the literature." The Robert M. Losey Award was established in recognition of contributions to the science of meteorology as applied to aeronautics in memory of Captain Robert M. Losey, a member of the Institute and a meteorological officer of the Air Corps, who was killed in Norway on April 21, 1940, while serving as an official observ-



er for the U. S. Government. It was awarded to Henry G. Houghton, Jr., Assistant Professor of Meteorology at Massachusetts Institute of Technology "for fundamental research in physical meteorology on the processes of condensation in the atmosphere."

Harllee Branch, Chairman of the Civil Aeronautics Board, Major General George H. Brett, Acting Chief of the U. S. Army Air Corps, Lieut. General Delos C. Emmons, Commanding General of the GHQ Air Force, and Griffith Brewer, President of the Royal Aeronautical Society, were made Honorary Members of the Institute. Honorary Fellowship was conferred upon Dr. George W. Lewis, Director of Research of the National Advisory Committee for Aeronautics. The following were elected Fellows of the Institute in 1940: Allan Chilton, Charles H. Colvin, Smith J. De France, Melvin N. Gough, S. D. Heron, Major Paul H. Kemmer, Paul Kollsman, George A. Page, Jr., F. W. Reichelderfer and Igor Alexis Sikorsky.

#### **Manufacturers Aircraft Association**

The primary function of the Manufacturers Aircraft Association, since the date of its formation in July, 1917, was to administer the various cross-license agreements and license contracts under which the aircraft manufacturing industry had operated since that date. The Association received the reports of the patents and granted all the patent licenses, including licenses to the U. S. Government, provided for by the terms of such agreements. It also served as a collecting and disbursing agency for the payments required to be made in accordance with the provisions of such agreements and license



THE BABCOCK LC-13-A



#### CURTISS INTERCEPTOR-FIGHTER

Model 21-B, claiming a climbing speed of more than a mile a minute, carries four machine guns and is powered by a Wright Cyclone engine.

contracts. In addition, it developed a specialized procedure which enabled it to conduct all the arbitration proceedings which were required in connection with claims for compensation on patents reported by members, and in the settlement of the relatively few disputes in regard to such matters which occurred within the aircraft industry. Since the payments on account of the original patents expired, the only royalty payments required were those resulting from the appraisal of new patents issued to member companies.

During 1940 a total of 87 airplane patents were acquired by members of the Association. Practically all the aircraft manufactured in this country were licensed under the 1,110 patents owned or controlled by members, thereby continuing to carry out the original policy of making licenses on the same terms available to all manufacturers desiring to enter the field. As in previous years, the primary objective of the cross-license plan, namely, the prevention of wasteful patent litigation within the industry, was attained. No suits for patent infringement were filed under any of the patents coming within the operation of the Cross-License Agreement. The contract relationship between the Association and the Government, which enabled the War and Navy Departments to obtain licenses on the same terms as members of the Association, also was continued throughout the year.

As a necessity incident to the administration of the Cross-License Agreement and also in order to supplement the other services rendered to members, the Association acquired throughout the last 20

years a private library devoted to engineering research and technical developments in the field of aeronautics. Nearly 300 books and periodicals were acquired during 1940, either by purchase or by gifts from various companies and individuals. In addition, a complete file of the aircraft patents issued in the United States, as well as in Great Britain, France and Germany was maintained by the Association, including an extensive classification and indexing system, useful not only for research in the patented art, but peculiarly adapted to the needs of the members in connection with engineering problems.

Services rendered the industry by the Patent Research Division comprised one of the most important functions of the Association. The publication of a comprehensive Digest of all current American and British aircraft patents, including abstracts of the specifications and official drawings, kept members informed regarding patented developments in the United States and foreign countries. The Patent Research Division also advised members of the Association in so far as practicable regarding the trend of technical development in this and other countries, with a view to minimizing infringement claims, and as a basis for the possible acquisition of patents, licenses and design rights. The facilities of the Division were made available for preparation and filing of patent applications on inventions which otherwise might be abandoned by member companies, but which eventually might have considerable value from a defense standpoint. As a result wasteful patent litigation largely was avoided and advancement of the art encouraged by making the important technical progress available to all aircraft manufacturers in the United States.

The offices of the Association provided a facility for maintaining



AIR CORPS BEECHCRAFT TRANSPORT

Used by the U. S. Army Air Corps for personnel transport, this Beechcraft C-45 is powered by two Pratt & Whitney 450 h.p. Wasp Jr. engines. The commercial version, 18S, won the 1940 Macfadden race with an average speed of 234.097 m.p.h. over a 1,084 mile course.

relations with non-member patent owners. Submissions of outstanding developments by all inventors in the field of aviation were given careful consideration and kept on file to be readily available in case of inquiry. Some inventors filed complete data such as blueprints, photographs and experimental and test records in regard to their patented inventions, so as to be assured that the Association members would have some indication of the real nature of constructive improvements offered for purchase or license. At the same time, no submission of a confidential nature was solicited or received from others than members of the Association.

A further important service rendered in connection with non-member patent owners has been the substitution of friendly arbitration proceedings for costly court litigation. Accordingly, as in the case of the elimination of patent litigation between members as a result of the operation of the Cross-License Agreement, the Association succeeded in establishing a somewhat similar service with non-member patent owners who wished to make worthwhile inventions available to the aircraft industry.

It is interesting to note that as a direct effect of operations under the Cross-License Agreement, there was no price fixing within the aircraft industry, no regulation or control of markets, nor any other restriction in regard to the sale of products. Patents of lesser consequence which might have been grouped for the purpose of controlling certain aspects of the manufacturing processes were licensed free of charge, while inventions of a more basic character which otherwise might have been held by individual companies to dominate the industry or withheld for the purpose of preventing competition, were made available at rates of royalty which permitted unlimited use by every member of the Association of all inventions coming within the operation of the Agreement. At no time since the Association plan was adopted more than 24 years ago was the practicability and importance of the Cross-License Agreement more generally recognized than during the national defense program.

#### National Aeronautic Association

The National Aeronautic Association was the American representative of the Federation Aeronautique Internationale, and the governing body for all sporting aviation in the United States. The new N. A. A. made rapid strides in 1940 following its reorganization. In the development of its America First in the Air Program, N. A. A. Chapters were revitalized and outstanding aviation leaders brought to the directorate. National Aeronautic Association activities were coordinated by its National Headquarters located in Washington,

D. C., and carried out by local Chapters and National and State Councils. Through the formation of State Councils prominent State-wide set-ups were established under the N.A.A. banner to promote, publicize and service all phases of aviation activity. Membership was available to all Americans desiring to take part in the program. Publications of the National Aeronautic Association were its monthly magazine, "National Aeronautics" and its weekly "Washington Newsletter."

#### **National Intercollegiate Flying Club**

The National Intercollegiate Flying Club, a division of the National Aeronautic Association, was organized in 1934 to promote and advance collegiate flying. An annual Intercollegiate Flying Conference was held each spring, and later in the year the National Intercollegiate Air Meet attracted contestants from every part of the United States. The location and events of the annual air meet were decided by delegates to the annual conference. Regional and sectional air meets also were sponsored by the club. Through these contests, and the exchange of club ideas and by other group activities, the N.I.F.C. acted to publicize and promote college flying. There were more than 60 college flying clubs affiliated with the N.I.F.C. in 1940, totaling more than 1,300 persons. The Loening Intercollegiate Trophy was presented to the Purdue University Flying Club in 1940. Award of the trophy was based on general club activity during the curricular year and on points won during the annual intercollegiate air meet. The Sixth Annual Air Meet was held at Lock Haven, Pa., July 20-22, 1940. Thirteen colleges participated.

#### **Society of Automotive Engineers**

A large number of the 7,000 members of the Society of Automotive Engineers were associated directly or indirectly with the aircraft industry. Fifty-five aircraft papers, covering a wide variety of pertinent aviation subjects, were delivered before S.A.E. National and Section meetings during 1940. With national defense on the upswing, many sessions of S.A.E. military meetings were devoted specifically to aircraft problems. The "S.A.E. Journal," official organ of the Society, steadily increased its schedule of aircraft articles for publication. The S.A.E. had 33 years of standardization experience in all automotive fields. When the need for and possibilities of important aeronautical standardization appeared, the S.A.E. extended its work in this quarter and engaged in national defense standardization work under assignment from the Office of Production Management.

### The Soaring Society of America

Founded in 1932 by a group interested in the promotion of motorless flight, The Soaring Society of America carried on and extended the work begun by the National Glider Association and others a few years previously. By laying stress on the practical advantages as well as the sporting angle of gliding and soaring, the organization greatly widened the scope of this new art, and enlisted the aid of scientific men as well as enthusiastic boys. The Soaring Society sponsored the National Soaring Contest, and many regional contests and expeditions.



### BOEING FLYING FORTRESS FOR BRITAIN

One of the B-17C long-range bombers on a check-out flight.

## CHAPTER X

### AIRPORTS AND AIRWAYS

Increase in Number of Landing Places—Congressional Appropriations for New Airport Program—The Federal Policy—Need for More Airports for Defense and Postwar Civil Flying—The Federal Airways System—New York the Busiest Air Terminal—C.A.A. Expansion Program—New Radio Facilities.

ON January 1, 1941, there were 2,656 airports, landing fields and seaplane bases in the United States and Alaska, an increase of 205 over the figure registered on January 1, 1940. The total included 788 municipal and 496 commercial airports, 289 Civil Aeronautics Administration intermediate fields, 507 auxiliary fields, 21 Naval Air Stations, 69 Army fields, and 161 miscellaneous Government, private and State airports and landing areas. Of these, 776 were either fully or partially lighted for night flying. Seaplane mooring floats, constructed under a joint program of the Civil Aeronautics Administration and the National Youth Administration, accounted for a large percentage of the increase in landing facilities. On January 1, 1940, there were 171 bases and anchorages available for use, including those of the Army, Navy, Coast Guard and Marine Corps. A year later there were 325, of which 15 were equipped for operations after dark. Six States and the Territory of Alaska each had more than 100 fields and airports, as follows: California 174; Texas 146; Pennsylvania 107; Florida 122; Michigan 116; Ohio 105 and Alaska 129.

By far the most important development in the airport picture was a Congressional appropriation of \$40,000,000 for construction and improvement of airports. Originally \$80,000,000 was requested, which would have started the first phase of the long-range airport plan on which the C.A.A. had been working for some time. As finally approved, the bill limited construction to 250 sites of national defense



#### VULTEE ATTACK BOMBER

It is powered by a Wright Cyclone engine.

importance. The long-range plan showed in detail the work required to give the United States a network of approximately 4,000 airports keyed to future needs, and included developments in Alaska, Hawaii and the South Pacific Islands. It originally was suggested to cover six years, at a total cost of \$560,000,000. The new law set up an airport advisory board, composed of the Secretaries of War, Navy and Commerce, to act on airport projects. It constituted the first clear Federal statement of policy toward airport construction.

On December 12, 1940, approval of construction or improvement projects on 200 airports was announced under the new program.



#### REPUBLIC GUARDSMAN 2-PA

With Pratt & Whitney Twin Wasp engine, it carries a 750 lb. bomb under the fuselage and six 100 lb. wing bombs.



Improvements were limited to actual landing facilities, and none of the funds were used for buildings, hangars or other facilities not actually a part of the landing field. The program was supplemented and enlarged by coordinating it with the work and funds of other Federal agencies. Meanwhile, the usual program of airport construction, which had been made possible by allotments from the Work Projects Administration and other Federal agencies, as well as contributions from local sponsors, continued during 1940. As directed by the Civil Aeronautics Act, each such airport project, before approval by the relief authorities, was first certified by the Administrator, following study, recommendations and approval from an aeronautical standpoint by the Airport Section as reasonably necessary in air commerce or for the national defense. In 1940 the Administrator issued about 275 such certificates. Those projects involved an expenditure of over \$40,000,000 in Federal funds, and sponsors' contributions of about \$14,000,000, making a total outlay of nearly \$55,000,000.

The need for a vastly enlarged national system of airports was ably described on February 20, 1941, by Assistant Secretary of Commerce Robert H. Hinckley, who said:

"There was some criticism, last summer (1940), of what were called our grandiose ideas. But with the tens of thousands of aircraft which have been ordered since, I am wondering if our estimates of six or seven months ago are not already obsolete. For despite our impending expansion, Central America has better airport coverage today, per square mile, than the United States.

"It is high time we took another hard look at the situation. We need a tremendous number of airports now, for national defense. After the emergency, we will need far more of them for a vastly expanded civil aviation. If they're planned and built right, airports



U. S. Navy photo

**GRUMMAN F4F-3**

A single-place fighter powered by a Pratt & Whitney Twin Wasp engine.



THE BELLANCA YO-50 LIAISON PLANE

last a long time; but so do the payments on bond issues. The investment cost of these airports must be properly distributed, and they must be planned for long-range civil use as well as emergency military use, if they are to end up as sound investments.

“Civilizations rise and fall in direct ratio to the efficiency of their transportation. So do cities. We are approaching the limits of ground speeds, yet we have pressing need to overcome our great distances. We have a transportation medium which can exceed ground speeds. But convenience and safety are important factors also—especially important in new forms of transportation. All of us can remember how the development of the automobile was held back: first, by the fact that it was considered dangerous, and second, by the lack of highways. Well, landing-fields are relatively more important to aviation than were terminals to the railways or harbors to ships. You can stop a train on a rural siding or anchor a ship offshore, even though neither action is very convenient for the passengers on board. But as yet you cannot do anything comparable with an air liner. You have to bring it in, somewhere. We have imperative need for some pretty heroic planning. A great air expansion is certain after this emergency.”

Other airport developments in 1940 included: A series of conferences was held at the Experimental Station at Indianapolis in a program to improve airport lighting facilities by establishing lighting standards for airports.

In twenty-nine of the forty-eight States members of the C.A.A. staff worked with representatives of State planning agencies preparing State plans for airport development in accordance with a national

plan. A program was formulated by the C.A.A. in cooperation with the Army Air Corps for collecting data concerning all major airports and surrounding areas throughout the country.

The C.A.A. developed a design for seadrome contact lights to provide a light weight reliable buoy and light for marking sea plane landing areas for use at night. The Navy found this design so satisfactory that it adopted it for its own use.

The \$12,500,000 Washington National Airport at Gravelly Point, just across the Potomac from the nation's capital, was opened to the air lines in December, 1940, for auxiliary operations. The completed port was scheduled for dedication late in April, 1941. While not the largest in the world, it was designed to provide, with future development, for all predictable air line traffic. Built largely on filled land reclaimed from the river, its safety and other aeronautical design features were well in excess of usual requirements. Planes could glide in or take off at an angle as flat as 40-to-1 in eight directions to and from its four runways, at least two of which were long and broad enough to be equipped with instrument-landing systems, and all of which were long enough to take care of anticipated developments in the size or speed of transport planes. At a later date, if needed, the runways could be paralleled at reasonable additional cost. In connection with the runways, it should be noted that the plan of the Corps of Engineers for the construction of the runways proved highly successful. By trenching out silt from the site of the runways and then pumping selected sand and gravel in upon solid sand and gravel foundation and allowing it to rest for a period of months, when it came time to bring the runways to final level and stabilize the surfaces, no appreciable settlement developed. The airport had a landing area of 565 acres, criss-crossed with runways, the longest of which was 6,500 feet. Six



THE AERONCA SUPER CHIEF



THE LUSCOMBE 8A ON SKIIS  
It was powered by a Continental engine.

large hangars and a model passenger terminal with waiting rooms, restaurant, post office, administration offices and traffic control tower were among the facilities.

New York City's new municipal airport, La Guardia Field, opened in October, 1939, was the country's busiest air terminal in 1940. The 558-acre airport was the scene of 86,563 landings and take-offs during the year. Less than one per cent of these landings and take-offs were military; 95 per cent were made by the scheduled air lines, and the rest by non-scheduled flyers.

At another of the most important air terminals in the nation—Oakland, Calif. Municipal Airport—airplane traffic tripled in 1940. Using November, 1940, as a sample month, statistics showed that a plane landed or took off every 51 seconds, compared to an interval of 152 seconds in the same month of 1939. To meet growing traffic, the runway system at Oakland was extended. Three hundred acres of land were purchased which, when improved, would give the 1,200-acre air terminal an operations area second to none in the country.

During 1940 the C.A.A.'s program for expansion and extension of the Federal Airways System continued on a large scale. By the end of the year, an estimated 30,488 miles of adequately lighted airways, fully equipped with radio communications and weather-reporting facilities, were in operation throughout the United States and its possessions. That compared with 28,745 miles of such airways

in operation on July 1, 1940. By July 1, 1941, the system was expected to aggregate 32,012 miles, an increase of 3,267 miles during the 12-months period from July 1, 1940. In addition to the new mileage completed between July and January, at the end of the year there was another 496 miles already under construction, and 1,038 miles had been surveyed. Facilities installed on the airways early in 1941, included 2,261 beacon lights; 85 full-power combined broadcast and range radio aids; 136 medium-power radio range stations; and 35 low-power range stations.

Installation of relatively static-free ultra-high-frequency radio equipment continued. As of January 1, 1941, there were two such radio stations in operation, 114 fan markers, and one instrument-approach system. Plans also contemplated ten range stations, 157 fan markers and nine instrument-approach systems by July 1, 1941.

An important undertaking in the airways development program was installation of radio facilities to serve foreign and territorial routes of American air carriers. Already in operation is a high-frequency radio station serving the transatlantic route, while additional stations were being installed in San Francisco and Hawaii to augment present facilities on the transpacific route. Opening of the Seattle to Juneau, Alaska, service brought installation of similar equipment along this airway. Cooperating with the Army, the C.A.A. moved forward during 1940 in the installation of equipment in Alaska which, in addition to serving commercial air carriers, was increasingly important to national defense. Installations included



PIPER CUB COUPE J-4

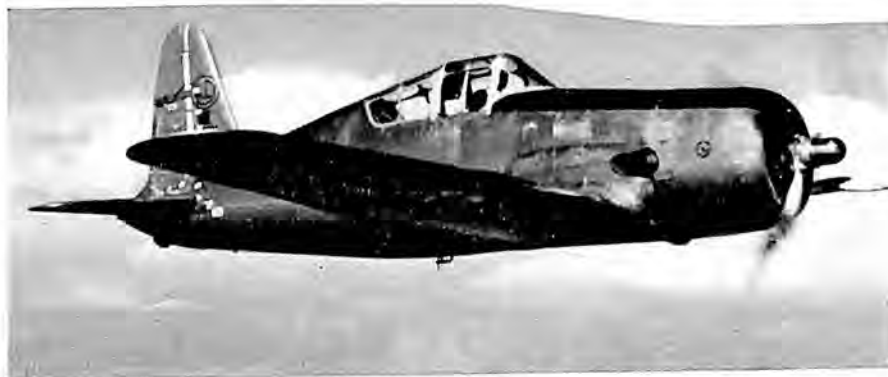
point-to-point stations and additional simultaneous range and broadcast stations.

For the transmission of weather information, there were in operation on January 1, 1941, about 28,050 miles of teletype weather-reporting circuits. On July 1, 1940, the total was 27,068 miles. By July 1, 1941, it was to reach 55,456 miles. The teletype traffic-control mileage was 12,260 miles, on January 1, 1941, against 11,714 miles on July 1, 1940, with an estimated 18,255 miles to be in operation by July 1, 1941.

Other Federal Airways System developments during 1940 included: Maintenance electricians were assigned to key stations to devote their entire time to insuring the uninterrupted operation of radio equipment. A new airway traffic control center was established at Atlanta, Ga., bringing the total to 12. Additional centers at Cincinnati, O., and Seattle, Wash., were almost ready for commissioning. Service handled by the 12 centers increased about 125 per cent over the previous year.

Municipally operated radio-equipped airport traffic-control stations were added at Cincinnati, O., Hyannis, Mass., Kansas City, Mo., Troy, N.Y., Dayton, O., New Orleans, La., Falmouth, Mass., Philadelphia, Pa. (Ambler Field), Philadelphia, Pa. (Municipal Airport), Rosharon, Tex., Walla Walla, Wash., Santa Monica, Calif., Minneapolis, Minn., Buffalo, N.Y., and at La Guardia Field, New York City.

A controlled light approach and landing system was developed and tested at the Indianapolis Experimental Station.



THE VULTEE P-48C PURSUIT

## CHAPTER XI

### THE AIRCRAFT MANUFACTURING INDUSTRY

The Industry's Full-out Effort for National Defense—Work of the Individual Manufacturers—Expansion of Plant Facilities and Personnel—New Planes, Engines and Accessories.

**M**ASTERY in the air, with all its military and economic implications, is coming into being in direct proportion to the accelerated technical progress reflected by the refinements in aerodynamic and structural design in American-made airplanes. Competition, whether between rival powers or manufacturers, will always serve to stimulate technical progress. The manufacturers turn to research laboratories in their efforts to speed their product to new degrees of higher performance. Technical progress which may materially affect present and future aircraft designs is being exemplified in the development work on a variety of major subjects. For example, the laminar flow wing is being developed, more attention is given to surface finish, and spot welding and flush riveting are being utilized on an increasingly large scale. High-lift wing devices are being perfected to compensate for the effects of high wing loading on landing and take-off characteristics. Wing loadings of more than 30 pounds per square foot are now commonplace, and the future doubtless will see this figure materially increased.

Cooling drag has been reduced as the fundamental principles of fluid mechanics have been applied to aircooled engine installations. Considerable thought has been devoted to the possibility of utilizing engine exhaust to obtain thrust through the use of properly designed jets. Engine power continues to increase as refinements are made in combustion chamber design, cooling, carburetion and aircraft fuels—and these improvements have been made at no sacrifice in reliability or economy in operation. In line with efforts to maintain engine power in rarefied air at high altitudes, two types of superchargers are employed currently. One type is geared directly to and is an integral



#### THE GLENN MARTIN BOMBERS—THEN AND NOW

This is the famous Glenn L. Martin bomber of 1918, which was one of the world's best for many years after World War I. (See opposite page.)

part of the engine, which tends to simplify installation problems; the other is an exhaust-driven or "turbo" type, actuated by the pressure drop between the engine exhaust system and the atmosphere. As the atmospheric pressure decreases with altitude, the pressure drop will increase, causing the supercharger to rotate faster and thus compensate for increased altitude. Development of new alloys, cooled turbine wheels and improved installation technique hold promise of overcoming some of the mechanical difficulties which heretofore have beset the turbo-supercharger.

The manufacturers also have developed propellers capable of absorbing increased engine horsepower. To eliminate torque, counter-rotating propellers have been perfected which retain their full-feathering characteristics. Four-blade propellers have been developed to reduce the diameter in order to maintain sufficient ground clearance in the case of planes with nose-wheel landing gear. Other significant improvements include the development of new blade alloys, new methods of propeller de-icing and new ways of studying and eliminating propeller unbalance and vibration.

Much technical progress has been recorded in the selection of design details suitable for production. This problem heretofore has had small attention from most design engineers because of the lack of production schedules. During the last 15 months, however, pro-





U. S. Army photo

**THE GLENN MARTIN BOMBER—NOW**

This is the Glenn L. Martin B-26, "faster than most pursuits in Europe," which is being produced in quantity for the U. S. Army Air Corps and the British R. A. F. during World War II.

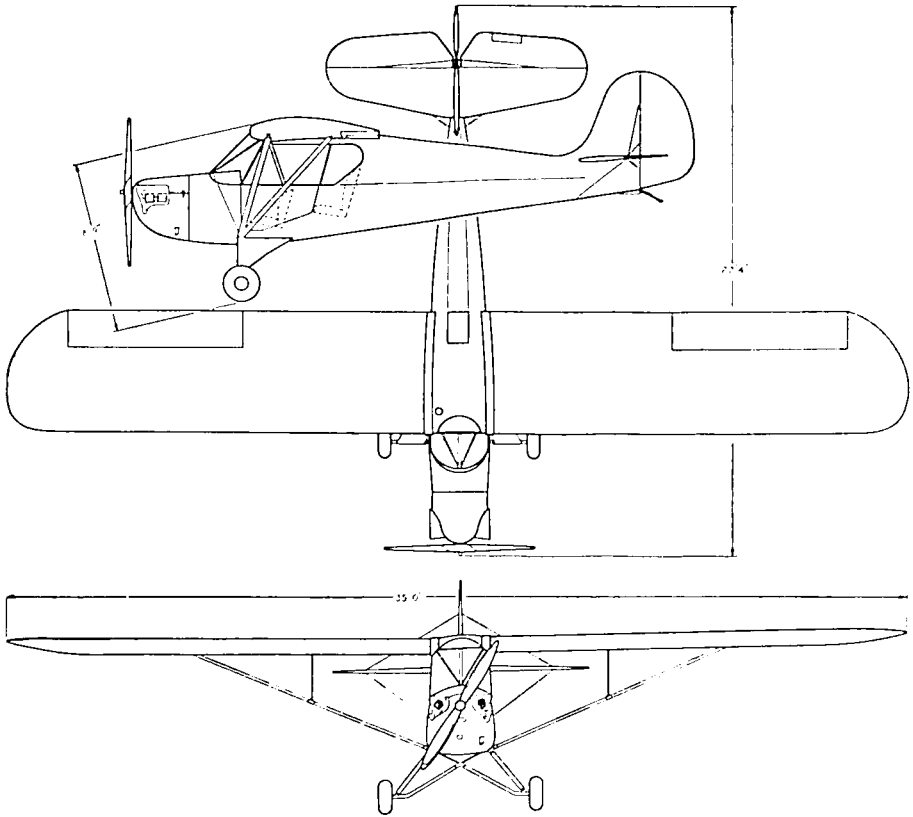
duction characteristics of design have been rated as almost as important as the aerodynamic features. New types of production tooling have come into being throughout the industry, and moving conveyor systems and endless belt assembly lines are now commonplace features in a majority of the plants.

Following are detailed accounts of the achievements of the manufacturers.

**Manufacturers of Aircraft**

Aeronca Aircraft Company, Middletown, O., was the new name of the old established Aeronautical Corporation of America, manufacturers of Aeronca planes. The company remained under the same management. It moved from Cincinnati to Middletown in June, 1940, a year which surpassed all others in point of production and sales. Aeronca reported more than 1,100 orders for its light plane models during the year. Two new models were introduced. One was the Aeronca Tandem Trainer, which was designed primarily for use in the Civilian Pilot Training Program. Approximately 700 machines were sold for that purpose. In September, 1940, the Aeronca Super Chief was introduced to the private flying market. The new plant on the Municipal Airport at Middletown, O., increased production floor space by nearly 100 per cent and enabled the company to step up its production proportionately. Plans for 1941 contemplated a 35 per cent increase in manufacturing space and similar increase in production.

Babcock Aircraft Corporation, DeLand, Fla., produced the Babcock LC-13-A, a 2-place monoplane powered by either a Franklin or a Glenn L. Martin engine.

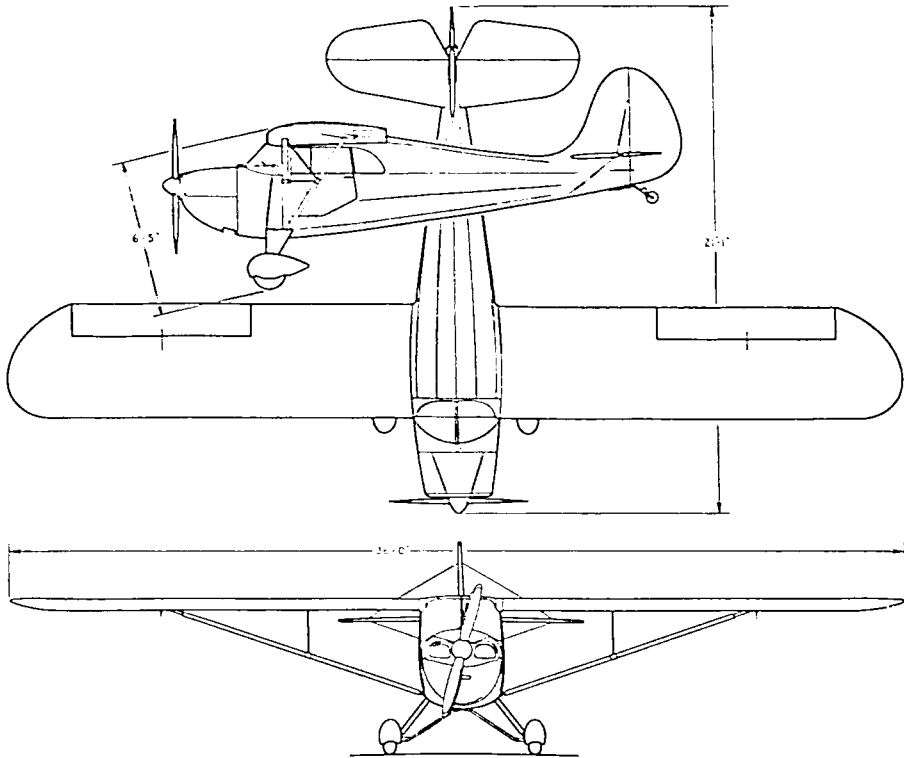


THE AERONCA MODEL T

This two-place trainer is offered with a choice of Continental, Franklin or Lycoming engines, with a range from 50 h.p. to 65 h.p.

Beech Aircraft Corporation, Wichita, Kans., undertook a major program of expansion during 1940, while continuing the manufacture of its single-engine biplane and twin-engine monoplane Beechcrafts in record-breaking quantities. At a cost exceeding \$1,800,000, production area was increased by May, 1941, from 125,000 sq. ft. to 550,000 sq. ft. and personnel from 780 to 5,500 employees. The output scheduled represented about a 1,000 per cent increase over the past rate. At the end of 1940, construction work was nearly completed; 300,000 sq. ft. of floor space were in use, and 2,500 persons were employed. The expansion was made necessary by orders from the U. S. Army Air Corps and Navy Bureau of Aeronautics totalling more than \$24,000,000 for trainers and personnel transports.

Manufacture of the Beechcraft E17B, F17D, and D17 series of biplanes was continued during 1940. Distinguished by their negative

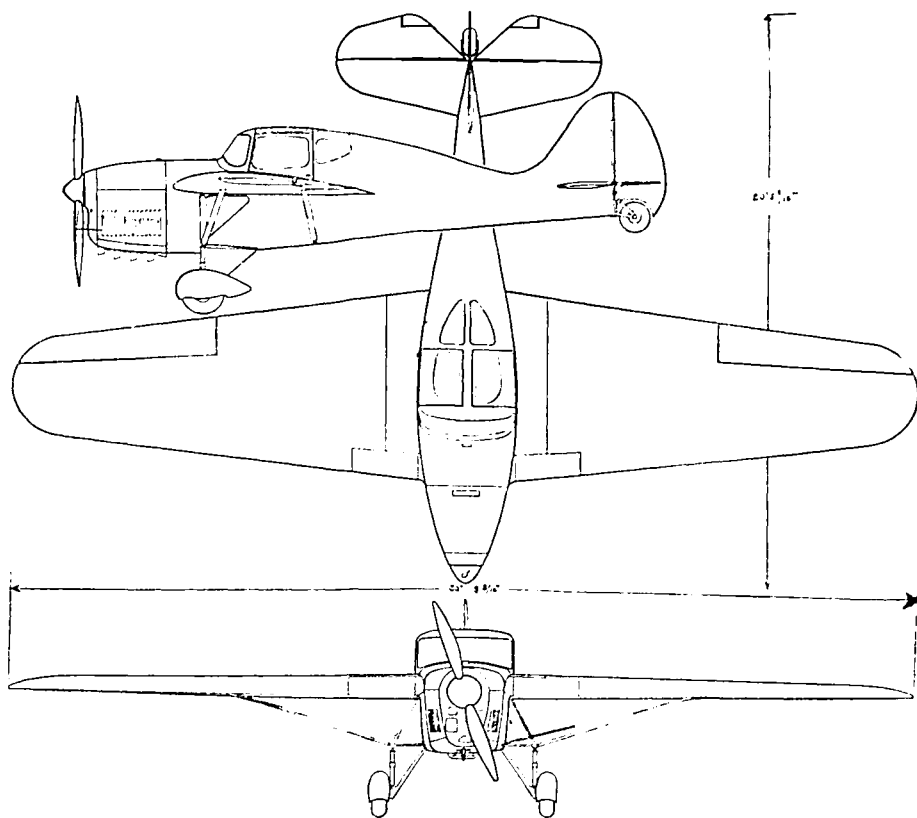


THE AERONCA SUPER CHIEF

A two-place plane for the private owner powered with either a Continental or Lycoming 65 h.p. engine.

wing stagger, retractable landing gear and tail wheel, low wing loading, and high speed, all those models were closed 5-place biplanes with a 32-ft. wing span, height 8 ft., and overall length approximately 26 ft. The E17B Beechcraft, powered with a 285 h.p. Jacobs engine, had a gross weight of 3,390 lbs. and a stated cruising speed of 177 m.p.h. The stated cruising speed of the F17D Beechcraft, which used a 330 h.p. Jacobs engine, was 182 m.p.h. and its gross weight was 3,590 lbs. Three models, all with a gross weight of 4,250 lbs., comprised the D17 series. The D17R Beechcraft, equipped with a 450 h.p. Wright Whirlwind engine, and the D17S Beechcraft, which used a 450 h.p. Pratt & Whitney Wasp Junior engine, had stated cruising speeds of 202 m.p.h. The D17A Beechcraft, designed for maximum range or load-carrying capacity, used a 350 h.p. Wright Whirlwind engine to attain a stated cruising speed of 170 m.p.h.

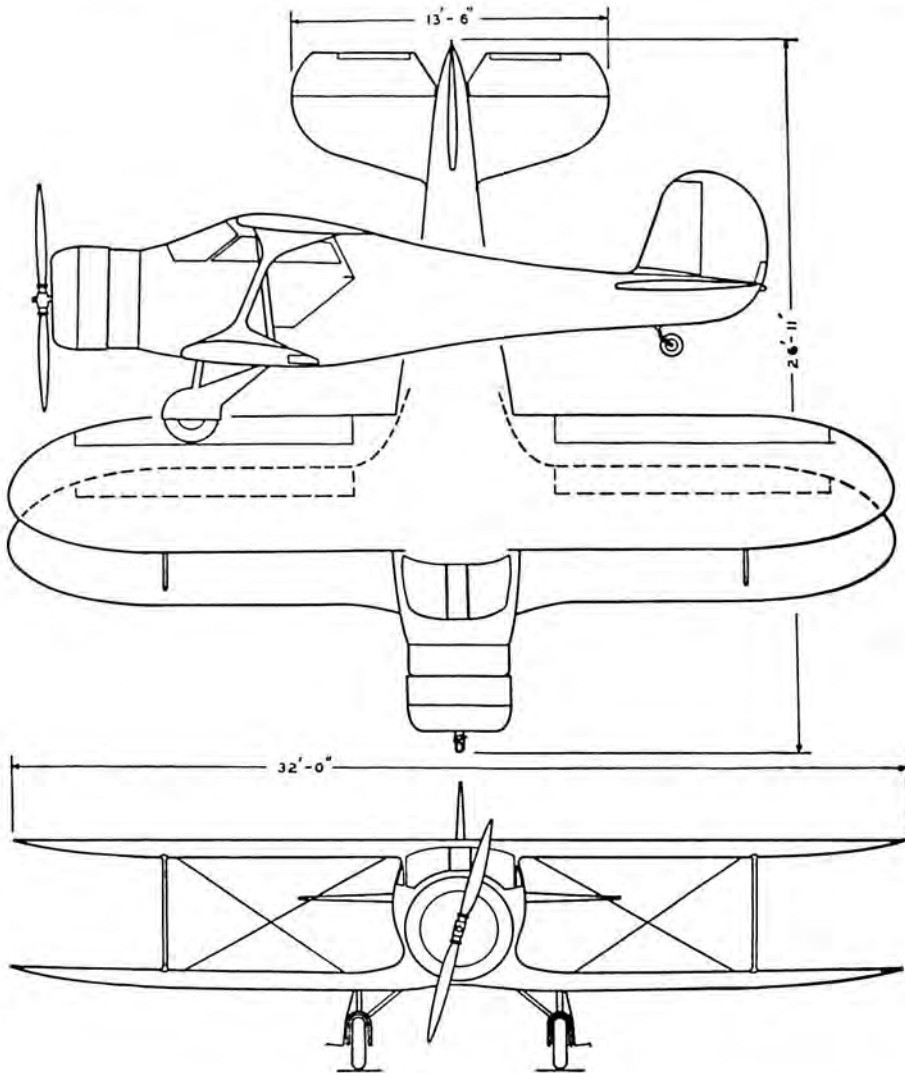
Commercial and military versions of the all-metal twin-engine



THE BABCOCK LC-13-A

A two-place plane powered with a choice of 120 h.p. or 130 h.p. engine.

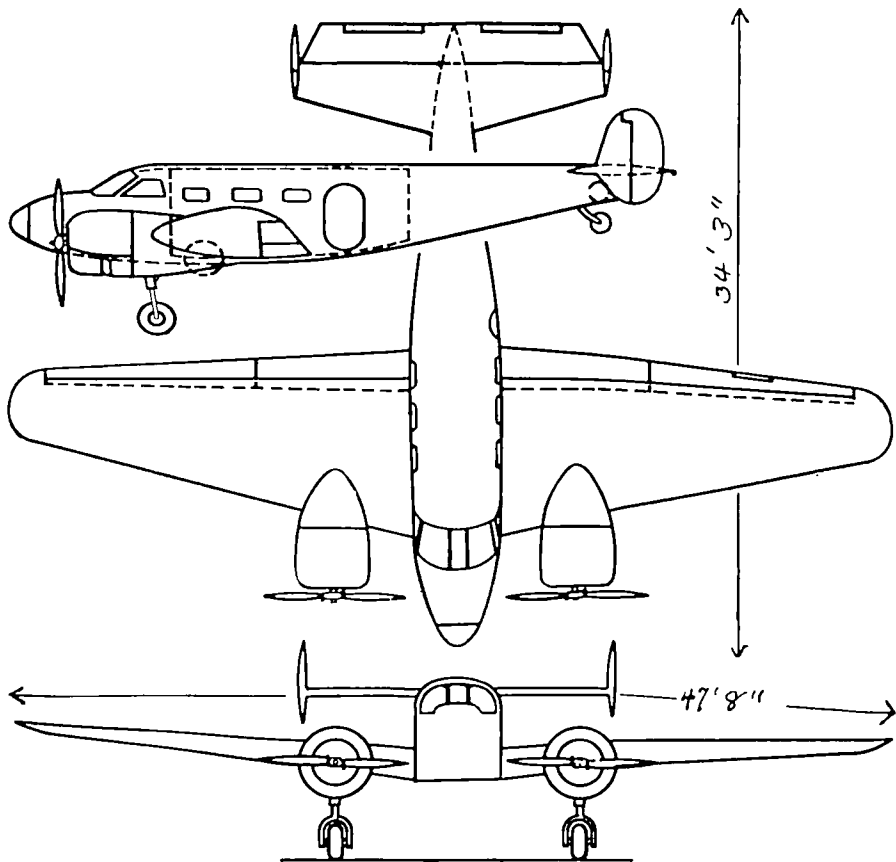
series 18 Beechcraft monoplane were produced in substantial quantities. All models of this series had a span of 47 ft. 8 in., a height of 9 ft. 5 in., and an overall length of 34 ft. 3 in. The model 18A Beechcraft was approved for an increase in gross weight from 7,200 to 7,500 lbs., with an increase in empty weight from 4,656 lbs. to 4,670 lbs. It used two 350 h.p. Wright Whirlwind engines to attain a stated cruising speed of 200 m.p.h. The 18R and 18S models, powered with two 450 h.p. Wright Whirlwind and two Pratt & Whitney Wasp Junior 450 h.p. engines respectively, had a gross weight of 7,500 lbs. and a stated cruising speed of 220 m.p.h. Military versions of these models were designed for service overloads up to a gross weight of 8,489 lbs., and were produced in various types, equipped for personnel transport, high-altitude photography, special observation, advanced training and tactical use. Several commercial model 18A Beechcrafts



BEECHCRAFT D-17

A five-place private plane with a choice of either a Pratt & Whitney or Wright engine both rated at 450 h.p. The E-17 version has a strut-braced tail group and is available with either a Jacobs 225 h.p. or a 285 h.p. engine, while the F-17 is offered with a 330 h.p. Jacobs.

were delivered to Canadian Airways for use on their Maritimes and Edmonton divisions. Commercial 18S models were sold to several individual companies and private owners. Midway in 1940, emphasis shifted from production of commercial Beechcrafts to military types



BEECHCRAFT 18

A twin-engine transport for from six to 10 persons, with a choice in power plants among Jacobs, Pratt & Whitney or Wright engines.

required by the Government under the defense program. Commercial sales were continued, however, subject to Government priorities.

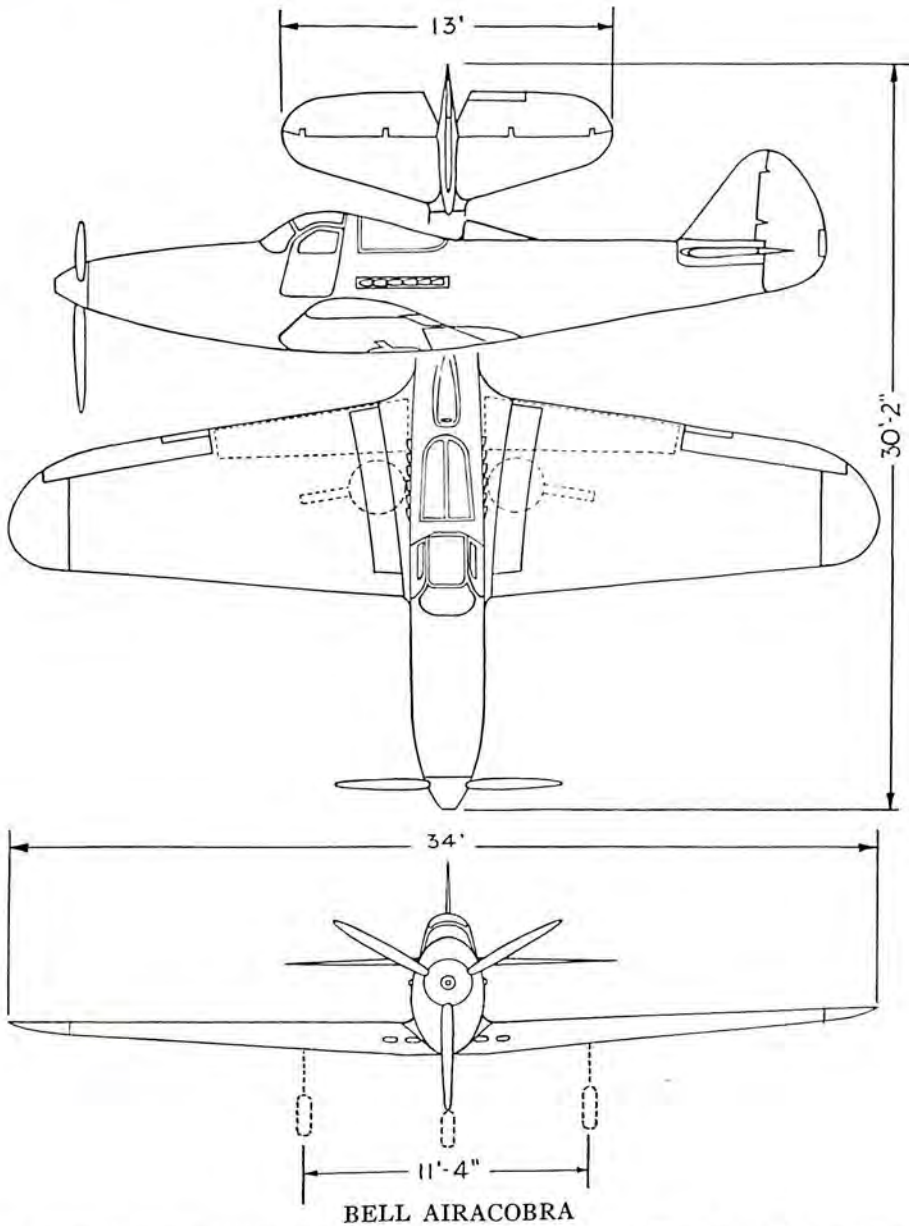
A new speed record for regular NC-licensed commercial aircraft was established on January 6, 1940, in the Macfadden cross-country race by the Beech Aircraft Corporation's 18S twin-engine monoplane. Piloted by Walter H. Beech and H. C. Rankin, the Beechcraft covered 1,084 miles non-stop from St. Louis to Miami at an officially timed average speed of 234.097 m.p.h. Its two Wasp Junior engines were operated at approximately 62½ per cent of their rated 450 h.p. A total of 1½ qts. of oil and 208 gals. of fuel was consumed in the fast run, unofficially establishing an economy record, speed and distance considered, for aircraft of this type. Other Beechcrafts, of single and

twin-engine type. took 3rd, 4th, 5th, 6th, 7th, and 9th prizes in the 1940 Macfadden race. On January 9, 1940, the 18S Beechcraft which won the Macfadden race was the sole entrant in the Congress Cup Race. It covered the 233 miles from Miami to Havana in 59 min. and 25 seconds, setting a new speed record between those points.

A new altitude record for the Antarctic regions also was established on March 9, 1940, by a D17A Beechcraft biplane attached to the Snow Cruiser unit of the U. S. Antarctic Expedition, according to a report from the Expedition's west base at the Ross Ice Barrier. Piloted by Technical Sergeant T. A. Petras, U. S. Marine Corps, the Beechcraft took off for a cosmic ray observation flight, carrying an observer and the necessary scientific instruments for registering the radiation of the cosmic rays. The dispatch from the Expedition stated: "At an altitude of 21,050 feet above Little America, the Beechcraft was still climbing but, as the temperature was then 45 degrees below zero, Petras decided to descend. As far as we are able to determine from past records, the altitude reached surpasses any past performance in the Antarctic by several thousands of feet."

Bell Aircraft Corporation of Buffalo, N. Y., having delivered the last of an order of YFM-1A Airacuda twin-engine multi-seater fighter planes to the U. S. Army Air Corps, rearranged and re-equipped its plant for the exclusive volume production of the Airacobra, single-engine, single-seat interceptor fighter for the Army Air Corps and the British Royal Air Force. The entire plant was staffed, manned and geared for this type airplane and at the beginning of 1941, Bell had completed 33 P-39s, as they were known in the Army. Eight were ahead of schedule. With orders on its books for approximately 1,600 Airacobra fighters, totaling more than \$60,000,000, this 5½ year-old company expanded the floor space already occupied in the massive Elmwood Avenue building in Buffalo from 250,000 sq. ft. to 450,000 sq. ft., and then was obliged to take steps for an additional plant nearby. Inasmuch as the Elmwood Avenue plant was not in close proximity to the Buffalo Municipal Airport, or any other suitable flying field on the Niagara Frontier, to accelerate Army Air Corps fly-away deliveries an assembly plant was established on the edge of the Niagara Falls Airport. Ground was broken in October and the plant was scheduled for occupancy in April, 1941. It was a rectangular building 600 by 400 ft. Provision was made for the assembling in that plant of Army Air Corps P-39s. All fabrication took place at the Elmwood Avenue Plant, and there the British ships were boxed for export. Parts were trucked to Niagara Falls for assembly and fly-away deliveries to the U. S. Army.

To undertake the program of constructing 1,600 pursuit planes,

**BELL AIRACOBRA**

This single-seat interceptor fighter is powered with an Allison 1,150 h.p. engine.

the personnel of the company was expanded from approximately 1,200 employees in January, 1940, to more than 5,000 by the end of the year. An additional 3,000 was necessary for the Niagara Falls





NEW BELL AIRCRAFT PLANT AT NIAGARA FALLS

While producing increasing numbers of planes, the nation's aircraft manufacturers expanded their facilities for defense production. This will produce more Bell pursuit planes for American and British air forces.

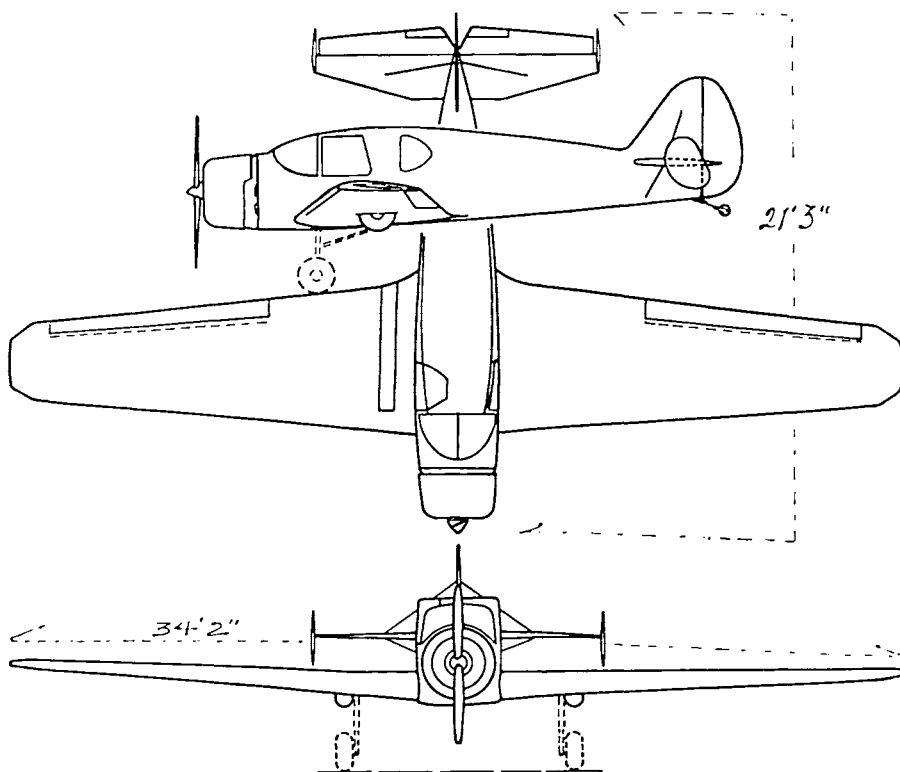
plant, and the total personnel by the end of 1941 was to number nearly 10,000.

The Niagara Falls plant was constructed by the Austin Company of Cleveland, O., at a cost of \$1,200,000 under facilities contract No. 1 between the War Department and Bell Aircraft Corporation. Private capital was used, and under the terms of the contract the building would become Government property at the end of 5 years, with an option to Bell Aircraft to acquire it as a permanent home. The area occupied in the Elmwood Avenue plant was under lease.

While the task of transferring Bell Aircraft Corporation from an experimental and development company to a production concern was accomplished in a few months, the design and engineering departments were already at work on new and advanced types of fighter planes for the Army and Navy. Bell Aircraft's armament division was in production on an aircraft machine gun recoil dampening device known as the Bell Aircraft machine gun adapter.

The company also established a complete physical, chemical and X-ray testing laboratory to conduct minute examinations into the various types of materials used in the production of the Airacobra. The facilities of the laboratory were made available to other firms not so equipped.

Bellanca Aircraft Corporation, New Castle, Del., produced for the U. S. Army Air Corps, the YO-50, an experimental, short range liaison plane with flaps and slots for take-off and landings in small spaces. The 1941 new features of the Bellanca standard Crusair

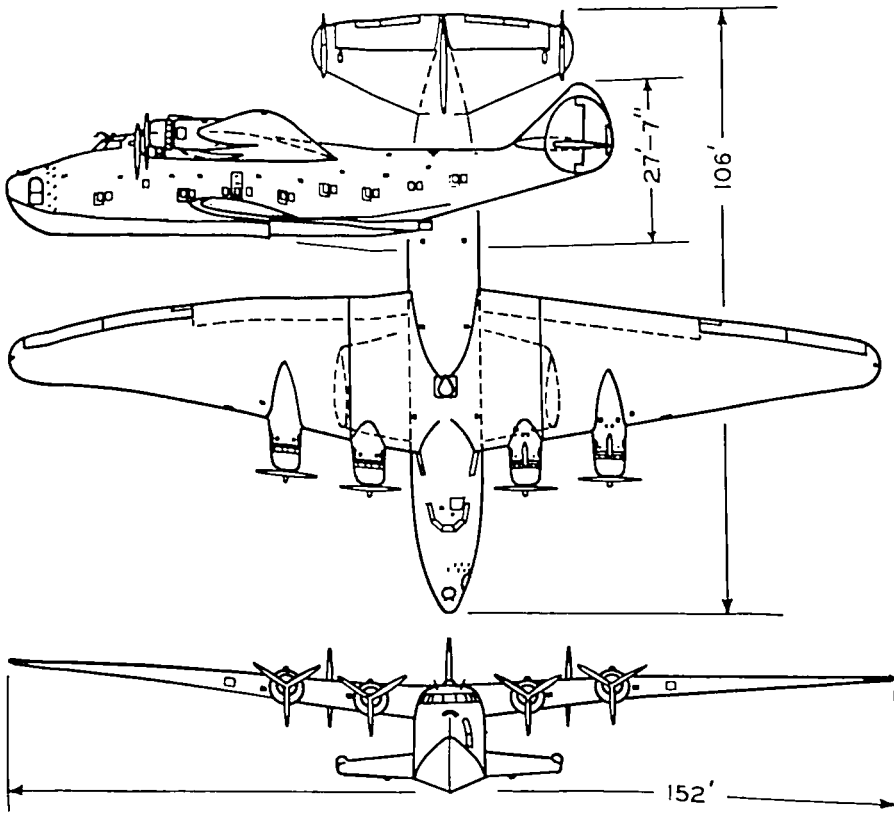


BELLANCA CRUISAIR

Available with either a Ken-Royce 90 h.p. or a Franklin 120 h.p. engine, this plane for the private flyer carries three.

commercial plane included slotted wing flaps, shock mounted instrument panel, hydraulically mounted tail wheel, plastic construction of wing ribs and application of plastic finish to wing panels. Bellanca also developed the T14-14 trainer with a 130 h.p. 6-cyl. Franklin engine, its wing panels identical to those of the Cruisair. The company was engaged in subcontract work on defense orders.

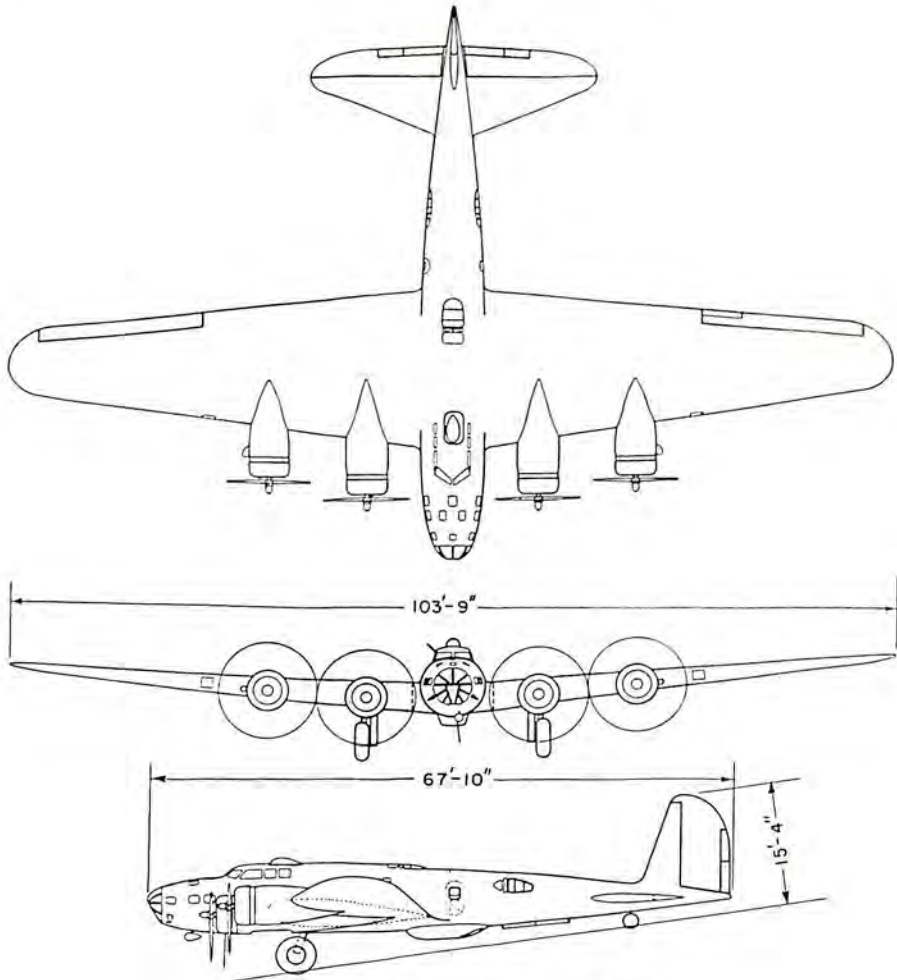
Boeing Aircraft Company, Seattle, Wash., produced its four-engine Flying Fortresses for the U. S. Army Air Corps at a rapidly increasing rate. New factory additions and "additions-to-the-additions" were being erected almost continuously at the Seattle plant, in preparation for still larger production. In step with the defense program, the company's floor area was nearly doubled during 1940, from 765,000 sq. ft. to 1,430,000 sq. ft. ; and early in 1941, a second and still larger expansion program was under way to increase the floor space



THE BOEING 314

Pan American Clipper ship for ocean passenger service, powered by four 1,500 h.p. Wright Cyclone engines.

to a new total of 2,400,000 sq. ft. The scene of all this expansion was Boeing Plant No. 2, center of Flying Fortress production. That factory unit was begun in 1936 when a long-range plant development program was laid out, based on the large four-engine planes which Boeing was then introducing. The initial units of the plant that were erected in 1936 and 1937 totalled 166,000 sq. ft. of floor space, and featured large unobstructed working areas. The 666,000 sq. ft. addition started in June, 1940, dwarfed this original structure; but the huge addition was hardly completed when defense requirements made further expansion necessary, and the company immediately began work on the second expansion, comprising nearly 1,000,000 sq. ft. additional area. The first expansion was accomplished in 90 days.



### THE BOEING FLYING FORTRESS

This model B-299T has four 1,200 h.p. Wright Cyclone engines and carries a crew of seven to nine.

The second and larger building program was completed in 140 days, by March of 1941.

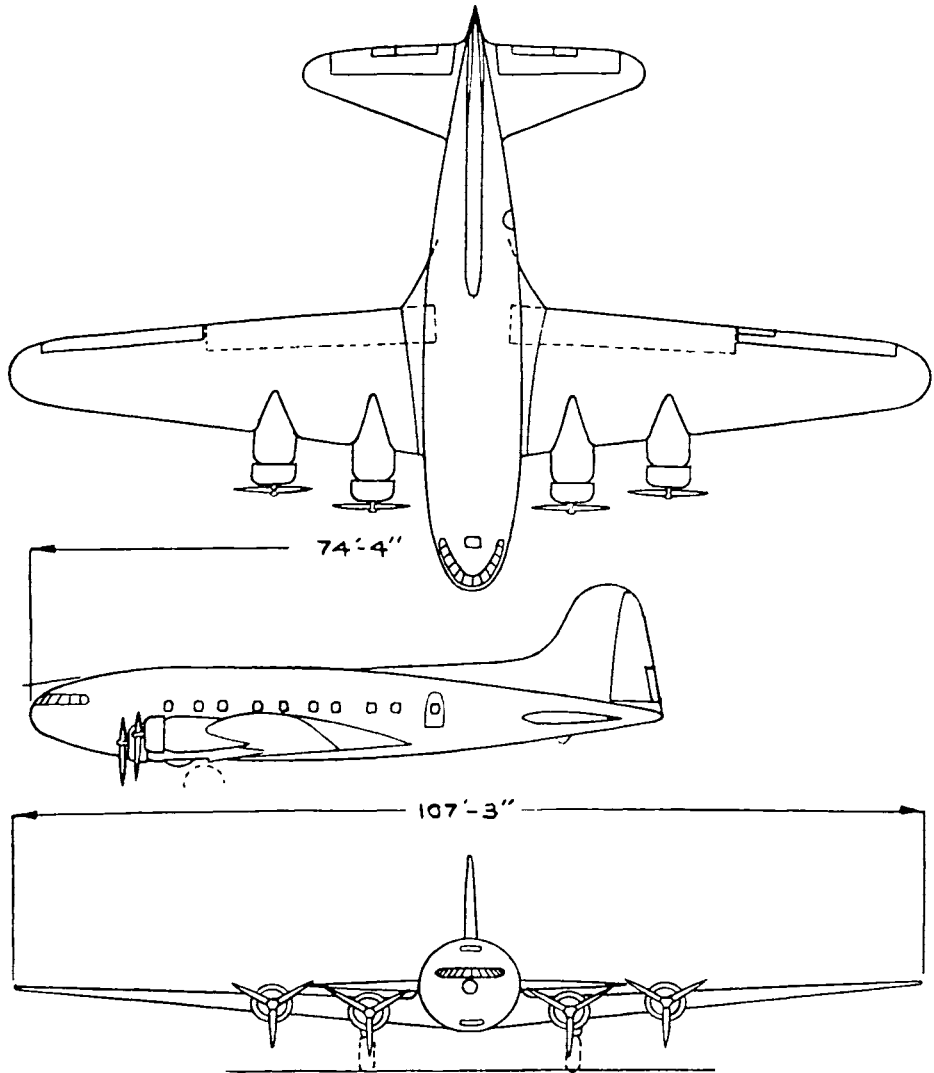
The enlarged plant No. 2 embraced nearly 1,800,000 sq. ft. of floor space under a single roof, with an outstanding production layout that was planned from the outset to handle large airplanes on a quantity basis. The production arrangement, simply described, consisted of a main manufacturing area with work progressing in one direction from primary stages in the rear part of the building to final assembly

at the forward end facing the airport, and with warehouse areas running virtually the entire length of the manufacturing area, on either side of it, to feed materials and purchased parts into the production lines. The main subassembly and assembly areas, with overhead clearance of  $32\frac{1}{2}$  ft. and  $35\frac{1}{2}$  ft., were served by a vast system of integrated overhead cranes. Beneath the factory floor 3,000 lineal feet of concrete access tunnels were constructed to provide orderly entrance and exit for the large number of workmen. That expansion made Boeing Plant No. 2 the main unit and headquarters of the Boeing Aircraft Company, with Plants No. 1 and No. 3 as subordinate units, the former for experimental work and the latter for the manufacture of certain subassemblies.

Boeing's program for increased Flying Fortress production also included the erection of a new plant in Wichita, Kans., to be operated by the Stearman Aircraft Division of Boeing and to be used in manufacturing subassemblies for the Fortresses. That is described in the paragraphs on Stearman activities.

The backlog of unfilled orders of Boeing Airplane Company, and its subsidiaries, including Boeing Aircraft of Canada Limited in Vancouver, B. C., and the Stearman Aircraft Division in Wichita, grew in 1940 from \$23,000,000 to more than \$200,000,000. The major part of the orders were for Boeing Flying Fortresses. Employment in the Seattle plants climbed from 6,000 at the beginning of 1940 to 8,500 in December. By February, 1941, it had reached 10,500 and by summer of 1941 it was about 18,000. The production rate of Flying Fortresses had been increased by the spring of 1941 to four times the rate of a year previous, and this was achieved without then making use of the major new plant areas under construction. Four models of the Flying Fortress, each an advance over the previous one, were produced. They included a fleet of B-17B Flying Fortresses completed early in 1940, a fleet of B-17C's completed in November, months ahead of original schedule, a fleet of B-17D's which were being delivered in the early part of 1941, and the company's principal production order under the defense program consisting of more than 500 advanced-type B-17E Flying Fortresses, the first of which were being produced in the spring of 1941.

The Flying Fortress was described as a long-range, high-speed, heavy duty 4-engine bombardment type, designed for large bomb-carrying capacity and effective defensive fire power. It carried a normal crew of 7 to 9 men. It was equipped with protective armor plate, leak-proof fuel tanks and machine guns firing in all directions. Data given for the Model B-299T Flying Fortress, an export version, included a maximum speed of 325 m.p.h., service ceiling of 36,700



THE BOEING STRATOLINER

A 38-place transport for substratosphere operations. It is powered by four Wright Cyclone engines of 1,100 h.p. each.

ft., and maximum range of 3,500 mi. The engines were four 1,200 h.p. Wright Cyclones equipped with exhaust-driven turbo-superchargers for peak performance at high altitudes. Wing span was 103 ft., 9 in., overall length 67 ft., 10 in., overall height 15 ft., 4 in., and maximum gross weight 47,500 lbs.

In the commercial field, Boeing produced the new Model 307 and 307-B 4-engine Stratoliners, three of which were delivered to Pan American Airways early in 1940 for inter-continental service to Rio de Janeiro, and five to Transcontinental & Western Air, for transcontinental service. The introduction of the new transports was considered a significant new turning point in commercial aviation. The T W A planes were the first 4-engine air liners to be operated regularly on any domestic line, and marked the beginning of the anticipated swing to 4-engine equipment in the nation's overland air transportation. The Stratoliners, moreover, were the world's first transport airplanes incorporating an altitude-conditioning system for comfortable over-weather flight at high altitudes. Their automatic cabin-supercharging system maintained comfortable low-altitude atmospheric conditions for passengers and crew during upper level flight, at altitudes of 14,000 to 20,000 ft. They marked a distinct step-up in the size of domestic transport airplanes. They carried 33 passengers and a crew of 5, as compared with the 21 passengers and crew of 3 customary in former transports. Their travel accommodations were increased proportionately in spaciousness and luxuriousness. The Stratoliner was an all-metal low-wing monoplane, its body designed in the form of an elongated "tear-drop," completely streamlined, and perfectly circular in cross-sections from nose to tail. The body diameter was 11½ ft., giving the cabin a width slightly greater than that of a modern streamliner railway train. The overall length was 74 ft., 4 in., wing span 107 ft., 3 in., overall height 20 ft., 9½ in. Weight empty was 30,000 lbs., gross weight 45,000 lbs. Night accommodations were provided for 25 passengers, with 16 upper and lower berths plus 9 individual reclining chairs. Equipped with four 1,100 h.p. Wright GR-1820-G105A Cyclones, the Stratoliner had a high speed of 250 m.p.h., and a cruising speed of 222 m.p.h. Take-off distance was 927 ft., rate of climb with 4 engines, 1,200 ft. per minute; with 3 engines, 600 ft. per minute; and with 2 engines, 113 ft. per minute. Service ceiling was 24,000 ft. with 4 engines, 18,350 ft. with 3, and 7,950 ft. with 2 engines. The maximum range with reduced payload (17 passengers and baggage) was 2,340 miles.

The first of a fleet of 6 new Boeing 314 type Clippers ordered by Pan American Airways was completed early in 1941 and all 6 were delivered several months ahead of schedule. These new 42-ton transoceanic flying boats were similar to the 6 Boeing Model 314 Clippers which Pan American placed in service over the Atlantic and Pacific in 1939. The new ships, however, incorporated several new features, including a new engine-propeller combination, increased fuel capacity and innovations in interior arrangement and decoration. The power

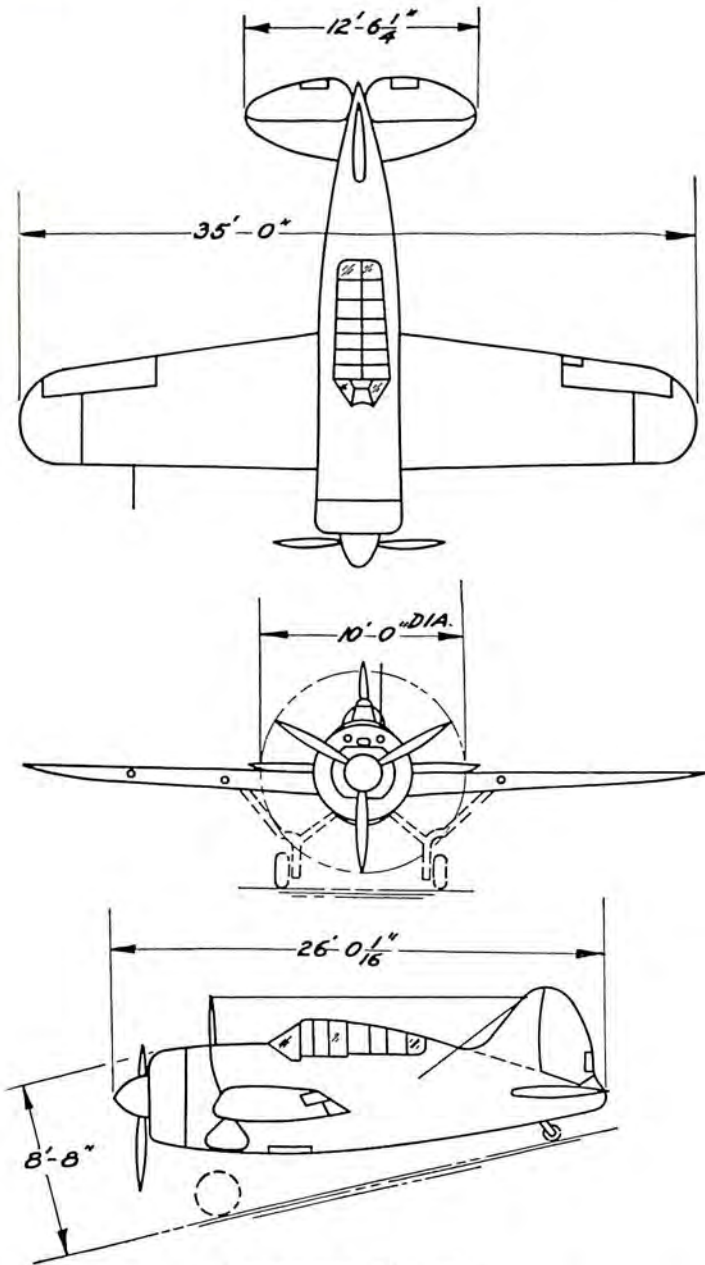
plants of the new ships were 4 Wright Cyclone 14's, with 1,600 h.p. available for take-off instead of the 1,500 h.p. per engine in the original 314's, and with improved specific fuel consumption. The Hamilton Standard propellers were larger in diameter than those of the previous ships, and incorporated an improved blade design. The built-in fuel tanks in the hydro-stabilizers were enlarged—without increasing the overall size of the hydro-stabilizers—to hold an additional 1,200 gals. of gasoline, or a total capacity of 5,400 gals. These changes meant improved performance, including quicker take-off, greater carrying capacity and an increase of maximum cruising range to more than 4,000 mi. The range and performance of the original fleet of Boeing Clippers in Pan American's service were being similarly increased by making the same changes in their fuel tankage and power plants.

Brewster Aeronautical Corporation, Long Island City, N. Y., carried on a large expansion program to provide space for defense orders. With 185,000 sq. ft. of floor space in the Long Island City plant, Brewster on May 16, 1940, leased the new hangar at Newark Airport, which provided an additional 217,000 sq. ft. There the last of a \$10,000,000 contract for wing panels, wing tip floats and braces for Consolidated flying boats was completed; and the company transferred from the Long Island City plant its operations on final assembly of wings to fuselage, flight testing and packing of Brewster models for the U. S. Government and Great Britain.

Two weeks after the Newark lease was negotiated, Brewster also acquired through lease an 8-story building comprising 482,000 sq. ft. of floor space, diagonally across from the original plant in Long Island City, formerly occupied by the Ford Motor Company. All sub-assembly and final assembly operations on the fuselage and wings as entities then were carried out in this plant; the original factory being devoted to forming and production of small parts. On March 28, 1941, work was started on a new assembly plant and modern airport on a 400-acre tract formerly devoted to farming at Johnsville, at Warminster Township, Pa. On completion it was to bring total space of the company to 1,334,000 sq. ft. The new factory was built in four units, each of which was occupied and placed in operation as completed in order to accelerate defense production.

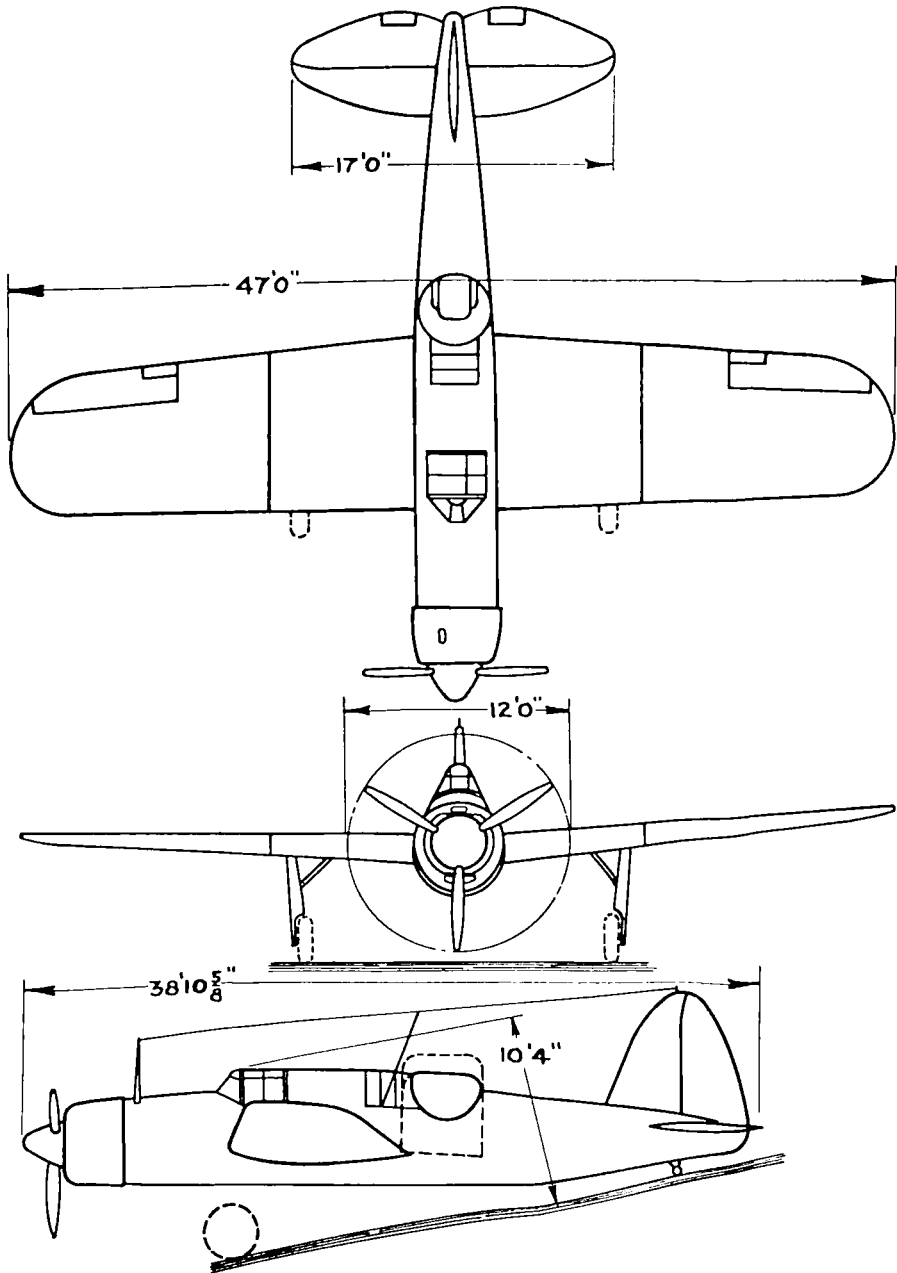
Brewster was building fighters for the U. S. Navy late in 1939, when Russia invaded Finland. Upon request, the Navy released its contract to the Finns with the understanding that it would take delivery later on similar planes incorporating any refinements developed as the result of research and service experience. The Finnish order, which totalled about \$3,000,000, was followed closely by an order





BREWSTER MODEL 339

This single-seat fighter bomber is powered with a Wright Cyclone engine rated at 1,200 h.p.



BREWSTER MODEL 340

A dive bomber powered with a 1,700 h.p. Wright Cyclone engine.

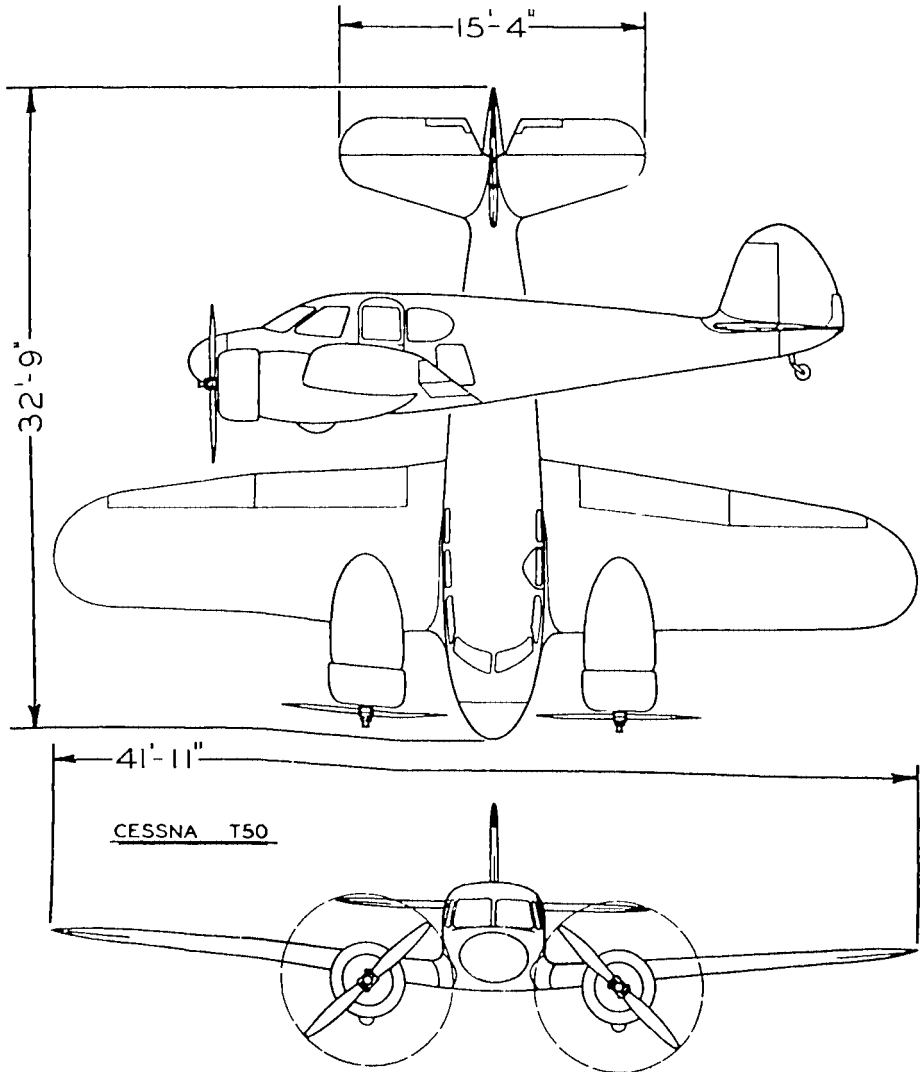
from Belgium for \$2,500,000 worth of fighters. The first Belgium ship was delivered on May 10, 1940, just as the German motorized units swept over the border. France assumed the undelivered portion of the Belgian contract.

Later the British Government ordered the Brewster 339 fighter which it named "Buffalo." The Navy also placed orders, followed by the Netherlands East Indies Air Force. Deliveries to all three customers were completed early in 1941, and production was started on a new type of dive-bomber designated by the U. S. Navy as SB2A-1 and by the British as "Bermuda".

The Brewster 339 fighter, which was the export version of the F2A-2 built for the U. S. Navy, was a single-seat, mid-wing mono-plane powered with either an 1,100 h.p. or a 1,200 h.p. Wright Cyclone engine and equipped with a Curtiss Electric full-feathering, three bladed propeller. It could be equipped to carry four 50-caliber machine guns, 2 in the fuselage and 2 in the wings, also two 100-pound bombs, mounted under the wings, radio, navigating and oxygen equipment. Provision was made for armor plating and fuel tank protection. The fuselage was of monocoque construction. The cockpit was covered by a plexiglas canopy with sliding door for entrance and exit and a plexiglas window was placed in the floor for down vision. The wing was metal covered and of the box-beam type of construction, while tail surfaces were of the cantilever type, fabric covered. Control surfaces were balanced. Landing gear was retractable. Fuel tanks were integral with the wing beam and had a capacity of 160 gals. The new Brewster dive-bomber, named the "Bermuda" by the R.A.F., was a 2-place, long-range type powered with a Wright Cyclone 14 engine rated at 1,650 h.p. equipped with a Curtiss Electric three-bladed propeller. With provision for a crew of 2, the new ship was equipped with the latest power machine gun turret, armor plate and bullet proof gas tanks.

Central Aircraft Corporation, Keyport, N. J., which succeeded to the ownership of the former plant of the Aeromarine Plane & Motor Company, with 200,000 sq. ft. of floor space, concentrated its activities on the development of high-speed bombardment aircraft as well as upon military cargo aircraft. A substantial engineering staff and a smaller shop personnel were employed in that work. The company also was undertaking the production of subassemblies for other manufacturers. The military development had progressed to the point of production of wind tunnel models.

Cessna Aircraft Company, Wichita, Kans., continued manufacture of its C-145 and C-165 Airmaster models, as well as the Cessna T-50 Twin model. The C-145 Airmaster was a 4-place cabin high-wing



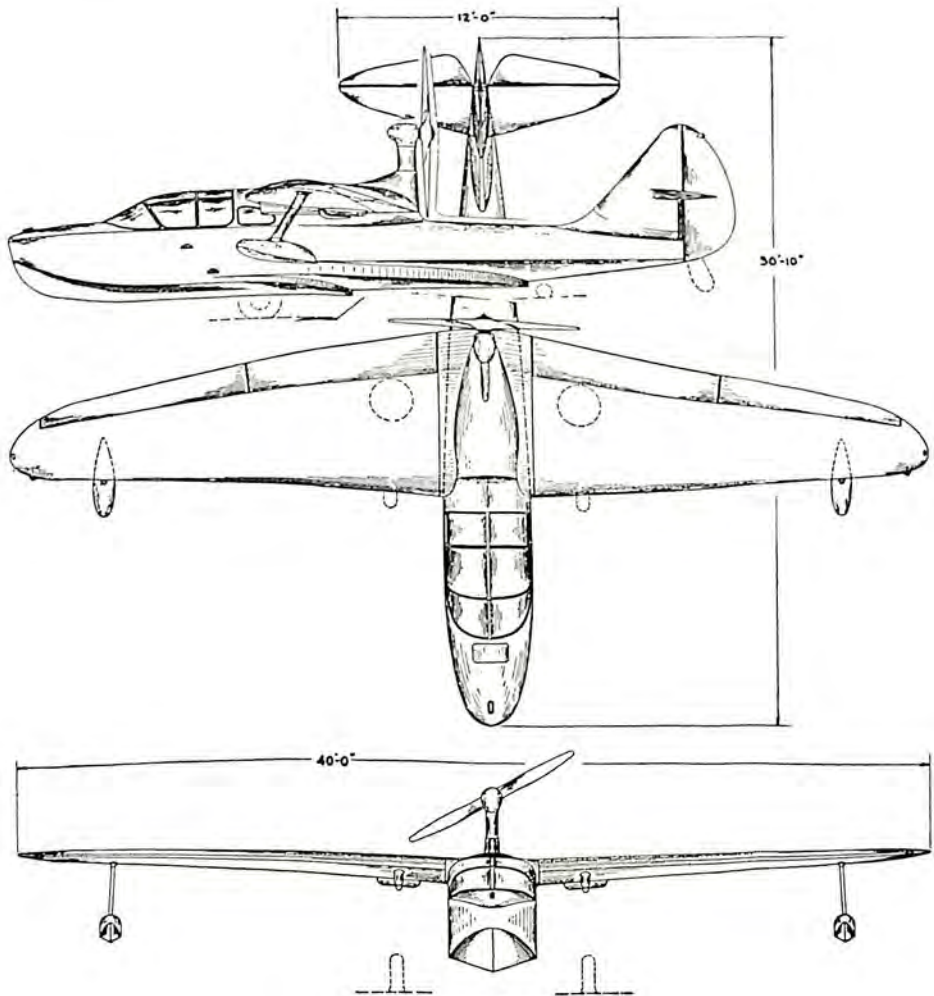
CESSNA T-50

A twin-engine personal transport, carrying five, and powered with two Jacobs engines of 225 h.p. each.

monoplane with wing, tail surfaces and landing gear of full cantilever construction. Its gross weight was 2,450 lbs. and it was powered with the 145 h.p. Warner Super Scarab engine. The C-145 had a cruising speed of 151 m.p.h. at optimum altitude and was available with a range of from 525 to 785 mi. The C-165 model of the Airmaster was similar to the C-145 except that it was powered with the 165 h.p.

Warner Super Scarab engine. Gross weight remained the same, cruising speed was increased to 157 m.p.h. at optimum altitude, with a range of from 485 to 725 mi. Take-off and climb were improved by the increase in horsepower. The 4-place Airmaster had a span of 34 ft. 2 in., length 24 ft. 8 in., and gross weight of 2,450 lbs. The Cessna T-50 Twin cabin monoplane, tested and licensed by the C.A.A., late in 1939, was manufactured as a twin-engine trainer for both the U. S. Army and the Royal Canadian Air Force. The commercial T-50 was powered by two Jacobs L4MB engines, rated at 225 h.p. each with 245 h.p. available for take-off. The T-50 carried 5 persons and baggage, with a range of from 750 to 1,000 mi. Stated cruising speed was 191 m.p.h. at optimum altitude of 7,500 ft. with 75 per cent power output. The T-50 featured a continuous cantilever wing of spruce construction and a fuselage welded from chrome molybdenum steel tubing, both fabric covered. Cessna claimed that this construction lent itself admirably to easy maintenance and repair as well as rapid, economical construction. The T-50 had a span of 41 ft. 11 in., length 32 ft. 9 in., and gross weight of 5,100 lbs. The T-50 was also available as a military airplane, a trainer, ambulance, personnel transport or photographic airplane. During the year an extensive expansion program was completed, which boosted floor space from 55,000 to 240,000 sq. ft. and expanded personnel almost 15 times. A half-million dollar machine tool buying program was completed, and the machinery installed. Expansion was being continued during 1941, with a backlog of orders on hand insuring maximum production during the balance of the year.

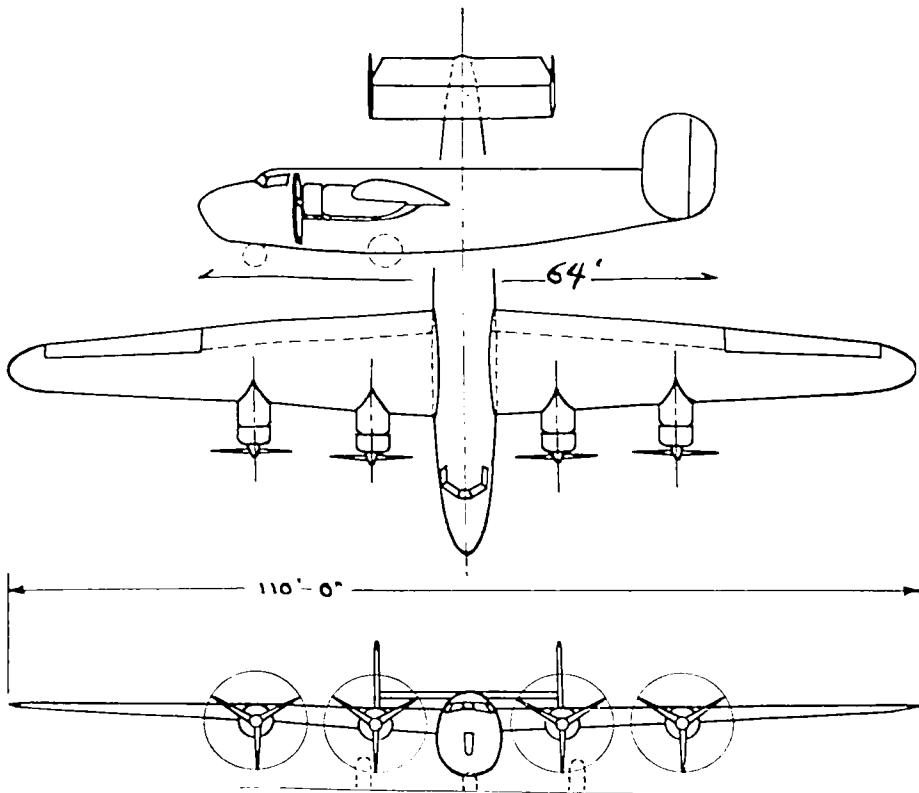
Colgate-Larsen Aircraft Company, Amityville, N. Y., formerly Spencer-Larsen, proceeded during 1940 with final development work on its CL-15, a 4-place amphibion for private use. In addition it developed a program of specialized sheet metal and machine work on a subcontract basis for other aircraft companies to aid in the defense program. The CL-15 was based on a 2-place ship previously completed for flight tests. It offered for the first time, a single-motored amphibion of the flying boat type without superstructure. It was a high wing full cantilever monoplane. The principle of the spiral bevel gear, widely accepted for propeller reduction gears was utilized for a right angle spiral bevel gear drive to provide a propeller amidship directly over the engine, which was mounted between the wing panels and within the hull to the rear of the cabin. Through this location of the propeller and power plant, superstructure was eliminated and parasite drag reduced to a minimum. An unusually low center of gravity was obtained, and the plane was removed from the turbulent area of the propeller to travel outside its own slipstream.



COLGATE-LARSEN

A four-place amphibion powered by a 200 h.p. Ranger engine.

With a Ranger 6-440C-5 200 h.p. engine, the plane had specifications showing a top speed of 140 m.p.h.; cruising at 125 m.p.h.; landing at 50 m.p.h.; range 500 mi., or 665 mi. with optional gasoline loading; rate of climb of 800 ft. per min.; gross weight of 2,860 lbs., and weight empty 1,730 lbs. Construction was entirely of plastic bonded mahogany plywood with no fabric used on any part of the ship. The hull was the N.A.C.A. Model 35, slightly modified. Landing gear was retractable with a 360-degree swivel tail wheel retractable into a well in the hull. The plant at Amityville was equipped for both metal pro-

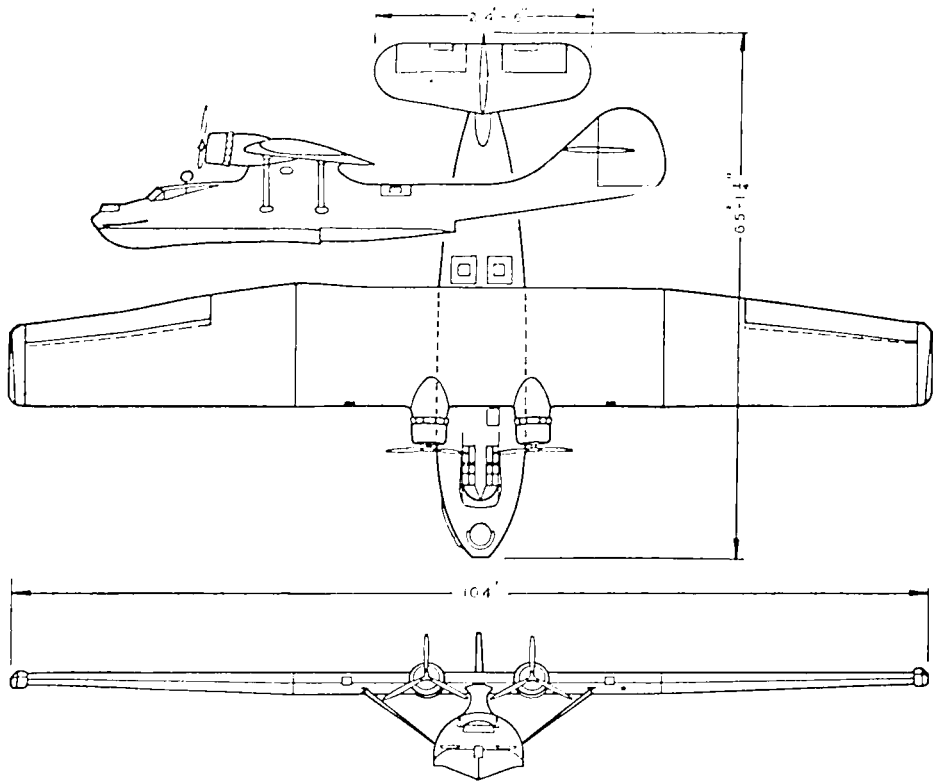


CONSOLIDATED LONG-RANGE BOMBER

It carries a crew of six to nine and is powered by four Pratt & Whitney engines of 1,200 h.p. each.

duction and the plastic bonded mahogany plywood production to be used for the company's special amphibion. Additional floor space was provided for this equipment and the limited personnel with which the company undertook production was increased 700 per cent.

Consolidated Aircraft Corporation, San Diego, Calif., during 1940 embarked on a record expansion program. Construction of new factory buildings began early in 1940, and the new facilities were dedicated in September. These buildings doubled the plant as of the first of the year. Before the end of 1940, however, work on an entire new plant, located about a mile north of the expanded Lindbergh Field factory site was begun, which was to double the manufacturing facilities. The new plant, devoted to parts assembly, had 1,553,000 sq. ft. of covered manufacturing area and 64,000 sq. ft. of loading platforms with car level sidings. The new plant was located on a site of 52 acres, and had an adjacent area of 72 acres for parking facili-



#### CONSOLIDATED PATROL

A 20-place flying boat powered with two Pratt & Whitney Twin Wasp engines.

ties. Employees as of January 1, 1940, totalled 3,200; as of January 1, 1941, 14,000; and a total personnel of 30,000 was in prospect. Due to the equable climate at San Diego, flight testing could be conducted virtually without interruption, and 30 per cent of the manufacturing operations could be conducted out of doors.

Consolidated backlog of approximately \$40,000,000 that started the year 1940 had grown to about \$325,000,000 at the beginning of 1941. Consolidated during 1940 absorbed all physical assets, as well as the name and good will of the Hall-Aluminum Aircraft Corporation of Bristol, Pa., through purchase. Key men of the Hall Company moved to the West Coast plant.

Concurrently with the exceptional expansion of plant facilities, Consolidated focused attention upon the production of its large land bombers and flying boats, tooling up for its huge U. S. Government and foreign orders. The first 26 powerful Model 32 four-engine land





#### PART OF THE CONSOLIDATED PLANT

Air view of the great plant of the Consolidated Aircraft Corporation at San Diego, Calif. One of the buildings shown under construction is 1,500 feet long.

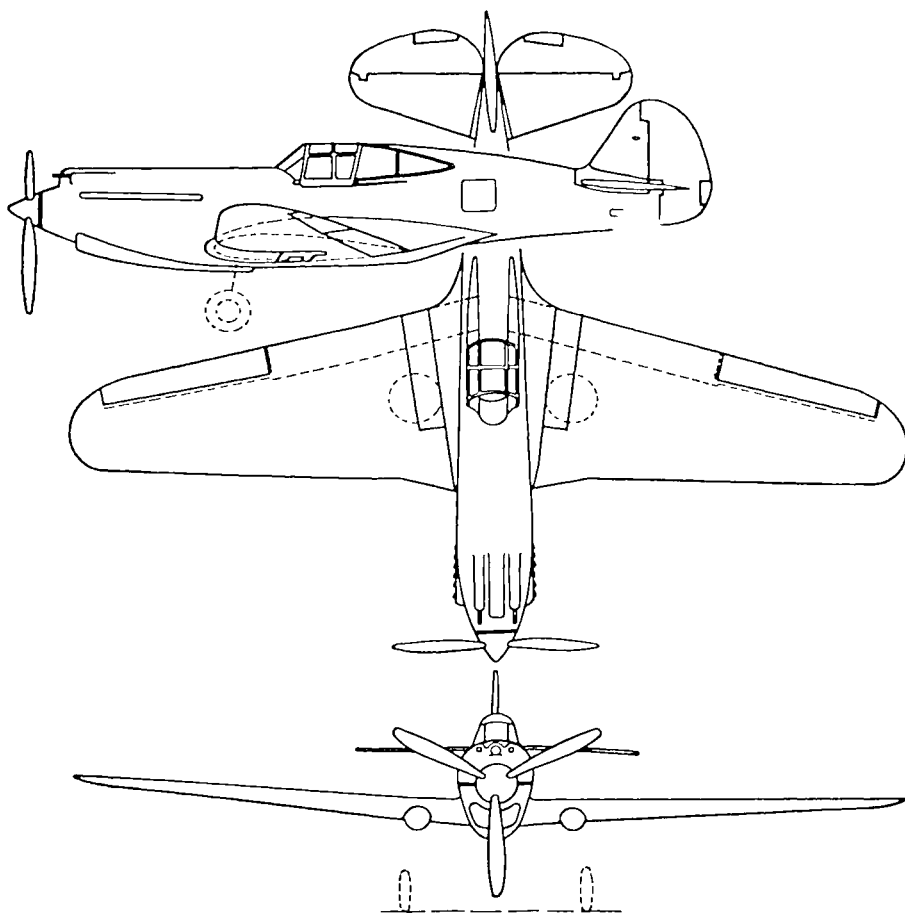
bombers, known in U. S. Army designation as B-24's, were released to Great Britain. The only non-military delivery of the year was to the U. S. Coast Guard—a twin-engine Model 28 flying boat.

Reaping the harvest of its tremendous expansion program, the addition of thousands to its personnel, and the thorough production tooling that had been accomplished as groundwork, Consolidated was making a notable contribution as its share in the national defense program.

Culver Aircraft Corporation, Wichita, Kans., purchased a new factory, permitting expansion to provide for Government contracts as well as commercial production. Culver brought out a new plane, the Cadet, a light low-wing monoplane. The company had a contract with the U. S. Army Air Corps.

Cunningham-Hall Aircraft Corporation, Rochester, N. Y., in 1940 manufactured aircraft parts and accessories, and produced its PT-6F light freighter.

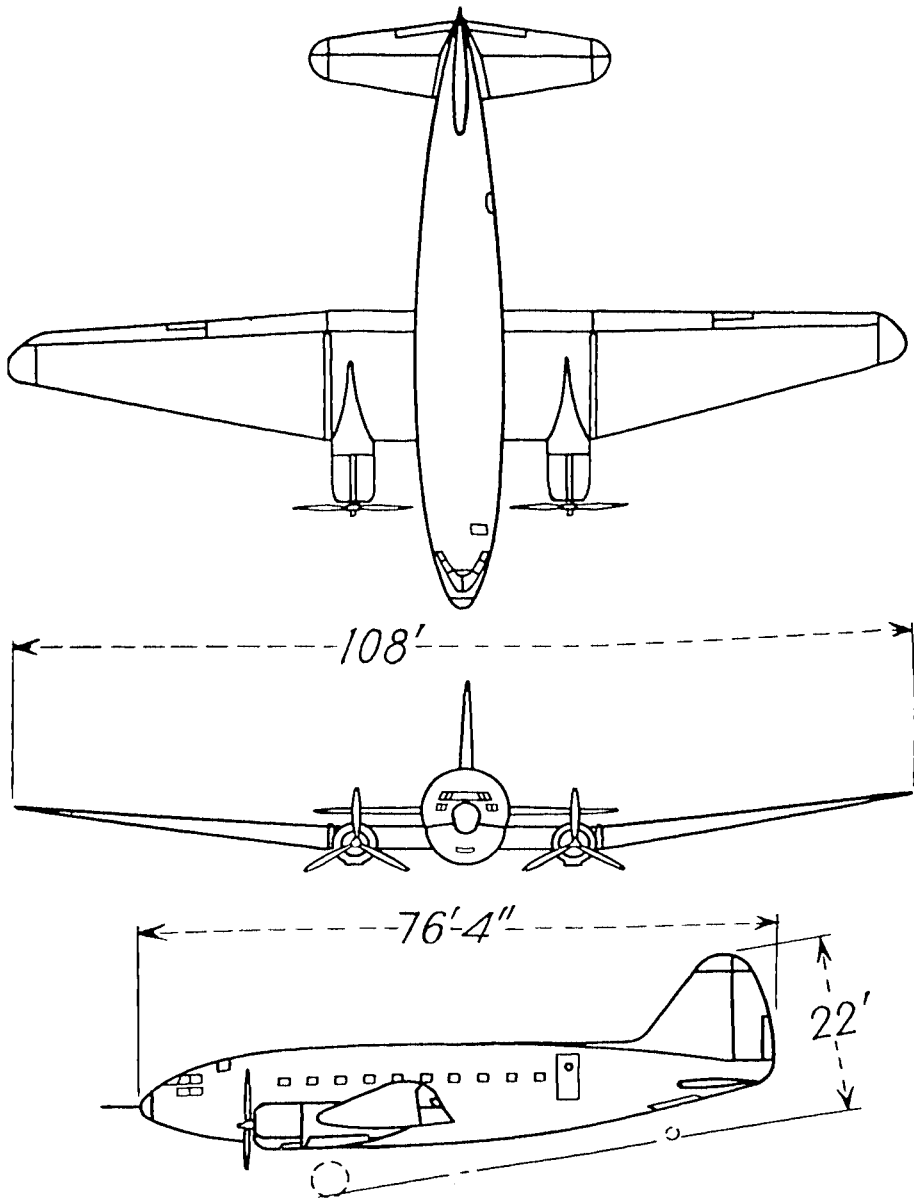
Curtiss Airplane Division, Curtiss-Wright Corporation, Buffalo, N. Y., in 1941 was in its fourth year of intensive production and expansion. Production of pursuit planes dominated the manufacturing output with an order from the U. S. Army Air Corps for the Curtiss P-40 type completed during 1940, and hundreds of a similar plane, designated the Tomahawk, produced for Great Britain. Peak production was reached by the latter part of 1940, when 10 planes of the varied designs produced left the plant each working day. Sup-



CURTISS P-40

This single-place pursuit is powered with an Allison engine.

plementing manufacturing of the pursuit type was a single-engine biplane scout bomber for the U. S. Navy, a single-engine high-wing observation for the U. S. Army Air Corps and the development of dive bombing, observation and pursuit planes in improved designs both for the United States and for export. The beginning of 1941 saw the Curtiss-Wright Airplane Division's vast expansion program well under way. An additional plant on the Buffalo Airport, considerably larger than the older factory currently operating was rapidly taking shape, as were additional factories in Columbus, O., and St. Louis, Mo. In January, 1940, the production floor area in Buffalo consisted of approximately 700,000 sq. ft., an increase over a period of three years from the original building area of 420,000 sq. ft. built in 1929,



CURTISS TRANSPORT

A twin-engine sealed transport powered by Wright Cyclone engines.

the original plant size maintained until the beginning of the current expansion program in the fall of 1938.

With the completion of the 3 new plants, the Curtiss Airplane

Division was to have over 4,268,000 sq. ft. of floor area for productive purposes. Curtiss employment at Buffalo set an all time high of 10,000 on January 1, 1941. This figure was to be augmented in the new plants to a total of 42,500 persons when peak production was reached.

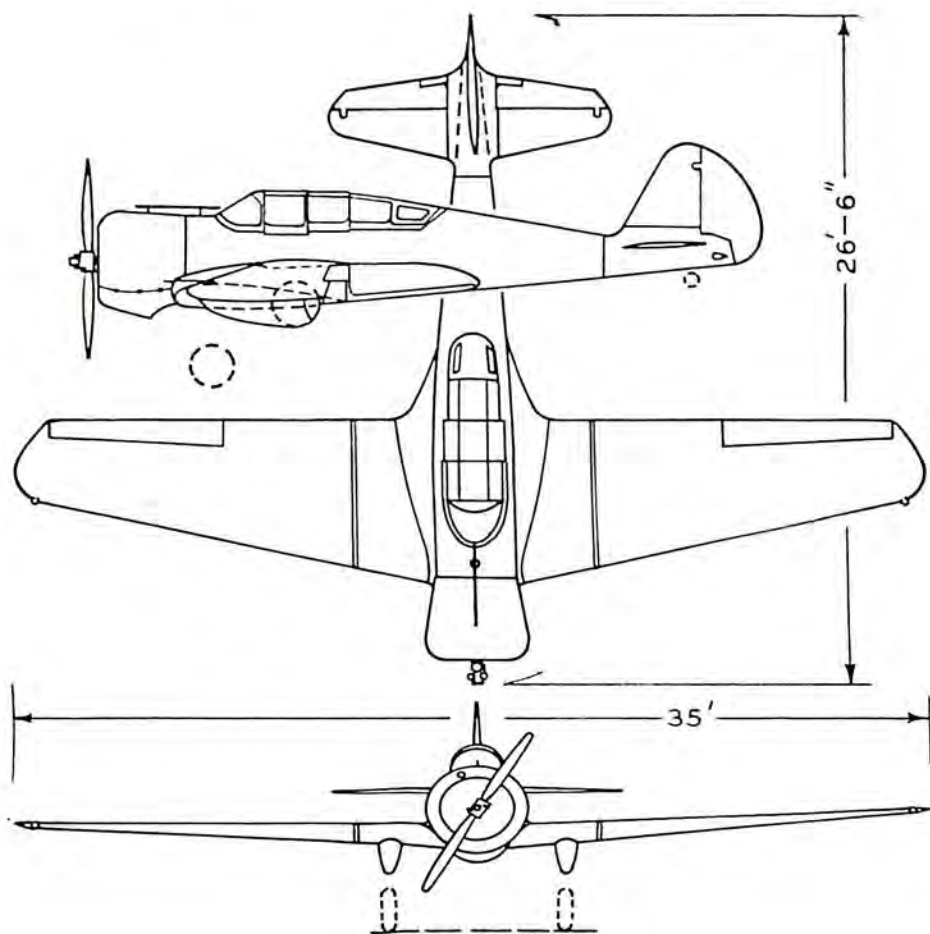
Three training schools, sponsored by the Airplane Divisions and manned by Curtiss personnel, rapidly were training employees for the plants. Courses in machine work, riveting, sheet metal and other trades vital to the aircraft industry predominated among the courses of instruction. Working in conjunction with the schools were municipally operated vocational training centers, which were also valuable sources of personnel. It appeared that those sources of supply would furnish the majority of the workmen needed in the vast expansion program.

The Curtiss P-40 was a single-seat low-wing monoplane designed for the most exacting pursuit missions. It was powered by a 12-cylinder Allison liquid cooled engine and a Curtiss electric propeller. The fuselage was of all-metal construction of semi-monocoque design and covered with Alclad skin. The wings and tail unit were full cantilever design and were also of all-metal construction and covered with Alclad stressed skin flush riveted, excepting the control surfaces which were fabric covered. The landing gear was fully retractable, and the wheels swiveled 90 degrees to lie flat in the wing panel. They were of the hydraulic-pneumatic oleo type. The P-40 could be equipped with oxygen and radio equipment for high altitude operation and communication missions.

The newly completed 36-passenger Curtiss (Model 20) transport was flown for the first time on March 26, 1940, by the St. Louis, Mo., plant of Curtiss-Wright Corporation's Curtiss Airplane Division. Powered with two 1,700 h.p. Wright Cyclone R2600 engines, the airplane attained a maximum speed of 262 m.p.h. during the flight tests. During the C.A.A. flight tests, the U. S. Army Air Corps expressed an interest in the model, with the result that it authorized the purchase of a large number of planes of this type for use as cargo transports.

The Curtiss Model 21 Interceptor-Fighter, powered by a Wright Cyclone R1820-G5 engine and carrying two 30-caliber and two 50-caliber synchronized machine guns in the fuselage, was developed further at the St. Louis plant during 1940 by the incorporation of a completely flush retracting landing gear, rather than the semi-retracting landing gear, and was built for higher strength and less drag.

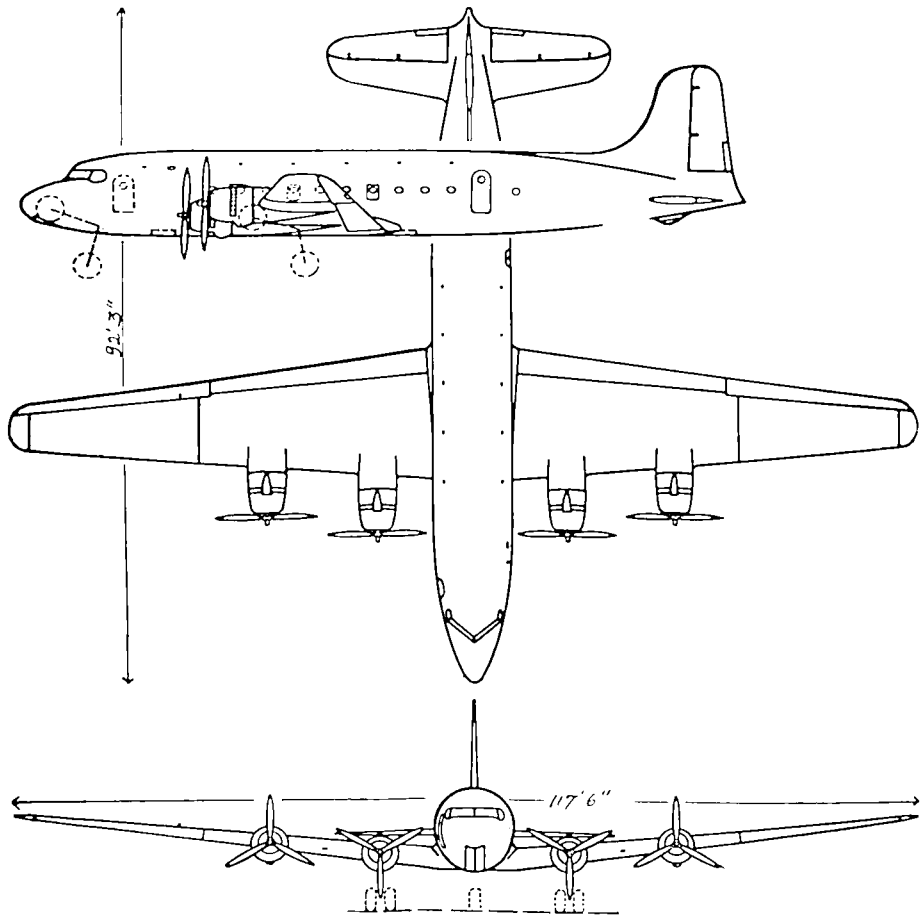
The Curtiss Model 22 Falcon, an advanced trainer type in-



CURTISS TRAINER

Model 22 has a Wright Whirlwind 420 h.p. engine.

incorporating various design features, including a semi-retracting landing gear, further proved its mettle as a combat training airplane. As a result of its demonstration, the U. S. Navy contracted for a large number for delivery in 1941. With the development of the defense program and the need for increasing the output of military aircraft, the St. Louis plant of Curtiss-Wright Corporation's Curtiss Airplane Division announced plans for erecting a mammoth aircraft manufacturing plant of 1,200,000 sq. ft. to replace its original plant of 149,000 sq. ft., on St. Louis' Lambert Field. Ground was broken for this new plant in November, 1940.



DOUGLAS DC-4

This 42-place transport is powered with either four Pratt & Whitney Twin Wasps or four Wright Cyclones.

The number of employees was increased to a total of 1,950 as of December, 1940. With the completion of the new plant expansion, that number was to be increased to a total of approximately 12,000 persons by December, 1941. Advanced types of aircraft were also under development at the St. Louis plant.

Douglas Aircraft Company, Inc., Santa Monica, Calif., in 1940 swung into tremendously accelerated production for defense. Under a \$20,000,000 national defense expansion program, Douglas broke ground for a huge new factory at Long Beach, Calif., announced plans for another assembly plant at Tulsa, Okla., and rapidly added men, machines and working area to its plants at Santa Monica and

El Segundo. To supplement the expansion program, and send airplanes down the line faster than ever before, shop departments and production lines were radically rearranged and "streamlined." As orders of unprecedented proportions poured in from the U. S. Army and Navy and Great Britain, backlog soared from \$72,500,000 on January 1, 1940, to nearly \$340,000,000 at close of the year. In the same period employment at the firm's Santa Monica and El Segundo plants rose from 13,000 to more than 20,000. Plans called for increasing personnel until completion of the expansion program, when employment was to exceed 50,000 with an annual payroll estimated at \$90,000,000.

Swifter and more formidable military airplanes flowed in ever-increasing numbers from the Douglas factories to meet national defense requirements. The U. S. Army Air Corps was taking delivery under large-scale orders for A-20A high-wing attack-bombers. It also signed substantial contracts for A-20 and A-20B attack-bombers and C-47 military transports. Deliveries were completed on an Army order for B-23 reconnaissance bombers.

The U. S. Navy and Marine Corps increased their orders for the speedy new SBD dive-bombers, and the Air Corps contracted for a large number of the same craft. Deliveries were underway throughout 1940.

Under the aid-to-Britain program, shipments of DB-7A attack-bombers were accelerated steadily. With the capitulation of France, the balance of that country's order for DB-7s was legally assigned to England and turned over to her representatives. Early in 1940, Britain made an allotment for a later model, the DB-7B. All-metal, twin-engine, high-wing monoplanes for crew of three, both the A-20 and DB-7 types were designed for use as attack ships or bombers.

Under a contract with the Norwegian Government, a number of new 8A-5 attack ships were delivered to Norwegian military units training in Canada. Deliveries also were completed during 1940 on an order for 8A-4 attack craft for Iraq.

As 1941 opened, the finishing touches were being applied to the huge and spectacular B-19 for the Army Air Corps. Largest airplane ever built, the super-bomber required more than 2,000,000 man-hours of research, engineering and production work. Its wings spreading 212 ft., and powered by four 2,000 h.p. Wright Duplex-Cyclone engines, the B-19 had a nonstop range of more than 7,700 mi. With bomb capacity of 18 tons, it weighed, completely loaded, over 82 tons. Upon completion of ground checks and flight tests, the "Guardian of the Hemisphere" was to be turned over to the Air Corps to become a flying laboratory for assembling and checking structural and tact-

ical information and serve as a guide in the design and construction of the great cargo and troop transports of tomorrow.

Military versions of the DC-3 transport were delivered in substantial numbers to the Army and Navy for use as personnel and equipment transports. Under authorization of the Federal priorities board, sufficient DC-3 skyliners were delivered to various air lines to maintain the efficiency of the nation's second line of air defense.

As construction progressed on the Douglas Company's new Long Beach factory, its main plant at Santa Monica was rapidly preparing for its own greater role in the new defense drama. Those preparations comprised a coordinated program of additional trained men, new buildings and high-speed machines, radically streamlined production lines, assembly jigs on tracks, relocated equipment and rerouted movement of materials. The result was a new high-speed airplane assembly technique designed to slash the elapsed time between the fabrication of parts and completion of the airplane, and bring into sight the long-sought mass production goal.

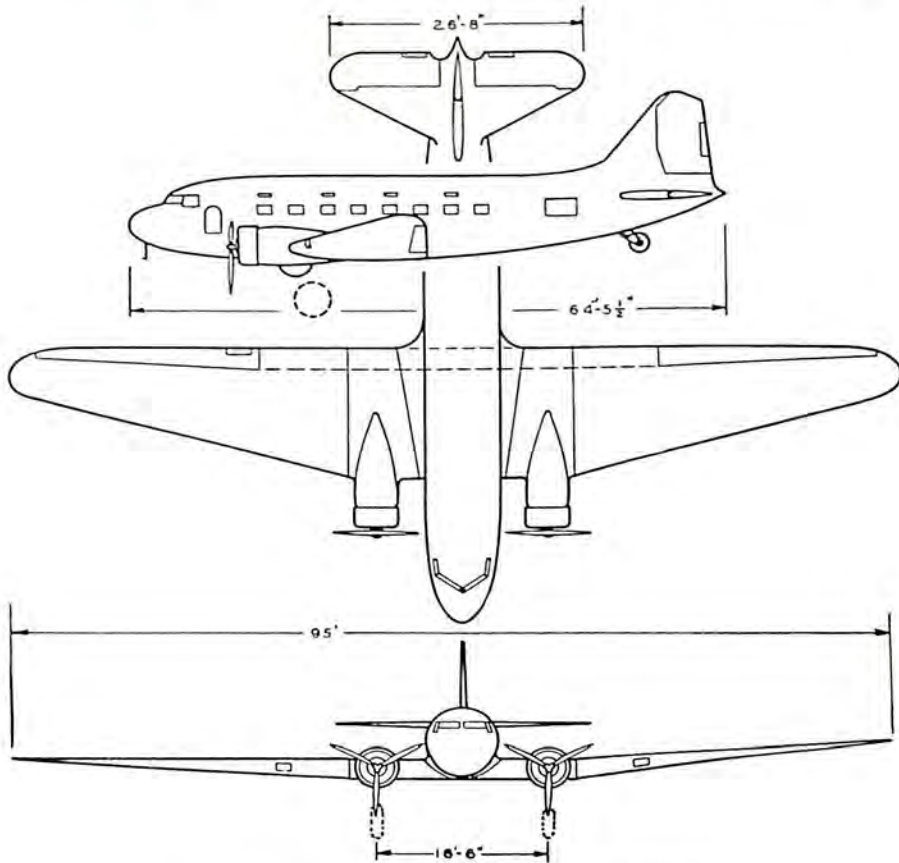
Shop departments and assembly lines were reorganized on a "progressive" basis, to send parts and materials through the factory in unbroken, continuous flow until they rolled out the door in the form of finished airplanes. Wherever the straight-line technique was launched, scheduling and planning were found to be greatly simplified, handling of materials was greatly reduced by elimination of backtracking and crosshauling, and production per given area of floor space was nearly doubled.

Parts from fabricating departments or outside production flowed into the major departments and emerged as complete sections of wings and fuselages. The flow of materials was virtually continuous, moving from jig to jig at regular intervals, without going into storage piles in between. In the case of fuselages and wing sections for attack-bombers, the jigs themselves were put on tracks and simply moved along, conserving production space and accelerating operations.

Research and engineering development continued to be the cornerstones of Douglas policy. Since 1930 Douglas had spent more than \$10,000,000 in developing and perfecting new commercial and military planes. Keeping pace with developments abroad, the company during 1940 equipped its latest attack-bombers with self-sealing fuel tanks, armor plating and increased armament.

Largest factor in the company's expansion program was its huge \$12,000,000 "blackout" plant at Long Beach. Construction began during 1940, and was scheduled for completion by mid-summer of 1941, when attack ships and military transports were to be rolling swiftly off assembly lines for delivery to the U. S. Army and Navy.





**DOUGLAS DAY-SLEEPER TRANSPORT**

Available either as a 21-passenger day plane (DC-3) or a 14-place sleeper (DS-T) these planes are powered with two Pratt & Whitney Twin Wasps or Wright Cyclone engines.

Designed for production of the largest number of the finest possible airplanes in the shortest possible time, the plant incorporated defensive arrangements, construction techniques and production systems never before employed in an aircraft factory on this continent.

Completely invisible at night from the air, all structures were artificially lighted, fully air-conditioned, with duplicated utility services and underground storage for vital supplies, and also provision for bomb-proof shelters for personnel. Added safety for plant and employees in event of air attack was provided by decentralization of the larger units, housing them in 11 separate buildings spaced so as to afford maximum protection from shell fragments. Erected

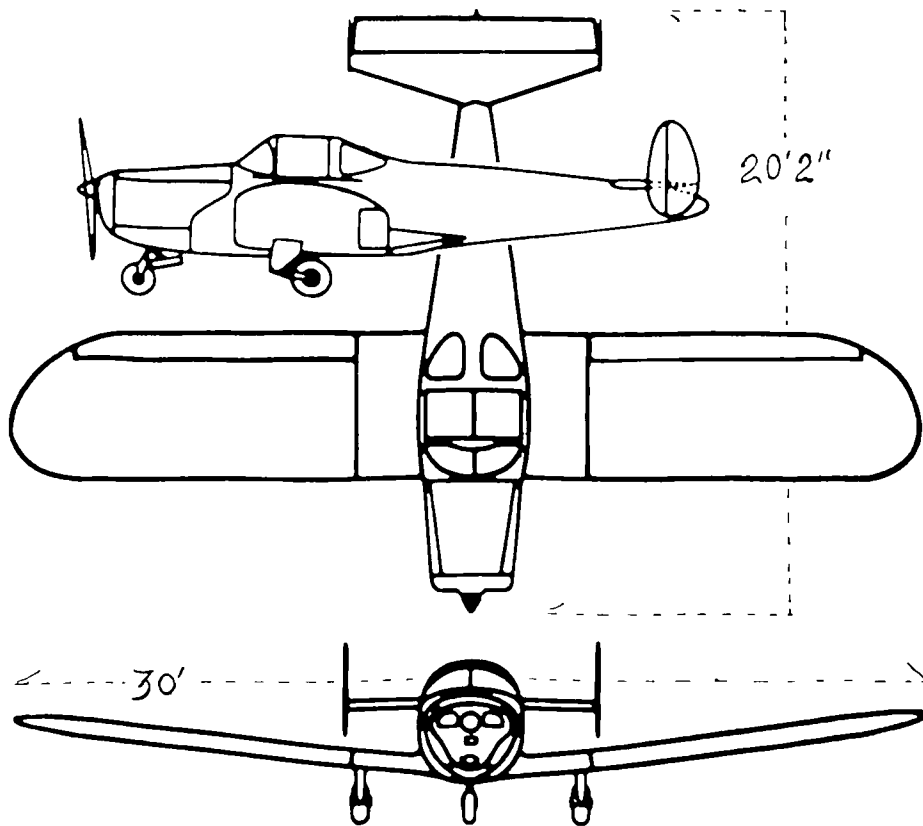
on a 200-acre site, the factory provided a total of some 1,400,000 sq. ft. of production space, nearly equal to the other Douglas plants combined. Completely windowless, lacking even skylights, the buildings were bright as day inside, but no tell-tale gleam could escape at night to aid any possible aerial "spotters." Light traps were provided for at all entrances to complete the "blackout" and render the plant altogether invisible from the air, and almost so but a few yards away on the ground. To make the structures less visible by day, all were flat-topped, with no light-reflective surfaces, and colored to match the area's special paving and to blend into the landscape. All entrances could be bomb-proofed. Oil and gasoline supplies and essential production materials were stored in subterranean vaults.

Output was to be augmented by employing various major parts and subassemblies built by large automotive and manufacturing plants in eastern and middlewestern industrial centers. At the start of 1941 a number of these plants were tooling up for production of airplane subassemblies under Douglas subcontracts that were expected to exceed \$100,000,000.

With personnel needs greatly increased under defense production pressure, the company's educational and training activities assumed more significance than ever before. During 1940 its educational efforts were extended, and a vast training program was launched to provide skilled workers for the new Long Beach plant. In cooperation with the local school system, special courses were offered in aircraft assembly methods. Thousands of men with experience in shipyards, oil fields, sheetmetal plants and machine shops enrolled for the new courses, and thousands more followed them, insuring that completion of the new airplane factory would find trained men ready. As the first quarter of 1941 closed, the company's huge expansion program was in full swing, and a force of 25,000 employees kept production lines rolling at a record pace day and night.

Engineering and Research Corporation, Riverdale, Md., after three and one-half years of intensive research and experimental work, started production on its new Ercoupe 415C, a 2-place monoplane. It had the tricycle landing gear, two-control operation, which permitted the entire operation of the aircraft by the control wheel, and exceptional visibility in all directions, both in the air and on the ground. The public reception of the Ercoupe was evidenced by a backlog of orders representing over one million dollars as of February 1, 1941. Production, barring curtailment of material, was planned to reach 3 planes a day by July, 1941.

For three years, the Engineering and Research Corporation had been working toward the production manufacture of the Schwarz

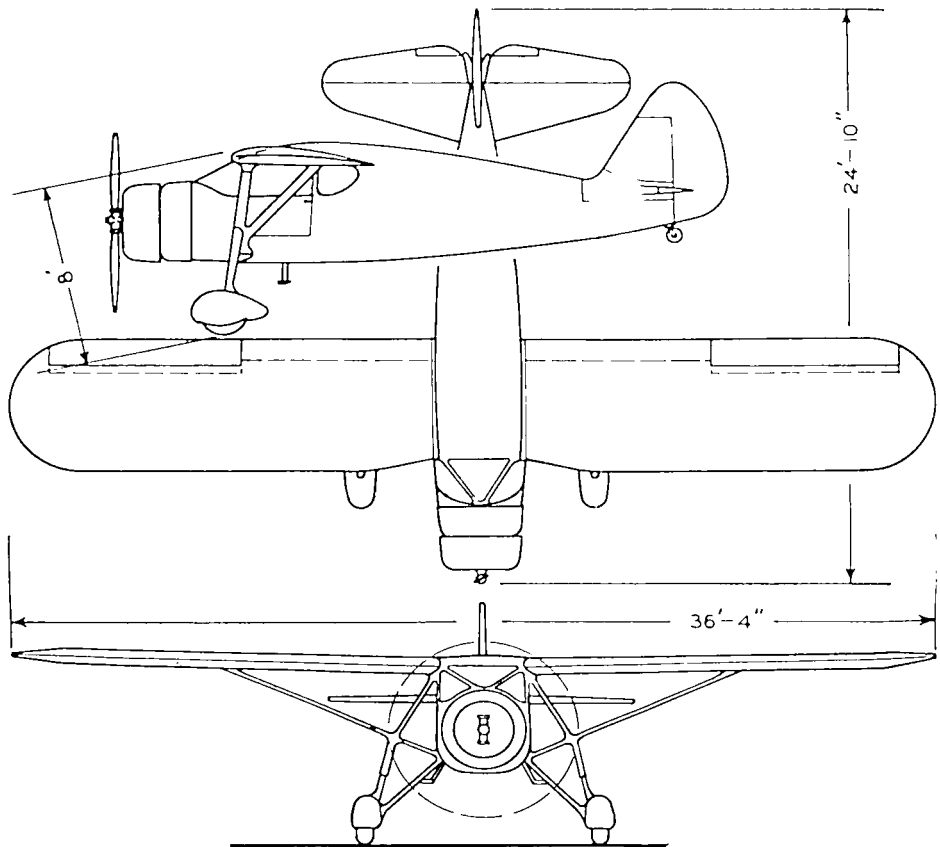


THE ERCOUPE

A Continental powered two-place plane for the private owner.

type of propeller, modified to fit American propeller practice. This lightweight durable propeller was in service extensively abroad, in both military and civilian use. The corporation was in production on blades to fit every existing horsepower, and was looking forward to still more powerful installations. The propeller was of plastic and wood construction.

In addition to manufacturing airplanes and airplane propellers, the Engineering & Research Corporation also manufactured a line of machinery especially designed by aircraft engineers to meet the wide variety and changing nature of aircraft work. The rapid growth of its machinery manufacturing division paralleled that of the aircraft industry as a whole. Its machinery line included the patented "Erco" Sheet Metal Forming and Flanging Machines and "Erco" Sheet Metal Shrinking Machines for forming and shrinking sheet metals. The

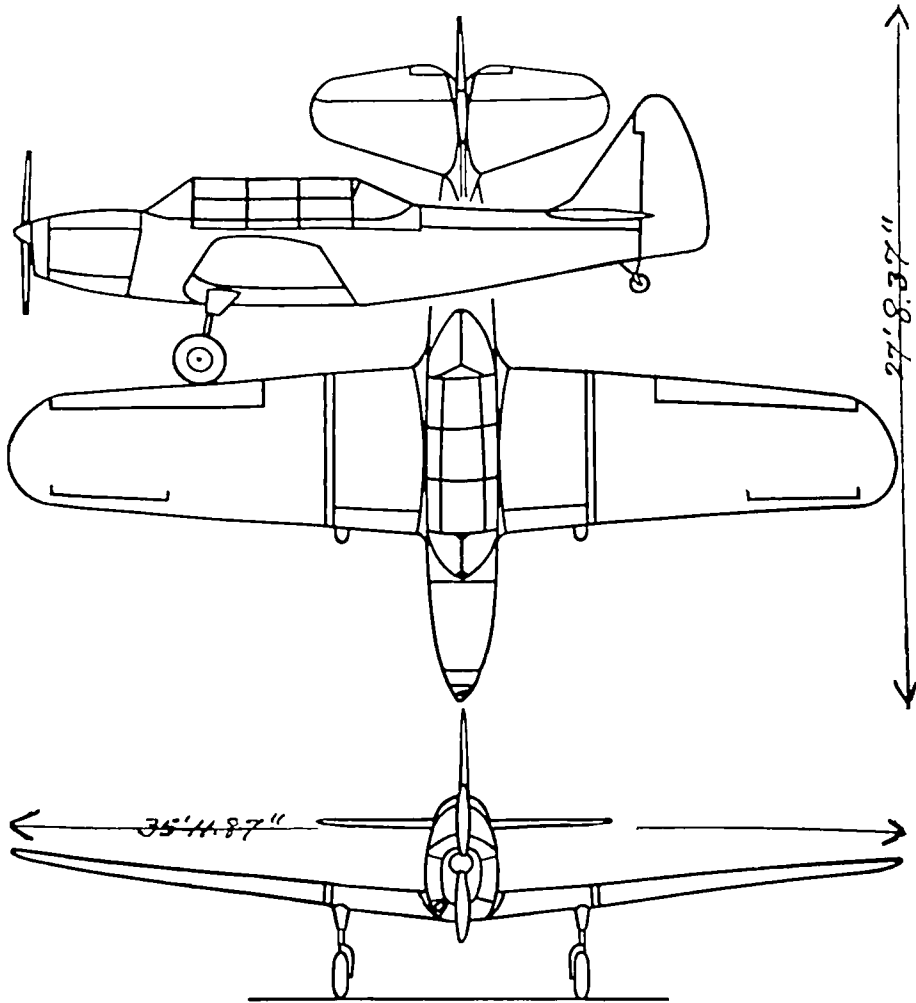


**THE FAIRCHILD 24**

A private owner plane with Warner or Ranger engine. Above is Warner installation.

patented "Erco" Automatic Punching and Riveting Machines that punched holes, fed the rivets into the punched holes and upset the rivets in one operation, and the "Erco" Hydraulic Stretching Presses for shaping dural outer skin sections of airplanes by stretching the metal over inexpensive cast iron, zinc or wooden forms. This method was fast replacing drop hammer, bumping hammer and laborious hand work in the making of many sheet metal components and in a fraction of the time previously required. Also included in its line of machinery was the ingenious "Erco" patented metal propeller blade profiling machine that finished aluminum propeller blade forgings on both sides with an accuracy of .002 in., taking from 30 to 40 min. depending on the size of blade.

Fairchild Aircraft Division of Fairchild Engine & Airplane Cor-



FAIRCHILD M-62

A Ranger-powered two-place military trainer.

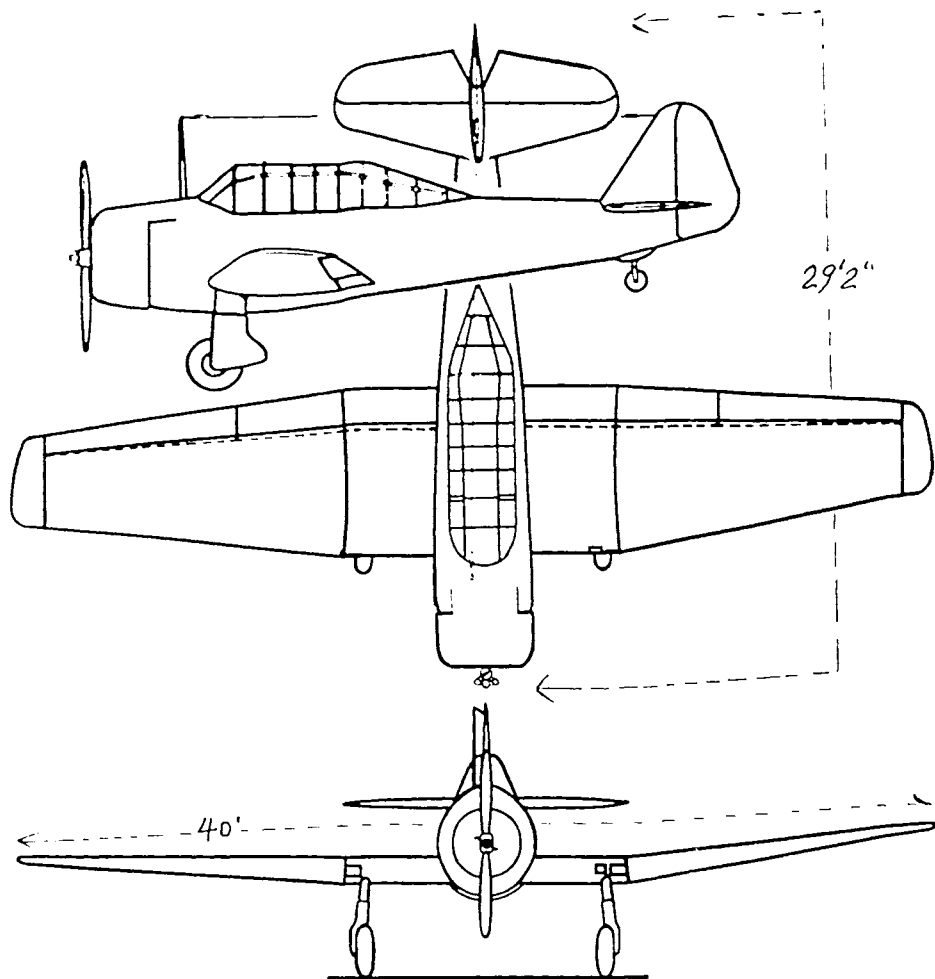
poration, Hagerstown, Md., by large increases in facilities and personnel brought its production to 3 planes a day by the end of 1940 and began the construction of a new factory to double that rate in 1941. Much of this increase was devoted to the Fairchild PT-19, a low-wing cantilever trainer for the U. S. Army Air Corps. This type, a trainer bearing those characteristics of the tactical plane to which cadets must become accustomed in their later stages, was ordered in increasing numbers in 1940. About 300 were delivered as production

was stepped up from 3 machines in April to 55 in December. The Army orders on this trainer, designated PT-19 by the Air Corps, aggregated about \$10,000,000.

The Air Corps' successful use of the PT-19 resulted in vigorous demand for the same type for other training operators. Without interfering with the Army orders, a commercial version of the plane was granted ATC 724 by the C. A. A., and was widely used by the C. A. A. itself as well as by commercial operators under the CPT program. Other purchasers were the Royal Norwegian Air Force, Toronto, Canada, and the Government of El Salvador. While keeping abreast of its military production schedules, Fairchild's experience and facilities enabled it to produce a record number of the familiar Fairchild 24. A total of 97 of those 4-place cabin monoplanes was produced in 1940. In accord with Fairchild policy various changes and improvements were introduced as they became available, instead of waiting for yearly model changes. In its year-end version this plane, designated 24 W-40, was equipped with the Warner 145 h.p. engine and carried 60 gal. fuel tanks for 6 hours range, manually operated flaps, steerable tailwheel and many other items normally classed as extras.

Due to the Army demand for the Ranger 175 h.p. engine, also manufactured by Fairchild, it was necessary to discontinue the equipment of the 24 with the inline, aircooled Ranger in April, 1940. The 720-mile range with 4 persons at low cost, however, continued the popularity of this model with the inspection forces of the C. A. A. and with the private owner. Commercial operators were able to profit from the "U-Fly-It" features of the model for charter and other business. Flying schools likewise found it extremely desirable for instrument flight instruction. Boeing School of Aeronautics alone purchased 3 more 24's for that purpose in 1940. Without interfering with its defense schedules the company continued to extend its business in subcontracting parts for other manufacturers, and devote a portion of its activities to basic research and engineering development perhaps larger than would be warranted by a strict view of current volume but one well justified in view of future possibilities.

Fleetwings, Inc., Bristol, Pa., in January, 1941, announced that it had delivered to the U. S. Army Air Corps for test its new stainless steel basic training plane BT-12. It had a wing span of 40 ft., length 29 ft., and fuselage constructed in 3 basic functions of spot-welded stainless steel. The wings, 35 per cent steel-covered, were fitted with slotted flaps. The fuel capacity was 120 gal. with built-in tanks for overload. Fleetwings also was preparing to produce a primary trainer of all aluminum construction—Model 33. It was to be of monocoque construction of formed Alclad sheet and stamped

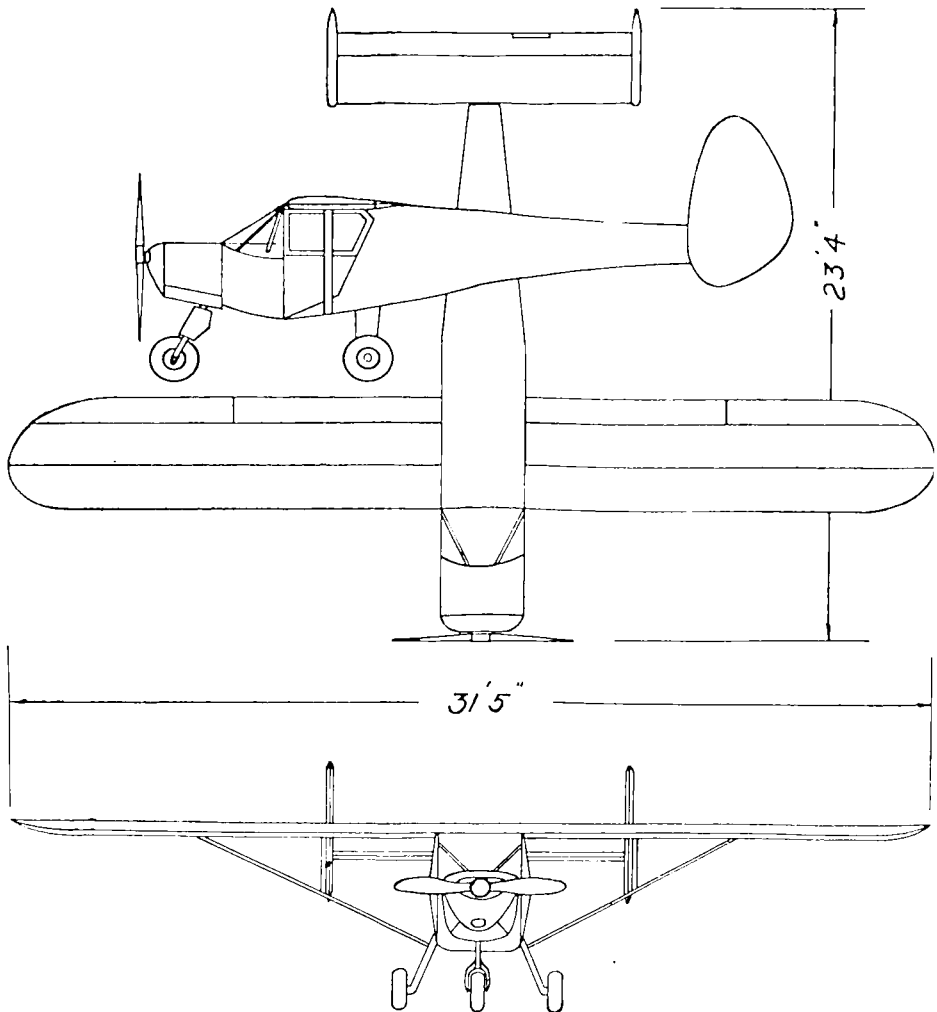


FLEETWINGS XBT-12

A basic trainer powered with a Pratt & Whitney 450 h.p. engine.

frames. Fleetwings also served the defense program by developing and fabricating hydraulic equipment and stainless steel and aluminum alloy parts.

General Aircraft Corporation, South Lowell, Mass, developed a 2-place private owner plane with a 75 h.p. geared Lycoming engine. It had a gross weight of 1,350 lbs. It was a side-by-side, high-wing cabin monoplane. It had no rudder, the rudder being replaced by 2 vertical fins which could not be moved. Flight control was accomplished by ailerons and elevators. No foot controls were provided except hydraulic brakes operated by a single foot pedal. The plane



GENERAL AIRCRAFT G1-80

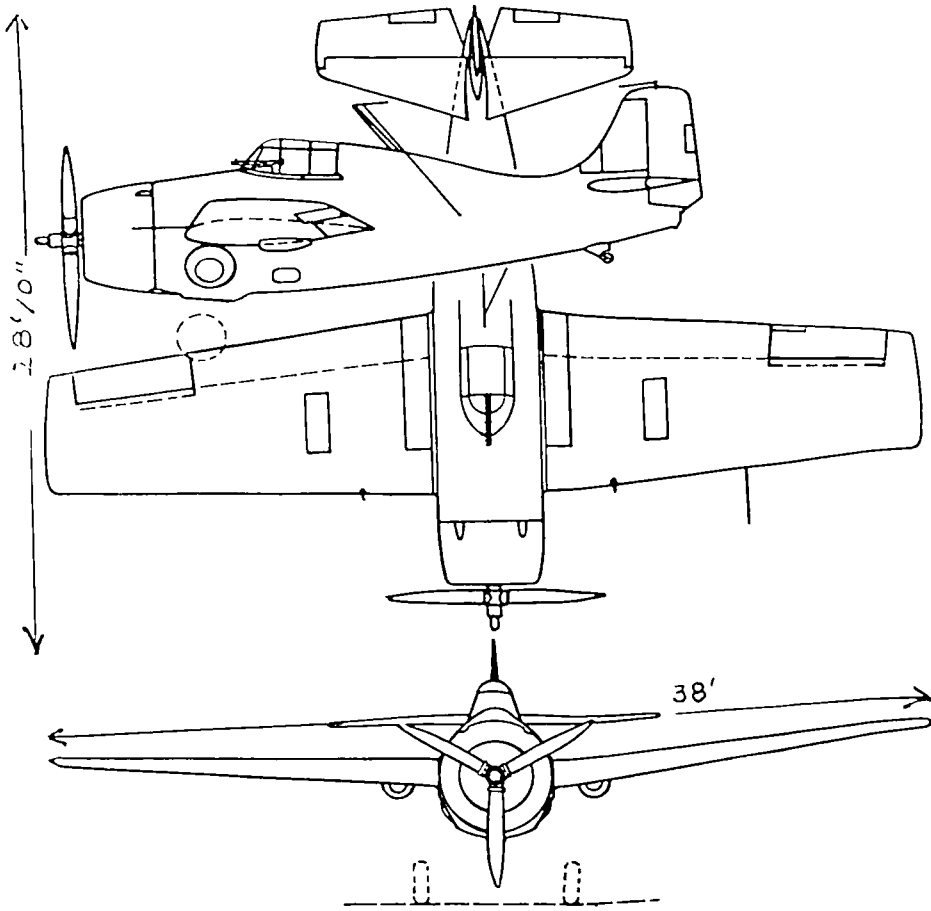
A two-place plane for the private flyer with a Lycoming 75 h.p. engine.

had a tricycle landing gear with a steerable front wheel connected to the same control which turned the plane in flight.

Globe Aircraft Corporation, Fort Worth, Tex., had under construction a small, 2-place private owner monoplane.

Grumman Aircraft Engineering Corporation, Bethpage, N. Y., completed a plant expansion program in July, 1940, which increased the floor area by approximately 32,000 sq. ft. Also, early in 1941 construction was well under way on a new plant at Bethpage to take care of increasingly large orders from the U. S. Navy. With a floor space



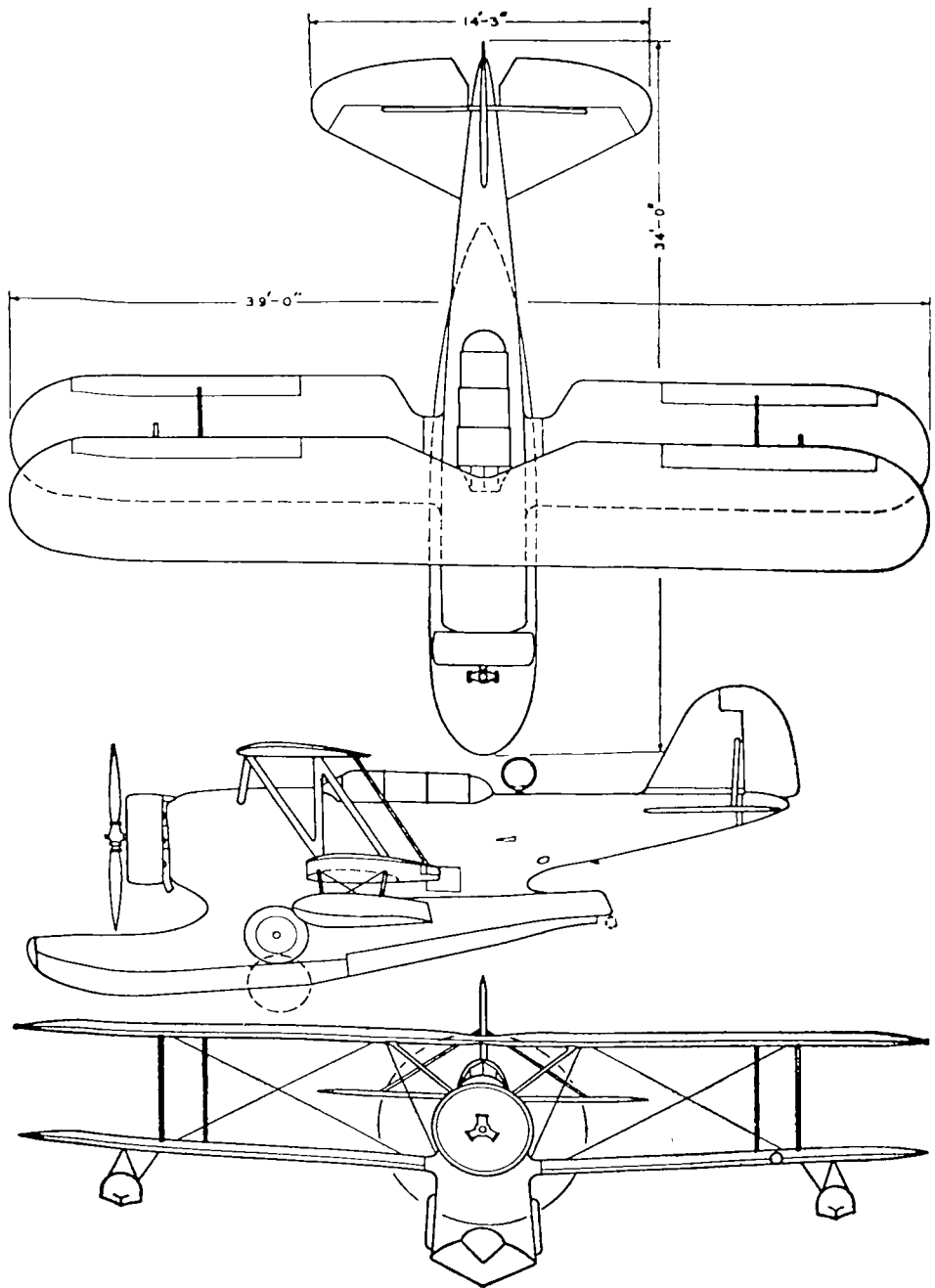


GRUMMAN G-36

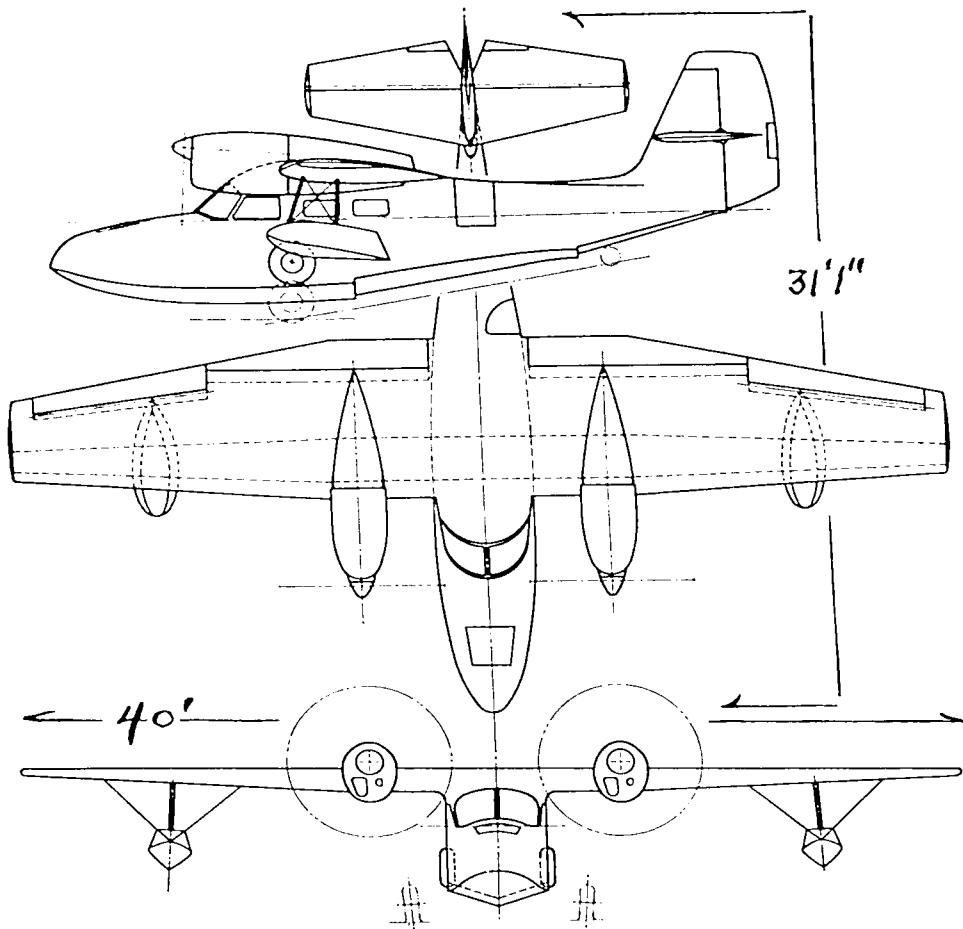
This one-place fighter may be powered with a Pratt & Whitney Twin Wasp or a Wright Cyclone engine.

of approximately 480,000 sq. ft.. Plant No. 2 was to be completed and in operation in a few months. During 1940, Grumman continued building single-seat fighters and utility amphibians for the U. S. Navy. An order for J2F type amphibians was completed and an additional order was received. Orders for JRF amphibians for the Navy and Coast Guard were completed and additional orders for this type also were received. The JRF was a service version of the G-21A, and was used for general utility, transport, coastal patrol and rescue work.

G-21A amphibians for the private and commercial market were produced, and a Portuguese order for G-21B's was completed. The G-21B was a military version of the G-21A, having provision for

GRUMMAN J<sub>2</sub>F-1

A two to four-place military plane powered with a Wright Cyclone engine.



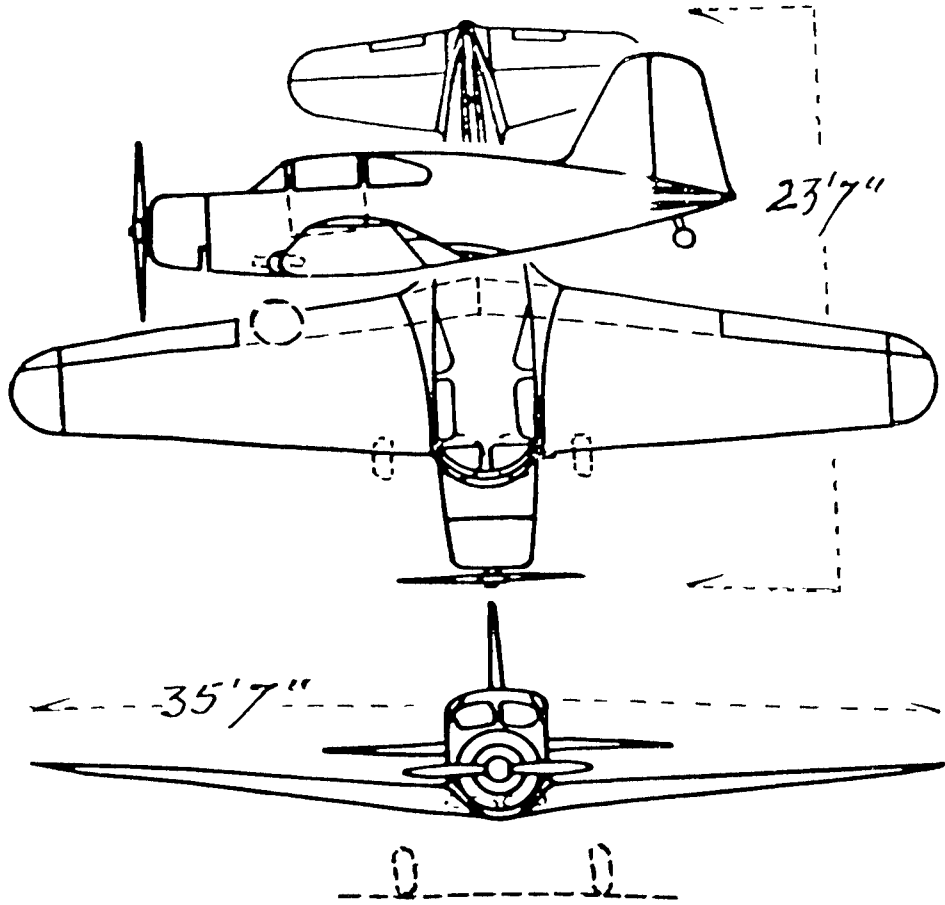
THE GRUMMAN WIDGEON

This four-five place amphibian is powered with two Ranger engines of 200 h.p. each.

mounting machine guns and bomb racks, and it was manufactured as a flying boat rather than an amphibian.

In the spring of 1940, Grumman announced the new "Widgeon" amphibian. A medium size 4-5 place, twin-engine amphibian, the Widgeon was powered with 2 Ranger engines rated at 200 h.p. each, and had a cruising speed of 150 m.p.h. Although designed and built for the private and commercial demand for an airplane of its type and size, it was ordered by the U. S. Coast Guard.

The Grumman F4F-3, single-place fighter, went into quantity production for the Navy. Designed as a shipboard fighter and light dive



HARLOW PJC-2

A Warner Super Scarab engine rated at 145 h.p. powers this four-place cabin monoplane. The PC-5A, another version of this basic model, is a two-place trainer with a 165 h.p. Warner engine.

bomber, the F4F-3 was being placed in service rapidly. An export version of the F4F-3, the G-36, was in quantity production for Great Britain. At the same time experimental projects were under way for both the U. S. Army and Navy.

Harlow Aircraft Company, Alhambra, Calif., in 1940 completed the development of two types, one a 4-place cabin plane of all-metal construction, powered with a 145 h.p. Warner engine and fixed pitch Curtiss metal propeller, and the other a 2-place enclosed tandem trainer of all metal construction powered with a 165 h.p. Warner engine and a Hamilton constant speed propeller. Both types had fully

retracting landing gear. During the year Harlow secured an order of PC-5A trainers for export.

Howard Aircraft Corporation, Chicago, Ill., early in 1940 was in production on a 5-passenger Howard Model DGA-15. It was powered with a Pratt & Whitney Wasp Jr. engine, developing 450 h.p. at take-off, or the Jacobs L6MB engine, developing 330 h.p. at take-off. On June 3, 1940, the engineering department began work on a new project, the designing of the Howard Model DGA-18, a 2-place, low-wing, full cantilever monoplane, powered with a 125 h.p. Warner engine, or a 160 h.p. Kinner engine. This airplane was designed in accordance with Army Standards for the main purpose of being used in the secondary C. P. T. program. From the month of June to September, the engineering department and portions of the factory were tooling up for production, and preparing for A. T. C. tests. Also, the first airplane of this model was being constructed for the purpose of test flying. During these months, the demand for a Howard Model DGA-15, powered with a Wright engine developing 350 h.p., made it necessary to run tests for procurement of an A. T. C. These tests were completed, and the first model DGA-15 airplane powered with a Wright engine was delivered in the month of October. On September 22, 1940, the prototype airplane of this new model DGA-18 was satisfactorily flown. From then until March 1, 1941, all required A. T. C. and C. P. T. P. tests were made.

Interstate Aircraft and Engineering Corporation, El Segundo, Calif., produced its 2-place 3-1A tandem trainer powered by a 65 h.p. Continental engine. The company doubled floor space and increased its payroll 300 per cent in 12 months.

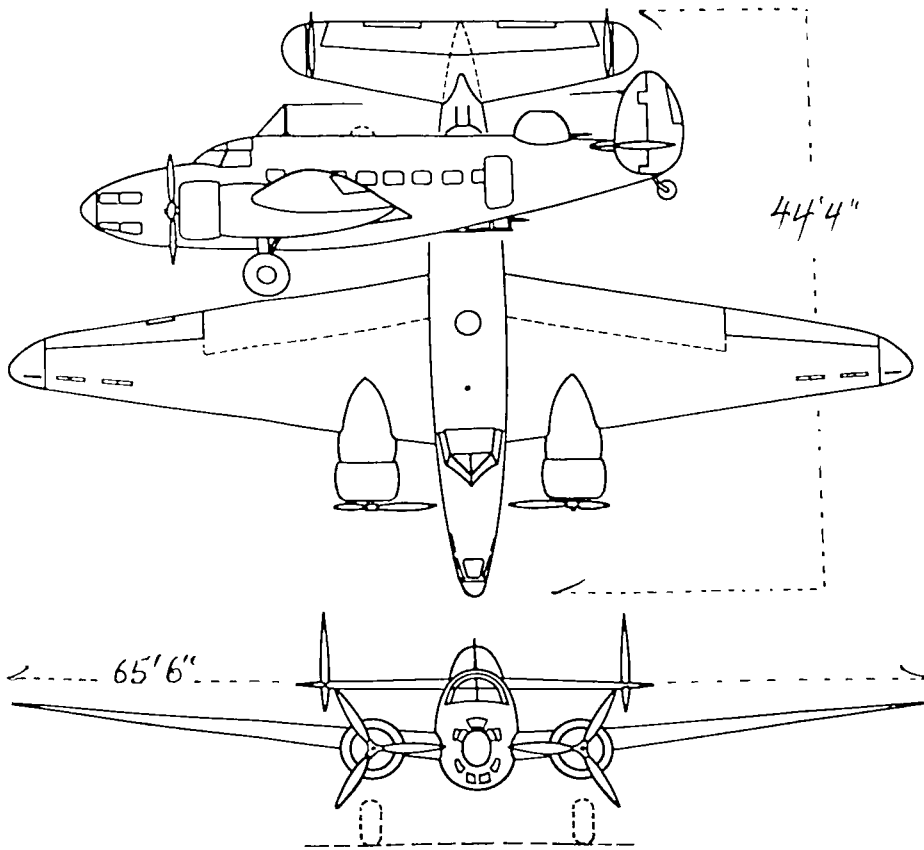
Kellett Autogiro Corporation, Philadelphia, Pa., assumed during 1941 a vital position in the defense production program as subcontractor to such leading manufacturers as Bell, Brewster, Consolidated, Curtiss, Glenn L. Martin, Republic and Wright Aeronautical. Deliveries during 1940 amounted to more than \$700,000 while 1941 deliveries, against orders in excess of \$2,000,000, were expected to double that figure. Principal items which Kellett was producing were engine mounts, airplane seats, flaps, bomb bay doors, fins and cowl and miscellaneous assemblies. Some of the military airplanes in which Kellett manufactured products were in use, were the Bell Airacobra, the Curtiss Tomahawk, the Consolidated PBV-2 and B-24, the Martin 167 bomber, and the Republic P-35A, AT-12 and P-43 Lancers. At the same time, Kellett's primary field of operations was not neglected, as work went ahead on contracts totaling more than \$100,000 for research, development and manufacturing projects for U. S. Army Air Corps rotorcraft.

A successful jump take-off autogiro was demonstrated to the Air Corps, which had contracted for it, in 1940; and subsequent improvements called for the installation of greater power, an advanced type of accelerated take-off mechanism and a special landing gear design calculated to permit vertical landings from considerable heights through ability of the alighting gear to absorb the resulting shock. Air Corps Kellett autogiros in 1941 were transferred to the National Park Service and the Border Patrol for use in vital patrol activities of both services. Need for efficient aerial sentry duty along the Mexican border, to block the entry of aliens, inspired an autogiro-reconnaissance program by the Border Force of which much was expected.

As 1941 opened, Kellett Autogiro Corporation found itself operating at full scale in new quarters which it had acquired late in the preceding year. This modern factory building, affording an increase of nearly 200 per cent over previous facilities, was at 58th Street and Grays Avenue, in Philadelphia. Large tooling and equipment expenditures, to meet requirements imposed by new orders and the need for expeditious delivery, were undertaken during the year.

Lockheed Aircraft Corporation, Burbank, Calif., at the beginning of 1940 had 7,464 employees and on January 1, 1941, had jumped to 16,569, with the number increasing monthly in 1941. The 1940 payroll was \$31,000,000 as compared to \$10,000,000 in 1939. Except for March, 1940, when there was a temporary lapse caused by inability to secure small component parts from vendors, the company's production shot forward under the impetus of President Roosevelt's program for a vastly larger output of aircraft. Without waiting for formal contracts, and without going to the Government for financial assistance, Lockheed realized that in order to produce the airplanes required it would be necessary for it to increase its production capacity enormously. This momentous task meant new buildings, selecting and installing tool equipment, constructing jigs and dies and training thousands of new men. There was no reservoir of experienced aircraft workmen to draw on, as there were in other industries, and this latter problem was a particularly complex one. In addition, anticipating the production to come when plant expansion was completed, it was necessary for the company to order huge quantities of raw materials so that they might be on hand at the appropriate time. Therefore, 1940 was a year of expansion of production facilities.

During 1940, Lockheed floor space increased from 668,000 sq. ft. to 1,259,387 sq. ft.; and there was to be 1,574,027 sq. ft. when the expansion program was completed. These figures did not include the company's subsidiary, Vega Airplane Company, which had 170,000 sq. ft. on January 1, 1940, and with a brand new 30-acre factory,



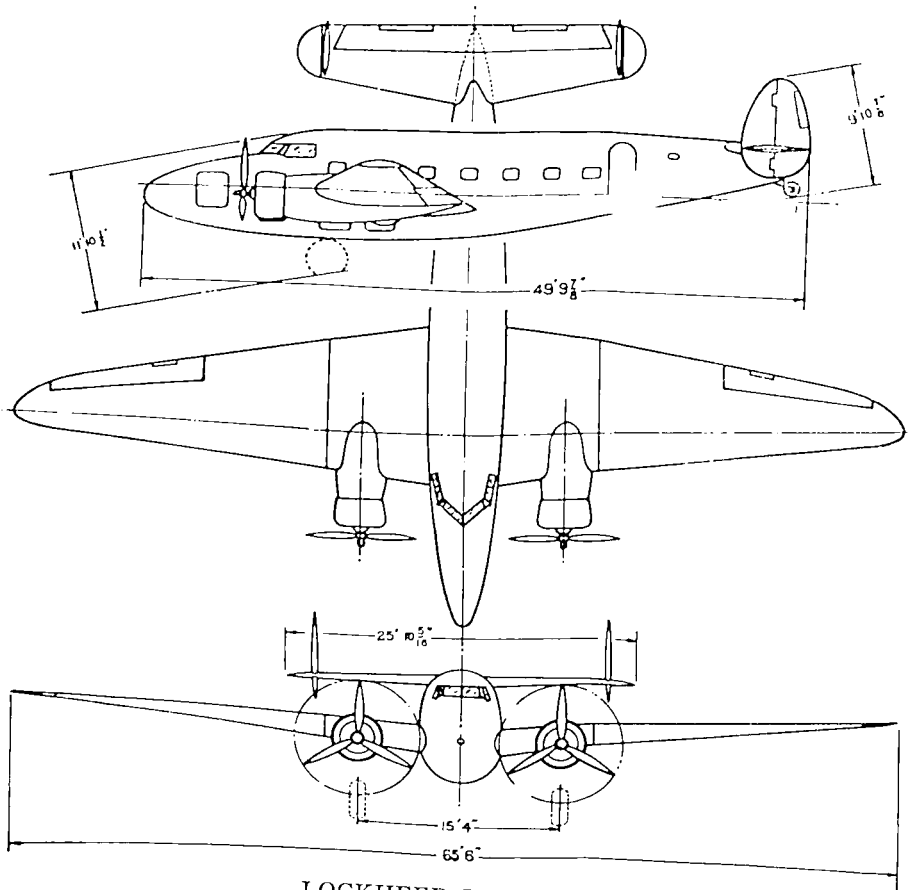
THE LOCKHEED HUDSON BOMBER

Powered either with two Pratt & Whitney or two Wright Cyclone engines with a total of 2,000 h.p., it can be used as a reconnaissance bomber, a dive bomber or a fighter.

early in 1941, had 1,289,901 sq. ft. Combining Lockheed and Vega, the figures were 838,000 sq. ft. for January 1, 1940, 1,438,363 for January 1, 1941, and 2,863,928 when the expansion program was completed.

Foreseeing a great future for commercial aviation and private flying in the family airplane of tomorrow, as well as to provide ample space for test flying the thousands of military planes to be turned out during the next few years, Lockheed in November purchased the 229-acre Union Air Terminal, fourth busiest in the United States.

The ultimate employment figures for Lockheed and Vega, with both factories in full mass production on an around-the-clock basis, were to be approximately 50,000 men, of which 30,000 were to be at



LOCKHEED LODESTAR

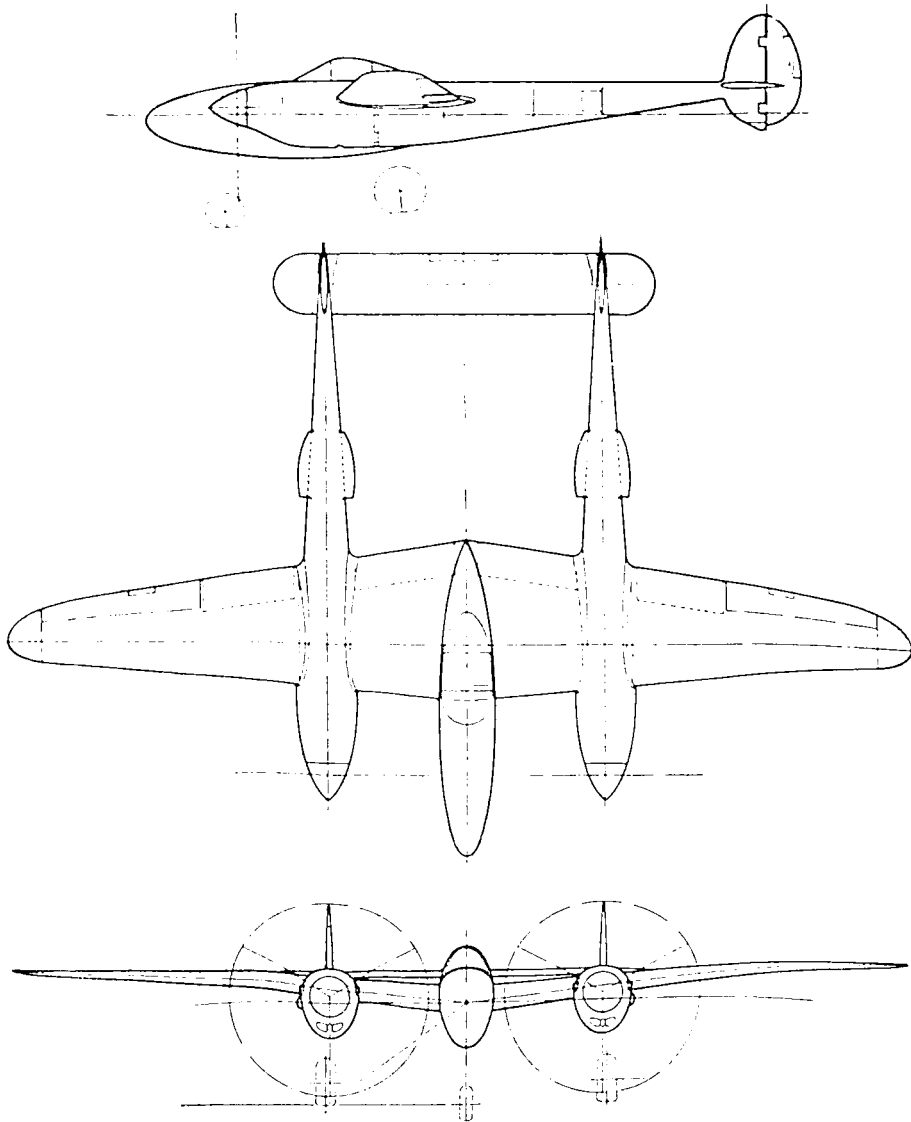
This twin-engine transport carries 17 and is powered with two Wright Cyclone or two Pratt & Whitney engines.

Lockheed and 20,000 at Vega. In May, 1941, the 2 plants were working 18,000 by day and 11,000 on 2 night shifts.

On January 1, 1940, Lockheed had a backlog of \$43,000,000 and Vega had virtually no backlog. On January 1, 1941, the companies had a combined backlog of \$277,236,000, of which Vega had \$75,000,000.

Lockheed's chief production for 1940 centered around hundreds of Hudson bombers for the British and several fleets of 17-place Lodestar commercial transports for air lines in the United States and South Africa. The Hudsons played a featured role in R. A. F. operations over Norway, Germany, Italy and the so-called "invasion ports"





THE LOCKHEED INTERCEPTOR

The P-38, export version, 322-61, is a twin-engine, single-place plane designed for interception and attack. It is powered with two Allison engines of 1,150 h.p. each.

of France, Belgium and the Netherlands. They performed exceptionally well during the evacuation of Dunkirk.

During 1940 Lockheed tooled up and began production on the

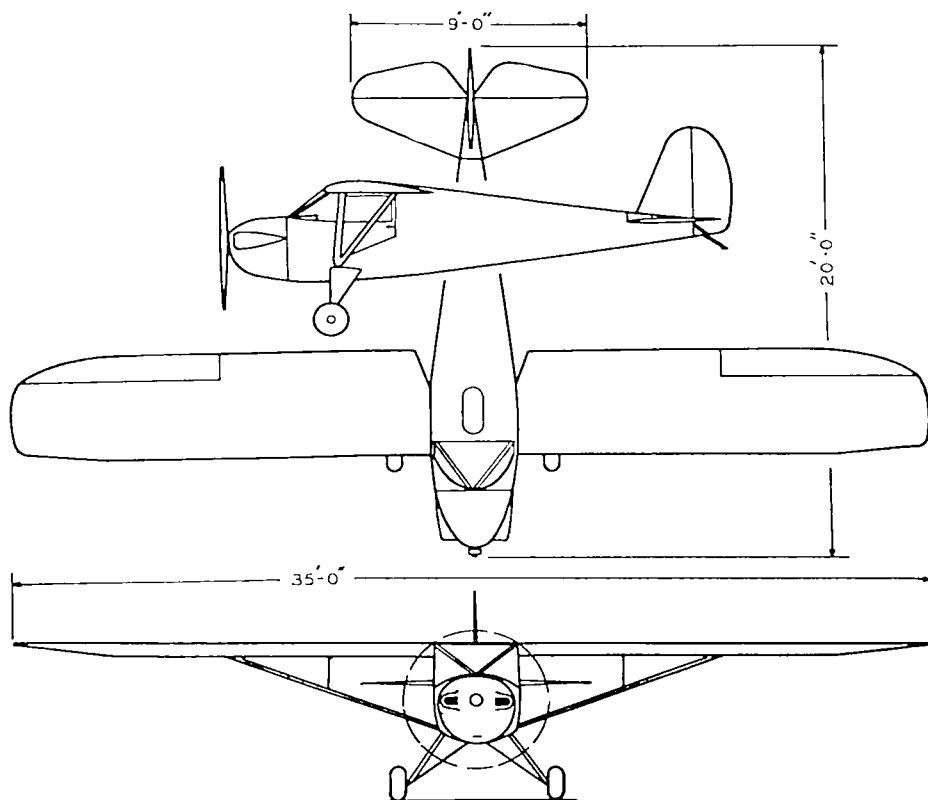
P-38 interceptor pursuit, powered by 2 Allison engines and Curtiss propellers.

The interceptor was being built both for the U. S. Army Air Corps and the British Royal Air Force. Although twin-motored, it was a single-place fighter with tremendous ability to rise off the ground quickly and intercept enemy bombers before they might reach their objective. It was to be in mass production, 8 or 10 a day, by the summer of 1941. The company stated that the P-38 had a speed in excess of 400 m.p.h.

The Lockheed Hudson reconnaissance bomber was an all-metal, mid-wing monoplane. It had a capacity for 4 bombs weighing 250 lbs. each or 6 bombs of 100 lbs. each. It carried a crew of 5. Its wing span was 65 ft. 6 in., length 44 ft. 4 in., height 11 ft. 10½ in., stated high speed at critical altitude 284 m.p.h., with cruising speed of 255 m.p.h. at 19,000 ft. It had a stated range of more than 2,000 mi. at operating speed. Originally purchased by the British for a reconnaissance bomber for the Coastal Command of the Royal Air Force, and for the Royal Australian Air Force, the Hudson performed so notably in combat that for many months it was used also for dive bombing and as a fighter. It had greater speed at certain altitudes than a majority of enemy aircraft, and proved most difficult to bring down even after having one engine and part of a wing, tail or nose shot away by anti-aircraft fire. The Hudson was powered with two Pratt & Whitney or Wright radial aircooled engines totaling 2,000 h.p.

Luscombe Airplane Corporation, West Trenton, N. J., in 1940 experienced a 100 per cent increase over its substantial 1939 business, producing small all-metal airplanes for private flying and instruction. One model was discontinued and two more added to the company's line. Model 8 was replaced in October by the 1941 model 8B1 trainer, with a Lycoming 65 h.p. engine. Also introduced during 1940 was the company's bid to the luxury market, the 75 h.p. Continental powered Silvaire, Model 8C. Its standard equipment included fuel injection, dual ignition, brakes, tail-wheel, wheelpants, de luxe interior with shock mounted instrument panel, ash trays and glove compartments. This model, which accounted for a large proportion of the company's 1940 sales, had a cruising speed of 110 m.p.h. and was available for 1941 with extra wing tanks increasing its range to 550 mi. Model 8A, the 65 h.p. Continental powered Luscombe, was continued in 1941.

Luscombe added 20 new distributors to its successful national selling organization. Many distributors opened their own airplane stores, exhibiting Luscombe planes in downtown New York, Chicago, Los Angeles, Knoxville, Philadelphia, Binghamton, N. Y., and Indian-



LUSCOMBE MODEL 8 SERIES

A two-place plane powered with a Continental 50 h.p. engine.

apolis. This method of selling was responsible for sales to persons who had never before been near an airplane. Free flying instruction was given to such persons.

Officials stated that new floor space added in 1940 exceeded 10,000 sq. ft., with a 75 per cent increase in skilled employees, and a 100 per cent increase in precision machinery and shop equipment.

McDonnell Aircraft Corporation, Robertson, Mo., was engaged in secret development work and subcontracting for the aircraft manufacturing industry.

The Glenn L. Martin Company, Baltimore, Md., had made exceptionally large additions to its plant at Middle River, near Baltimore, and by the summer of 1941 was to triple productive floor space which was already huge because of expansion work carried on for two years previously. While turning out several other types of planes under secret orders from the Government, the Martin company

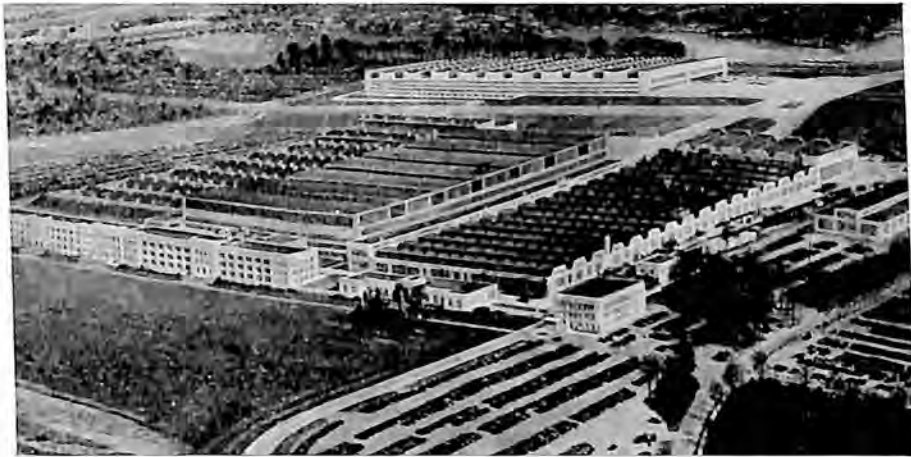
was devoting the greater part of its production capacity to twin-engine bombers for the American air forces and the British R.A.F.

Plant expansions which, by the summer of 1941, would increase The Glenn L. Martin Company's factories from 1,263,000 sq. ft. of floor space to around 4,000,000 sq. ft. were begun during 1940. These additions cost about \$24,000,000, raising the plant value to \$32,500,000. Preliminary plans for large-scale plant building had been drawn by Martin before 1940, and actual engineering work was started in mid-summer when the company definitely decided to go ahead with the work without waiting for new legislation or for facilities contracts. This step was taken upon definite assurances from Washington of what the company's program was to be. On September 4, ground was broken for two extensions and an office building. Work had already begun on a project to triple the size of the drop-hammer building. On November 4, ground was broken for Plant 2, an entirely new factory a mile and a quarter across the Glenn L. Martin Airport from the present plant and containing 1,181,000 sq. ft. of floor space. That factory was to be used for Army bombers, operating as a separate unit, with its own shops, drop-hammer building, employment building, oil house and boiler house. On the same day ground was broken for an entirely new Navy assembly building, more than double the size of the existing Navy Bay, already known as the largest aircraft assembly floor in the United States.

Work was later started on an extension to double the size of the Martin engineering building and more than double the space for laboratory and research work.

Excavation work was started early in 1941 on a group of buildings on the Martin Airport, the 500-acre field used for testing and delivery of Martin airplanes. There was to be an administration building and five large hangars. Another project was the extension of the airport runways from 3,000 to 4,400 ft. About 3,000 houses were to be built at Middle River to aid in taking the influx of new residents. Four railroad spurs were built into the Martin properties to take care of factory needs. Four and a half miles of new roads were needed, and 46½ acres were given over to parking lots for about 15,000 employees' motor cars.

For years the Martin company had been able to solve much of its personnel problem by a system of cooperation with the Baltimore and Maryland vocational and technical high schools. Martin initiated this scheme shortly after the factory was moved to Baltimore from Cleveland in 1929; and loaned instructors, equipment and materials to the schools. The company continued to look to the

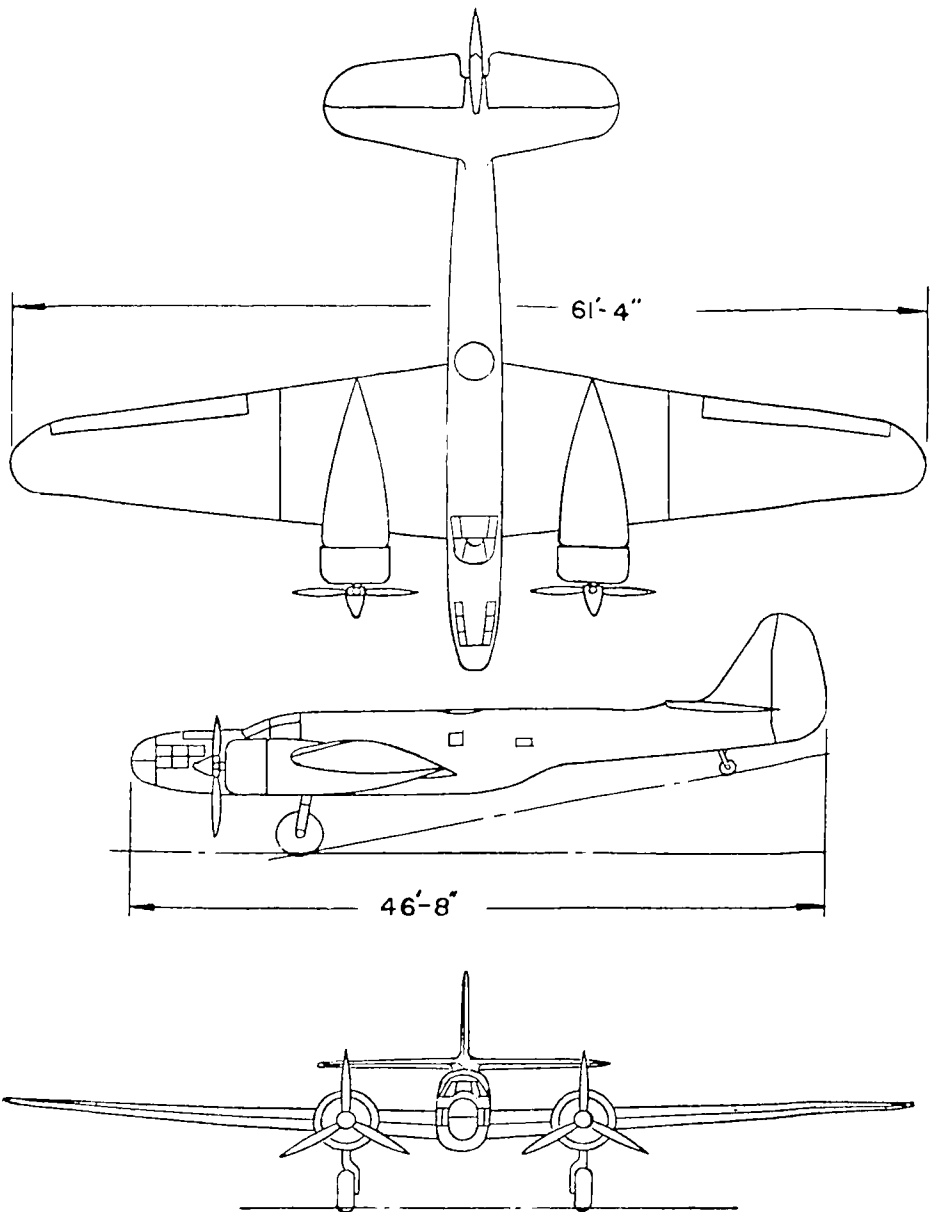


THE GLENN L. MARTIN PLANT

As the rapidly expanding factories near Baltimore appeared early in 1941.

augmented facilities of the schools for basically trained young men, but the personnel needs were so great under the rapidly-expanding program that several other sources had to be tapped.

At the beginning of 1940, Martin was already far advanced on the third consecutive contract for 167F attack bombers for the French Government—ships which had been turned out in record time and numbers in 1939. It was also producing an important order of 20-ton PBM-1 patrol bomber flying boats for the U. S. Navy, and was tooling and even fabricating some parts for the B-26, a medium army bomber. When France sued for a separate peace in May, 1940, the British Government took over the French contracts with Martin, including another large order for 167-B4 attack bombers. Meanwhile, designs had been perfected and engineering work advanced on a new type of medium bomber, the Martin 187, which had been designed especially to fit the tactical needs of the French and British air forces. This agreement with Martin, covering all the airplanes of this type that the company could produce by the end of 1941, also was assumed by Britain. New and very large national defense contracts brought the company's backlog to about \$320,500,000 at the beginning of 1941. The plant was already elaborately tooled and building the Army's B-26 and far along with tooling for rapid production of an improved-type PBM patrol bomber order for the Navy and for the 187, or "Baltimore," for the British. Late in 1940 the first B-26 was test flown. It had self-sealing fuel tanks, armor, power turrets (the Army's first) and great defensive firepower. It was



MARTIN 167B4

A twin-engine bomber carrying a crew of three and powered with two Pratt & Whitney Twin Wasps.

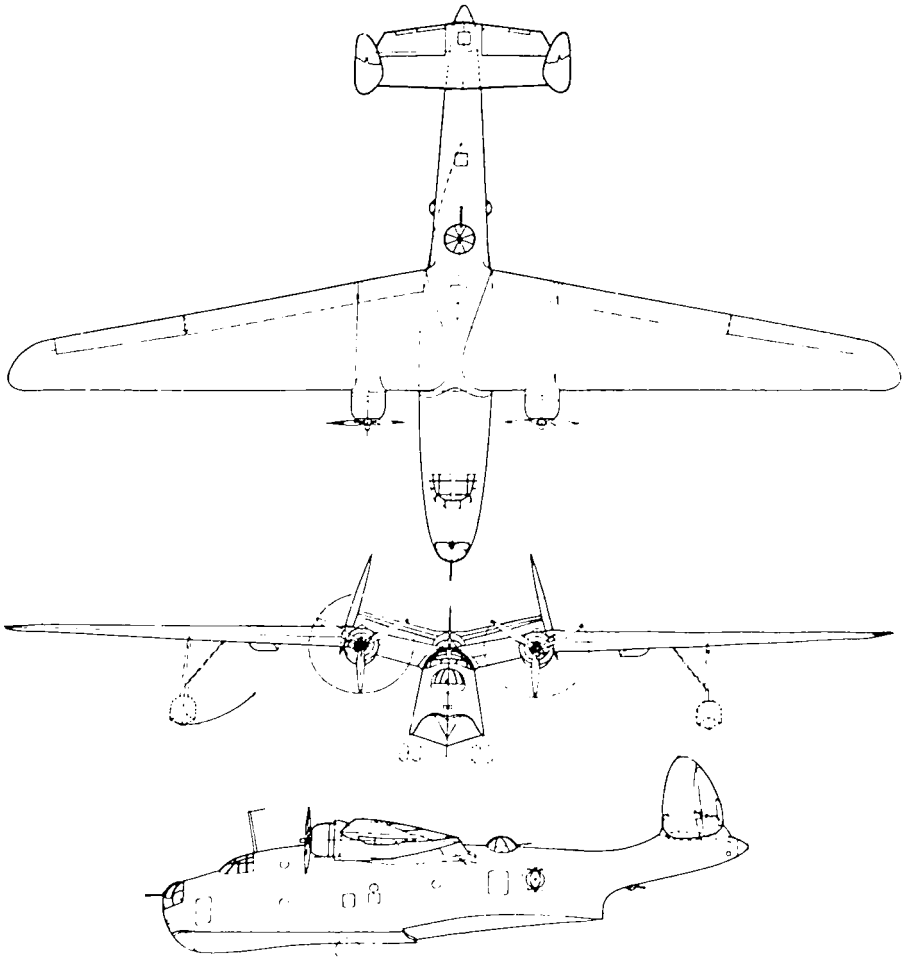
faster than most of the pursuit planes in Europe. Instead of being a prototype this first B-26 was the first production model, with scores of others on the assembly lines behind it. The new permanent tooling was designed for mass-production methods which emphasized simplified methods looking toward the use of workers of lesser skills. Extremely close tolerances in the manufacture of parts and subassemblies made for rapid and accurate work of assembly and for a high degree of interchangeability. In addition, the company made extensive arrangements for subcontracting work, ranging up to 30 per cent on the B-26.

Being delivered at the rate of several a day were the Martin 167-B4's, and PBM-1's were being flown away by the Navy every five or six days.

Also well along in manufacture was the largest flying boat in the world, a closely-guarded leviathan. It was so large that there were official ceremonies when the keel was laid, an honor that the Navy heretofore had reserved for surface vessels.

During 1940, Martin contributed to the defense program several notable collateral developments. One was a self-sealing fuel tank which proved that it would stand the fire of 50-caliber, as well as 30-caliber, machine-gun fire without spillage. The company also introduced a new photographic reproduction process for rapid reproduction of drawings on coated aluminum alloy and many other materials, effecting a saving in time, space and drafting costs. Important developments in plastics, including all-plastic trim tabs, an all-plastic nose for the B-26, a plastic-and-plywood bomb-bay door and numerous plastic parts to substitute for metal counterparts, also were introduced. Among other important contributions made by Martin, was a graphical solution to flutter conditions in airplanes, which was presented to the industry. Year's end found the company ready to turn out its B-26's in quantities as soon as Army tests had been finished, the PBM-1 contract nearing completion and work under way on other patrol bomber contracts, the 187 taking form, and the 167-B4 contract well along toward completion, with excellent battle reports of this bomber's performance in the war zones. The company's employee rolls contained nearly 17,000 names. The number ultimately required on completion of the Middle River factories was to be about 42,000.

Besides the two great factories at Middle River, The Glenn L. Martin Company was to operate a third, for the assembly of bombers, at Omaha, Nebr. That plant was designed by Martin and built by the Government under the Knudsen plan providing for such assembly plants to be operated by the aircraft manufacturers, assembling planes



### MARTIN NAVY PATROL BOMBER

Model PBM-1 carries a crew of seven and is powered by two Wright Cyclone engines 1,350 h.p. each.

with parts provided, insofar as was practicable, by members of the motor car industry working under subcontracts.

Monocoupe Aeroplane & Engine Corporation was developing a new program at Orlando, Fla.

North American Aviation, Inc., Inglewood, Calif., together with its wholly owned subsidiary, North American Aviation, Inc., Dallas, Tex., forged ahead to new production records under the gathering impetus of the defense program.

At the end of 1940, the company's widely respected production





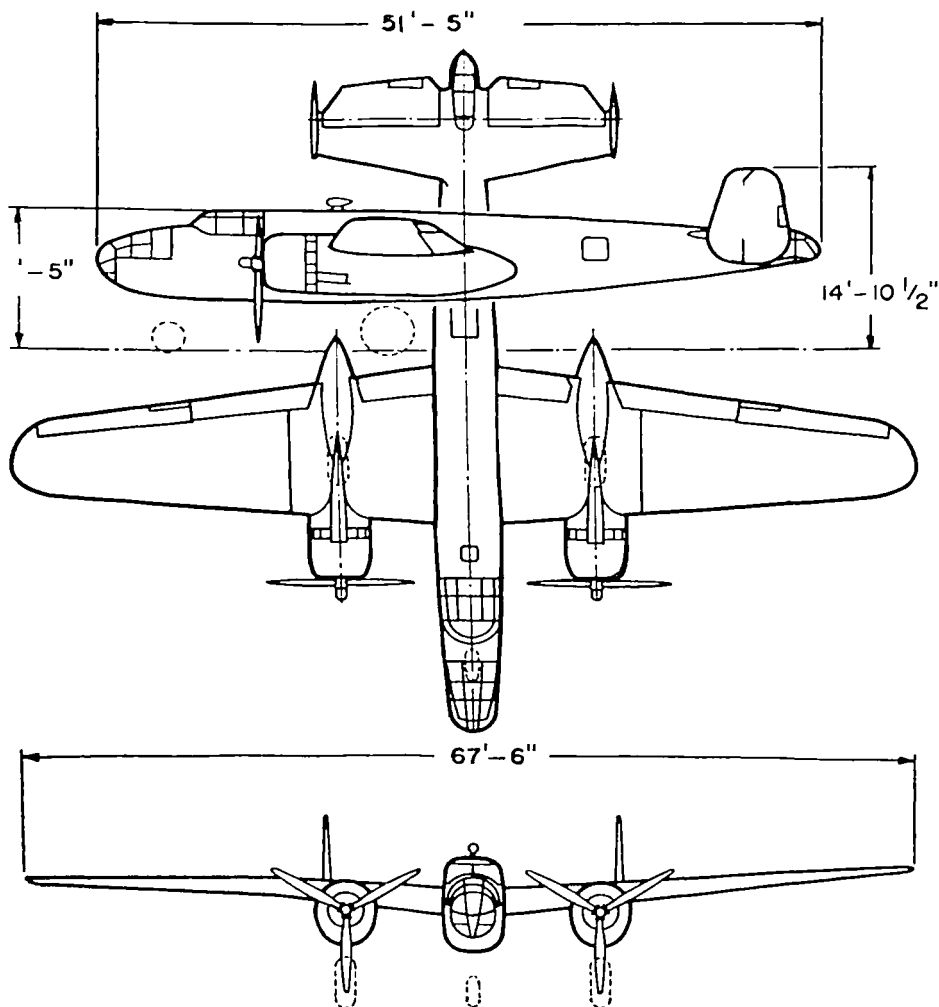
ONE OF NORTH AMERICAN AVIATION'S PLANTS

Aerial view of North American Aviation's huge plant at Inglewood, Calif. It has more than 1,000,000 sq. ft. of floor space. Note employee's motor cars in the foreground.

organization had standardized its output to three basic types—a twin-engine medium bomber, a 2-place advanced combat trainer, and a fast Allison-powered pursuit plane. During 1940 North American expanded its productive area and personnel in the Inglewood plant by 55 and 75 per cent respectively, and in December had nearly completed its new million sq. ft. factory at Hensley Field near Dallas, Tex. Other outstanding developments from the expansion standpoint found Army engineers completing plans for the erection of a million sq. ft. bomber assembly plant in Kansas City, to be operated by North American Aviation in conjunction with subcontracting work by General Motors.

During 1940, North American produced 83 per cent as many airplanes as were produced in the Inglewood plant during the previous four years of operation. But the real performance had scarcely begun, for in December of 1940 North American delivered 175 per cent the number of planes delivered during the best month of 1939, and future production schedules indicated that even this new record would soon fade into insignificance.

Plant expansion in Inglewood brought the available floor area from 654,000 sq. ft. on January 1, to 1,014,365 sq. ft. on December 31, 1940. This expansion program extended the main building west-



#### NORTH AMERICAN MEDIUM BOMBER

This bomber carries a crew of five and is powered with two Wright Cyclone engines 1,350 h.p. each.

ward to an overall dimension of 725 ft. and filled in the corner of the factory rectangle. On December 31, the main building covered a ground area of 13 acres. By filling out the factory rectangle, North American thus completed the carefully organized expansion plan which had been conceived before the first earth was turned at the Inglewood site late in 1935. Each of the major expansion steps during the 5-year period had been taken in accordance with the original layout prepared in 1935.

In the summer of 1940, it became apparent that even a million sq. ft. of floor space could not meet the demand of the U. S. Army Air Corps for advanced combat trainers. Accordingly, because Inglewood could expand no more without mushrooming beyond the efficient unit size set in the expansion plan, North American Aviation turned inland, and found the site it wanted on an Army Reserve Field near Dallas, Tex.—population center of the great Southwest. Events moved fast after a ground-breaking ceremony on September 28. Steel was rising on December 1. Long before that date, North American had begun to train personnel for the new manufacturing unit at its temporary quarters in Dallas. Company officials anticipated that the first plane would roll through the factory doors to Hensley Field late in March or early in April, 1941. From that date forward, production would be fast and efficient in the modern Texas plant, for the new plant was designed to utilize the best features of a proven "straight-line" production system. In size, it differed from the Inglewood factory only slightly, comprising 1,022,400 sq. ft. of floor space. But the Texas plant was windowless and completely air-conditioned, with fluorescent lighting throughout to supply ideal working conditions at all hours of the day or night. Should the need for specific defense precautions arise, the type of construction utilized in the Texas manufacturing unit would lend itself admirably to blackout or daylight camouflage.

Another and even more significant development in North American Aviation's phase of the defense expansion program occurred late in 1940. Announcement was made by the War Department that a new bomber assembly plant would be erected by the Government at Fairfax Airport in Kansas City, Kans., for operation by North American Aviation. Subsequently it was revealed that the new plant, which was expected to contain approximately 1,060,000 sq. ft. of floor space, would utilize the tremendous production facilities of General Motors Corporation for the fabrication of component assemblies.

In summary, at the beginning of 1941, North American Aviation had 1,014,365 sq. ft. of floor space engaged in capacity production, 1,022,400 sq. ft. under construction and scheduled to begin production early in 1941, and 1,060,000 sq. ft. in the planning stage—with every indication that the summer of 1941 would find 3,000,000 sq. ft. of floor space in use.

Planes manufactured by North American Aviation for the U. S. Army Air Corps during 1940 included the following: BT-14 basic trainers, O-47B observation airplanes, BC-1A basic combat airplanes, B-25 twin-engine medium bombers, AT-6 advanced trainers, and AT-6A advanced trainers. At year-end North American was concen-

trating on production of the AT-6A advanced trainer and the B-25 twin-engine bomber.

Described as the last word in advanced combat trainer design, the AT-6A was a 2-place, low-wing monoplane in the tradition of the BC-1 and BC-1A planes. All three fell under the NA-16-3 classification, which also included the Harvard trainers for Britain and Canada and many other models basically similar in design which were in service throughout the world. AT-6A trainers ordered under the defense program were flying daily to advanced training centers of the Air Corps as early as September of 1940, although the contract for the type was signed by the War Department only 40 days before the first ship was completed. This unusual production performance was possible because North American began production on its own responsibility in order to expedite the Nation's air training program.

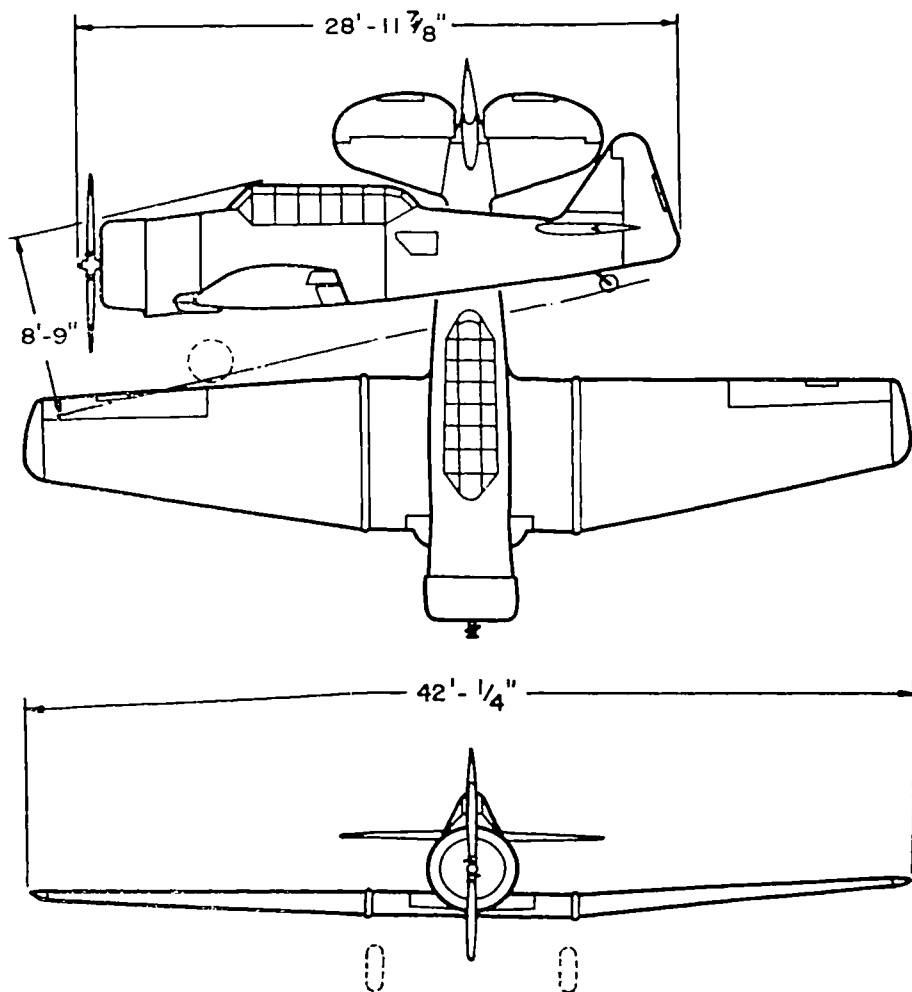
North American's new Texas plant was to produce AT-6A trainers exclusively during 1941, its first year of operation.

Although comparatively few B-25 twin-engine medium bombers were produced during 1940, North American's high performance bombardment plane was thoroughly tested and readied for production during the year, with the result that 1941 was to see the Air Corps bomber rolling forth from assembly lines in Inglewood and Kansas City with rapidly increasing frequency.

The B-25 bomber was a twin-engine, mid-wing craft with tricycle type landing gear and a dual tail. Designed to carry a crew of five highly trained specialists, the B-25 constituted an effective addition to the Army Air Corps' striking power, combining long range and large bomb capacity with exceptionally high speed. The B-25 was an improvement over North American's NA-40-A design, incorporating the latest developments in defensive armament which the war experience in Europe had produced.

Planes built by North American for the U. S. Navy during 1940 included three versions of the scout trainer series, the SNJ-1, SNJ-2 and SNJ-3. All were basically the North American NA-16-3 type—2-place, low-wing monoplanes with retractable landing gear. Like the AT-6 and AT-6A of the Army Air Corps, they were delivered to training units to serve in the final stage of training pilots for combat duty. Deliveries under large orders placed by the Navy for the SNJ-3 type carried well into 1941, and it was significant of the new coordination between the Army and Navy air services that the SNJ-3 and AT-6A for the Army were almost identical in all respects except external markings.

Production of the highly praised Harvard trainers for Great Britain and Canada continued to be an important part of North American



NORTH AMERICAN NA-16-3

A two-place advanced trainer powered with a 550 h.p. Pratt & Whitney Wasp engine.

Aviation's activities during 1940. On December 31, more than 800 of these low-wing NA-16-3 type advanced trainers had been delivered in Britain, Canada and other parts of the British Empire. January brought a personal cablegram from Lord Beaverbrook, British Minister of Aircraft Production, congratulating J. H. Kindelberger for his company's achievement in bettering the production schedule set for 1940 on the Harvard II type. Because training activities of the British Royal Air Force had been concentrated at various points in

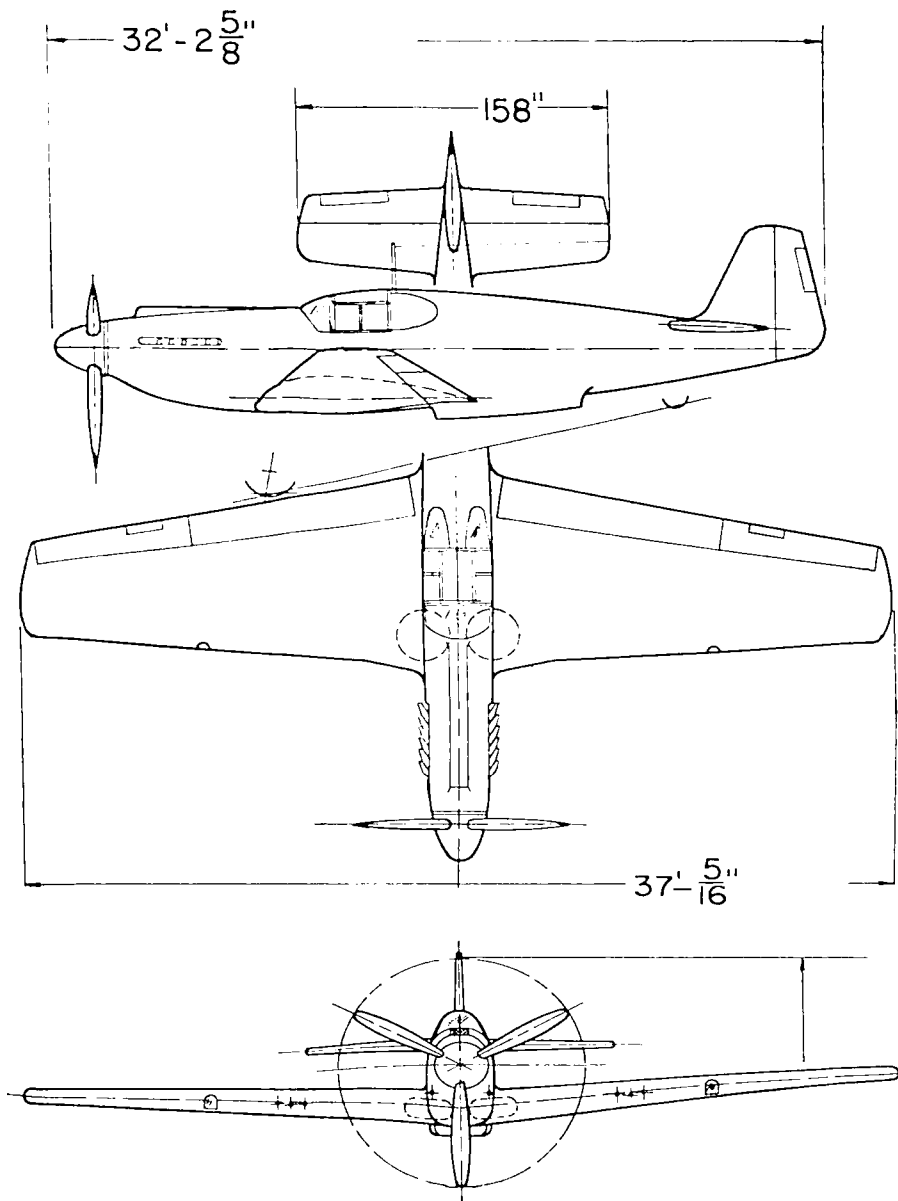
the Empire, most Harvard trainers delivered during 1940 traveled under their own power from the factory in Los Angeles to training bases in Canada. The tremendous job was performed by a staff of skilled American pilots who delivered the trim yellow monoplanes in Canada and returned immediately to Los Angeles via scheduled air lines for the next consignment.

Turning from training craft to a more spectacular phase of design and production for Britain's war effort, North American in 1940 developed a new type of single-seat fighter powered with an Allison liquid-cooled engine. On the basis of secret flight tests conducted on the first of the new type late in 1940, it appeared certain that North American had one of the fastest fighting airplanes in the world, despite the fact that rated horsepower of the engine was far below that of some of the newer aircooled engines. The new fighter was being produced in quantity during 1941. It was introduced to the British Royal Air Force as the NA-73 Mustang. With minor design changes it went to the U. S. Army Air Corps as the P-51 pursuit airplane.

Other planes produced for export by North American during the year included advanced trainers for Venezuela, light attack bombing planes of the NA-44 type for Brazil, Chile, and Thailand, and Model NA-50 single-seat fighters for Thailand. At the end of the year most of these orders had been completed, and it appeared certain that North American would be able to accept few, if any, new export orders during 1941 because of the concentration of all production facilities on B-25 bombers for the Air Corps and advanced trainers and pursuit airplanes for the Air Corps and Britain.

Despite full speed ahead on production for national defense, North American engineers worked constantly on experimental projects and research to improve materials and processes. At least one of the new designs, a twin-engine bombardment type reportedly the most effective yet developed, was scheduled to begin flight tests in 1941. In the field of production improvement, North American instituted a methods department in 1940 to study production techniques and recommend improvements. Wind tunnel testing of scale models was conducted in several West Coast wind tunnel laboratories, and considerable enlargement of both personnel and facilities occurred in North American's own well-equipped factory research laboratory.

Personnel expansion was consistent during the year and far more rapid than in previous years. Thus, from a total of 4,639 employees on January 1, 1940, the payroll increased to 5,819 on July 1 and 8,290 on December 31. As a basis for comparison, the total number of employees on January 1, 1939, had been 2,731. These figures revealed



NORTH AMERICAN PURSUIT  
A single-place fighter, Allison powered.

a net gain of 1,908 employees during 1939 and a net gain of 3,651 employees during 1940. A speculative glance into the future on January 1, 1941, suggested that North American's Inglewood plant probably would have from three to four thousand more employees on the payroll at the end of 1941, and that North American's three manufacturing units—in Inglewood, Dallas and Kansas City—might eventually employ as many as 40,000 persons when the peak of the production curve was reached.

Although first examination of these phenomenal personnel expansion figures would seem to indicate a hopeless labor training problem, North American Aviation, with the aid of educational authorities—local, State and National—and private and public trade schools, was doing such a good job of developing labor sources that a rough survey at year-end showed 90 per cent of new men to be in the skilled and semi-skilled brackets, with only 10 per cent unskilled.

In Inglewood, North American met its expansion problem through three major training plans, as follows: 1, pre-employment courses encouraged and assisted by North American in public schools and reputable private schools; 2, apprentice training through adequate supervision within the factory; and 3, trade extension courses in nearby public schools, open only to employees and designed to prepare employees for advancement into jobs requiring more skill and offering more responsibility. Through this comprehensive program, guided and coordinated by North American's personnel officials, North American was meeting its personnel needs as they arose despite the added drain on skilled personnel occasioned by the development of new organizations in Dallas and Kansas City.

In Dallas, 1940 saw the inauguration of a training program necessarily far broader in scope than anything attempted in Inglewood. Using temporary quarters in Dallas while the new factory at nearby Hensley Field was under construction, skilled supervisors from Inglewood, equipped with jigs, tools and materials shipped from Inglewood, were developing a nucleus of trained workers against the scheduled opening date of the new factory. Under the plan in use, 100 new applicants were being started each fortnight on a two-week training course calculated to serve also as an entrance examination. At the end of the two-week period, those who had successfully completed the course were placed on the payroll and assigned to the departments for which they were best fitted, after which they began actual production work under adequate supervision as the final phase of their training. The first group of applicants began the preliminary course early in November, 1940, and results obtained through December pointed toward a highly successful achievement of employment schedules.





#### NEW CONSTRUCTION FOR DEFENSE

Addition to the plant of Northrop Aircraft, Inc., at Hawthorne, Calif., giving the company more than a half million sq. ft. of factory space.

First steps toward formulation of an adequate personnel training plan for the North American Aviation assembly unit in Kansas City were taken when five State and local education officials arrived in Inglewood from Kansas City early in February to confer with North American personnel officials regarding a tremendous defense training plan in the Greater Kansas City area, which would develop adequate semi-skilled workers to staff the new manufacturing and assembly unit.

That the personnel problem would become progressively more acute as expansion throughout the industry continued was not doubted by company officials, but, as the early weeks of 1941 passed, North American Aviation was confident that new methods could be devised as needed to meet specific personnel problems not provided for under the present program. As long as public and private agencies continued to cooperate with manufacturers in the interest of national defense, North American's leaders indicated they could and would get men fast enough to deliver airplanes on schedule.

Northrop Aircraft, Inc., Hawthorne, Calif., was incorporated on March 7, 1939, a company on paper only, without a plant or manufacturing facilities and without an employee. Following incorporation, officers of the new company worked day and night to get the company organized, visiting possible plant sites, meeting with investment people and laying the foundation for a progressive manufacturing plant. In June, 1939, the company was publicly financed through the sale of stock and warrants to the amount of \$1,250,000. Shortly thereafter negotiations for the purchase of a tract of 72½ acres were completed with the city of Hawthorne.

In August, 1939, the company moved into rented temporary quar-

ters in Hawthorne and there the first six employees started work on the new Northrop design. These temporary quarters comprising 9,000 sq. ft. of floor area were in a former hotel building. Plans for the new plant structure were completed during August. The original layout was planned for future expansion of the factory in units and the wisdom of this was apparent. On September 30, 1939, ground was broken for the first unit, and the ceremonies were attended by all the employees, numbering 26 at that time.

During the balance of the year, the company's staff, particularly the engineering department, was gradually enlarged and by December 31, 1939, the company had 73 employees. The hammer house was the first structure completed and while the main building was still under construction, work was started on the mock-up of the Northrop design in that building.

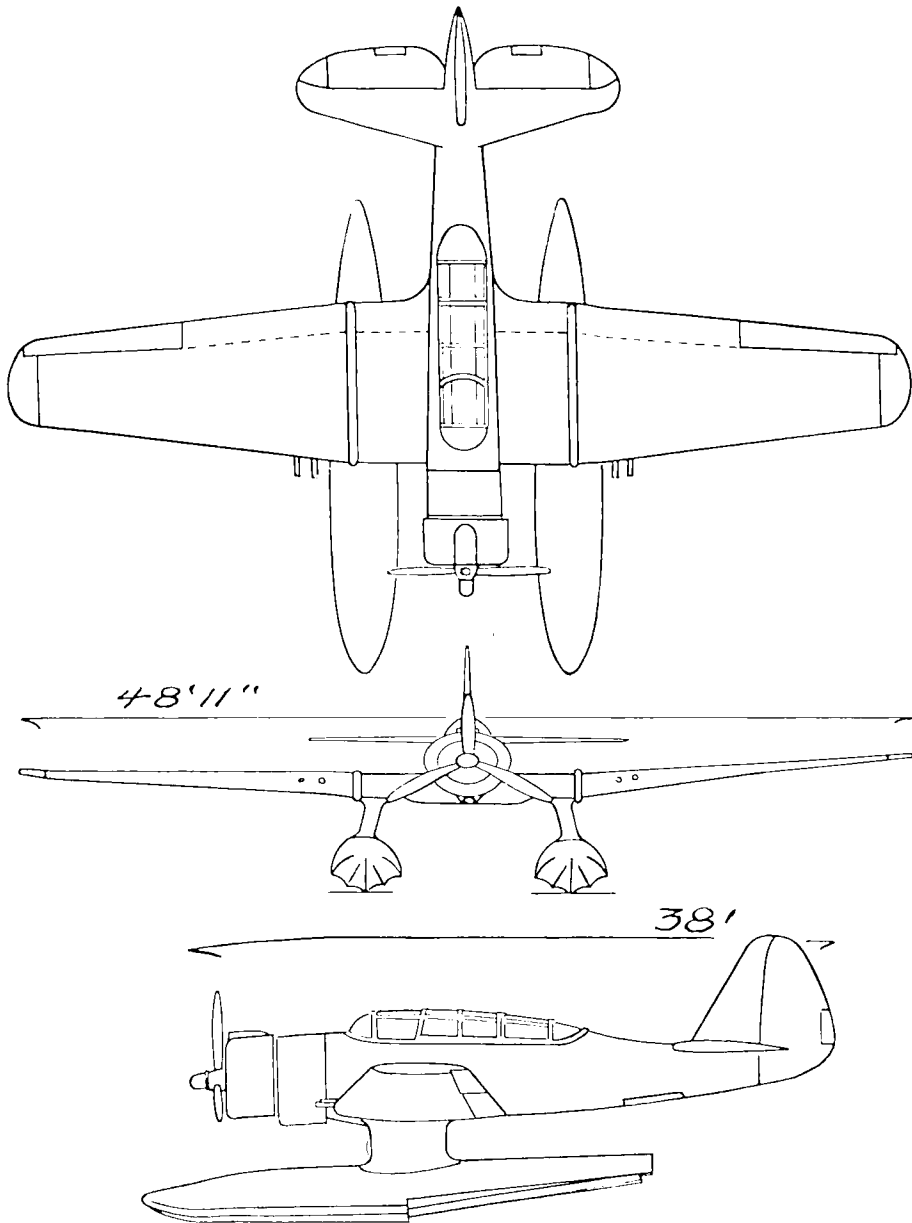
On February 20, 1940, the main plant building was ready for occupancy, and the rapidly expanding departments quickly moved into the new factory. anxious to go to work on a subcontract received the latter part of January from Consolidated Aircraft. This was the first contract received by Northrop Aircraft. It amounted to about \$650,000.

With 122,500 sq. ft. of factory area in use during February, March and April of 1940 the company found that more floor space was necessary to take care of their rapidly expanding business which by May 1 was up to the two and one-half million mark. During May the first expansion took place, with addition of 65,280 sq. ft. bringing the total to 187,780 sq. ft.

April, 1940, also marked the first contract for complete airplanes received by the new company. This order, from the Royal Norwegian Government was for 24 seaplane patrol bombers. Eight months later the first ship was test-flown at Lake Elsinore. The ship's performance exceeded all the design specifications.

By August, 1940, one year after the first six employees started work in the rented temporary quarters, the number of employees had increased to almost 1,000. Production was in full swing, and deliveries were being made on schedule. In October, Northrop Aircraft received its largest order, when the British Government contracted for \$17,000,000 worth of high performance planes of newest design. That order made it necessary for the company to expand facilities. Contracts were immediately placed to increase the floor area to approximately 500,000 sq. ft. This was to increase the production capacity of the plant by 150 per cent.

Late in 1940, additional orders increased the company's backlog to over \$25,000,000. These orders were subcontracts from Boeing



THE NORTHROP N-3

A three-place patrol bomber powered with a Wright Cyclone 1,200 h.p. engine.

Aircraft for the Army's big Boeing Flying Fortresses and included \$1,750,000 worth of cowling and \$3,500,000 worth of engine nacelles.

At the beginning of 1941, Northrop Aircraft had made an impressive record of achievement in 10 months. Employees had increased to 2,090, and \$351,556 worth of equipment had been delivered. On March 1, 1941, employees totaled 2,318 and floor space 216,280 sq. ft., with 300,000 additional sq. ft. to be completed in a few weeks.

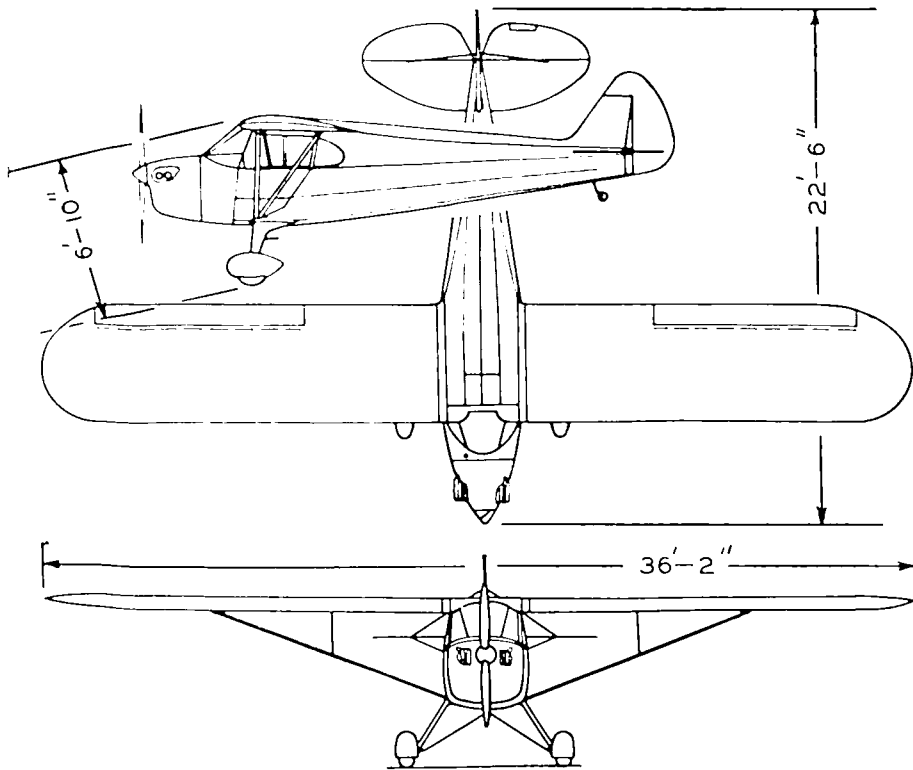
The Northrop N-3PB patrol bomber, 24 of which were destined for use by Norwegian pilots flying as a unit of the British Royal Air Force, was a 3-place single-engine, low-wing full cantilever monoplane incorporating extensive armament and novel features of design and construction. In addition to a load of 2,000 lbs. of bombs, it carried six machine guns. Four 50-caliber machine guns were fixed in the leading edge of the wing, two on each side of the fuselage; two other guns were flexible. One 30-caliber was in the turret above the fuselage aft, and another 30-caliber fired through a gun trap under the fuselage aft. In addition, bomb racks gave a wide selection of the type of bombs which might be carried, permitting a range choice of from 30- to 1000-lb. types or one 2000 lb. torpedo.

The fuselage was a semi-monocoque type utilizing aluminum alloy 24ST and incorporating a stressed skin covering. The structure was fabricated in two sections, divided along the horizontal centerline. The crew occupied tandem cockpits covered by easily operated, streamlined enclosures with good visibility in all directions. The front cockpit was equipped with all necessary flight and engine controls and instruments, and was occupied by the pilot. The rear cockpit was occupied by a gunner-observer located in the upper forward section, and a gunner-radio operator-bombardier stationed in the lower rear section.

The wing was of full cantilever design, had a stressed skin covering, and was composed of five sections, the center section, two outer panels and removable tips. The NACA 2400 series airfoil section was used, and the flaps were of the split trailing edge type. Power was supplied by a Wright Cyclone GR-1820-G200 series engine rated 1,200 h.p. at 2,500 r.p.m. Two Edo floats were used in the seaplane, and were attached by full cantilever pedestals replacing the usual strut and wire type of support, thereby giving an unusual streamlined installation.

Maximum stated speed at 16,400 ft. was 250 m.p.h., cruising 215 m.p.h., service ceiling 24,000 ft., gross weight 7,900 lbs. The wing span was 48 ft. 11 in., height 12 ft., length 38 ft., and cruising range 1,400 mi.

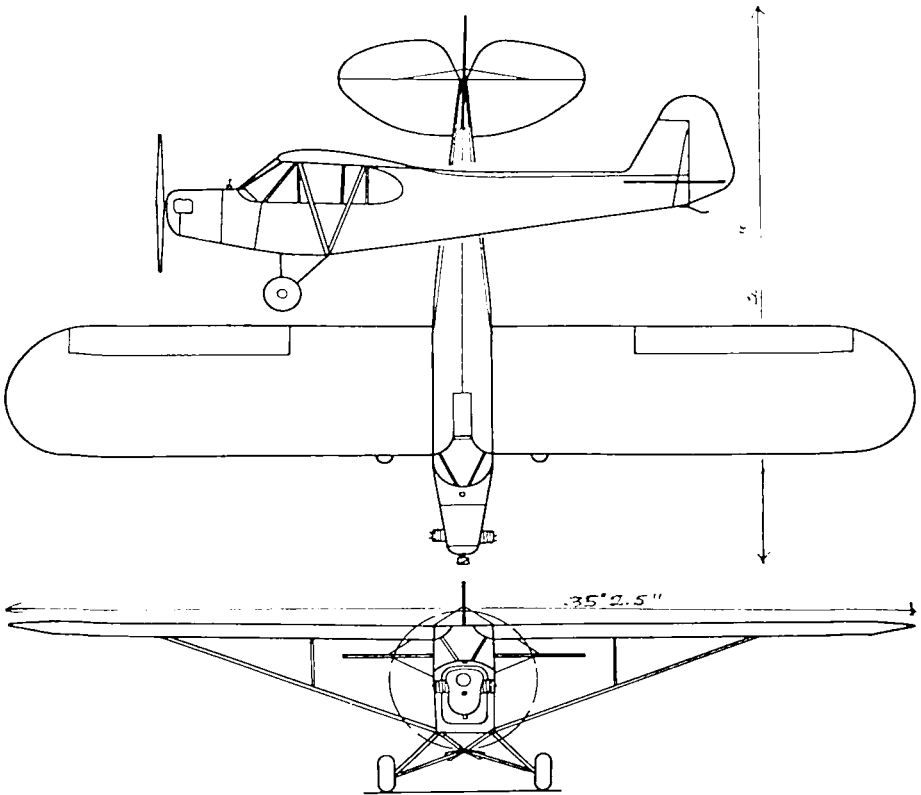
Piper Aircraft Corporation, Lock Haven, Pa., in 1940 claimed



THE PIPER CUB COUPE

It is powered by a Continental 75 h.p. engine.

delivery of 3,016 Piper Cubs, a record. To make possible that record production, many additions and improvements to the Piper plant at Lock Haven took place. The ground area was doubled by the addition of two new assembly buildings 400 ft. long, bringing the total floor space up to more than 180,000 sq. ft. Other manufacturing facilities were improved for speedier production. Nearly a mile of monorail conveyor system was installed to connect all departments and greatly speed up movement of wings and fuselages. The system was complete with switches, crossovers and double track in places, closely approaching automotive practice. Considerable new machinery was installed, cutting production costs. The plant operated throughout 1940 on a virtual 24-hour basis with three shifts, employing at the end of the year 1,125 persons. When the new assembly buildings were completed in October, 1940, production jumped to over 100 Piper Cubs a week. In November, 406 Cubs were delivered. A new two-story office building also was added for sales, accounting and engineering departments.

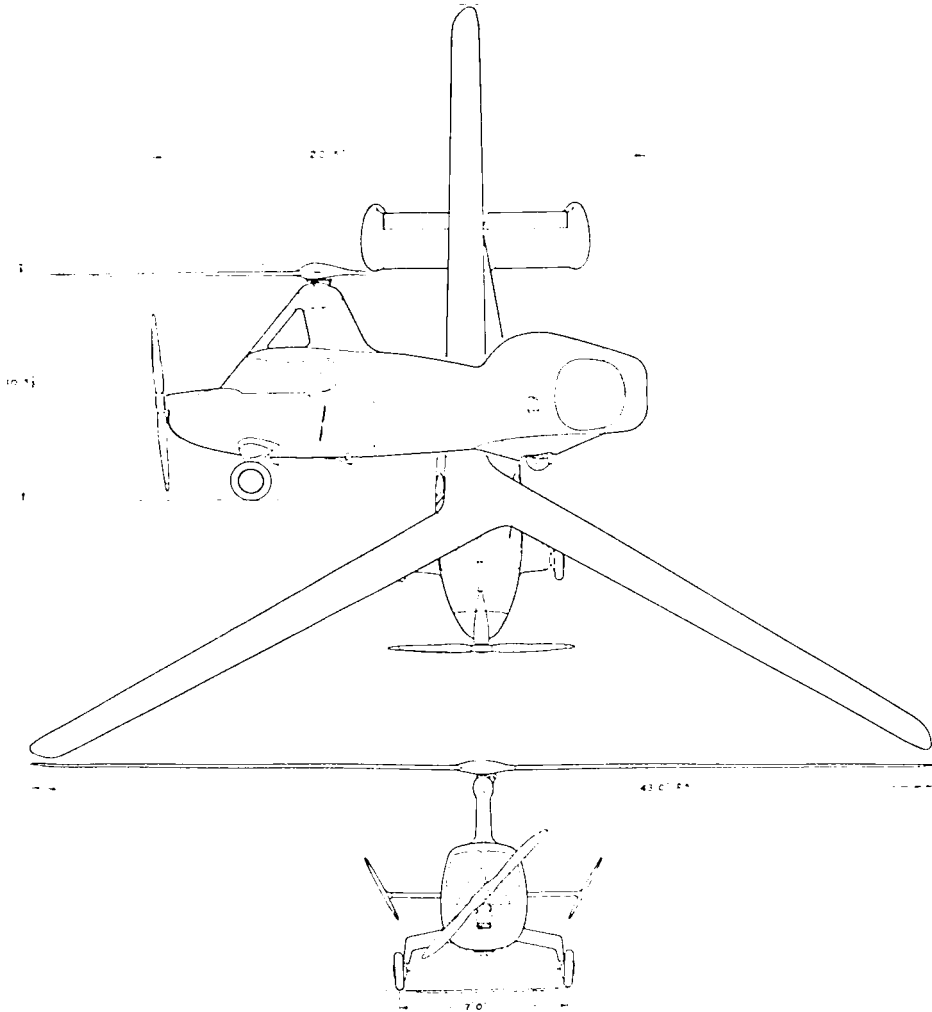


PIPER CUB TRAINER

This two-place Model J-3 is available with Continental, Franklin or Lycoming engine in a power range from 40 to 65 h.p.

Three basic models were turned out by Piper Aircraft in 1940. Largest production was on the Piper Cub trainer which was supplied in numbers for the Civilian Pilot Training program. Over 75 per cent of the ships used in that program were Cubs. The performance of the ship was improved greatly during the year by the installation, as standard equipment, of 65 h.p. Continental, Lycoming or Franklin engines. Mufflers and dual ignition were included as standard equipment. The 40 h.p. trainer was still available at \$995. Available for the first time in 1940 was the Piper Cruiser, a 3-place airplane with 75 h.p. It was used extensively by airport operators for advanced student instruction, charter and passenger carrying. It seated the pilot forward with two passengers aft. Dual controls were standard.

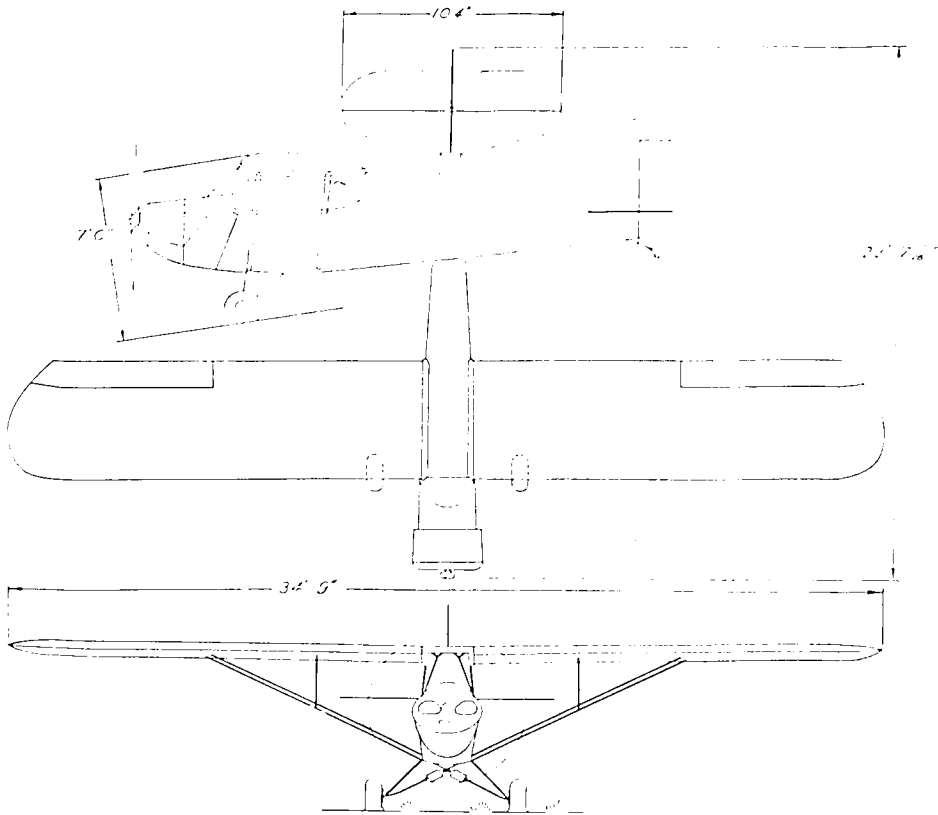
The Piper Coupe with many improvements was accepted readily by private pilots. With a range of 450 mi., muffler, enclosed engine



PITCAIRN-LARSEN WHIRL WING AUTOGIRO

A two-place cabin autogiro powered with a Warner Super Scarab 165 h.p. engine.

and many cabin refinements, it was offered as an example of the rapid strides made to make private flying more practical. The Light Plane Cavalcade to Florida which started at the end of 1940 showed nearly 1,400 planes in the group of which over half were Piper Cubs flown mainly by private pilots, rather than commercial pilots as in former years. The 1941 Piper Coupe featured 75 h.p. which gave it approximately 100 m.p.h. cruising speed and a range of over 500 mi. Practically every need for the private owner had been included as standard



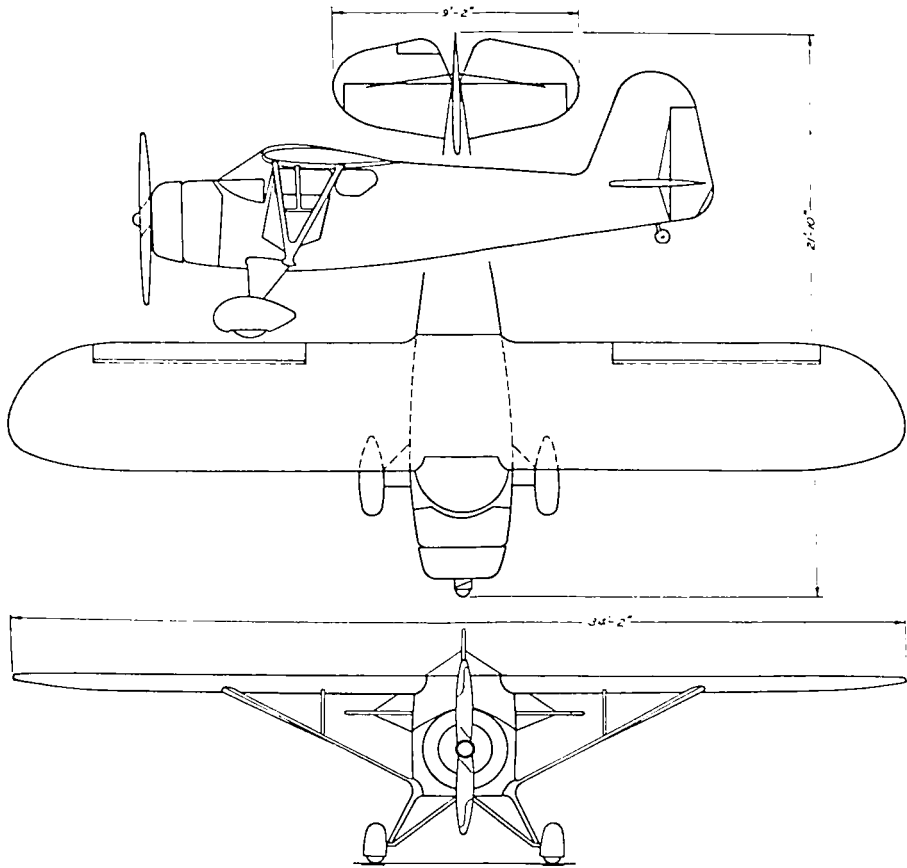
#### PORTERFIELD TRAINER

A two-place tandem trainer available with Continental 50 and 65 h.p. or Lycoming 65 h.p. engine.

equipment in that model—dual ignition, locks on the doors, clock, two glove compartments, engine starter, muffler, 105-lb. baggage compartment, hydraulic brakes, wheel pants, custom built radio receiver and wind driven generator.

Pitcairn-Larsen Autogiro Company, Inc., Willow Grove, Pa., on February 7, 1941, announced incorporation, stating that it had taken over the personnel, plant and contracts of Pitcairn Autogiro Company which would have other quarters. Its PA-36 "Whirlwing" autogiro was a 2-place machine with cabin; its length 20 ft. 5 in., height 10 ft. 3½ in., rotor diam. 43 ft., weight empty 1,425 lbs., useful load 625 lbs., fuel capacity 36 gal., powered by a Warner 165 h.p. Super-Scarab engine, stated high speed in level flight 121.7 m.p.h., cruising at 102 m.p.h., range with 36 gal. on 60 per cent power 350 mi.





REARWIN CLOUDSTER

A two to three-place private owner plane with a choice of Ken Royce engines from 90 to 120 h.p.

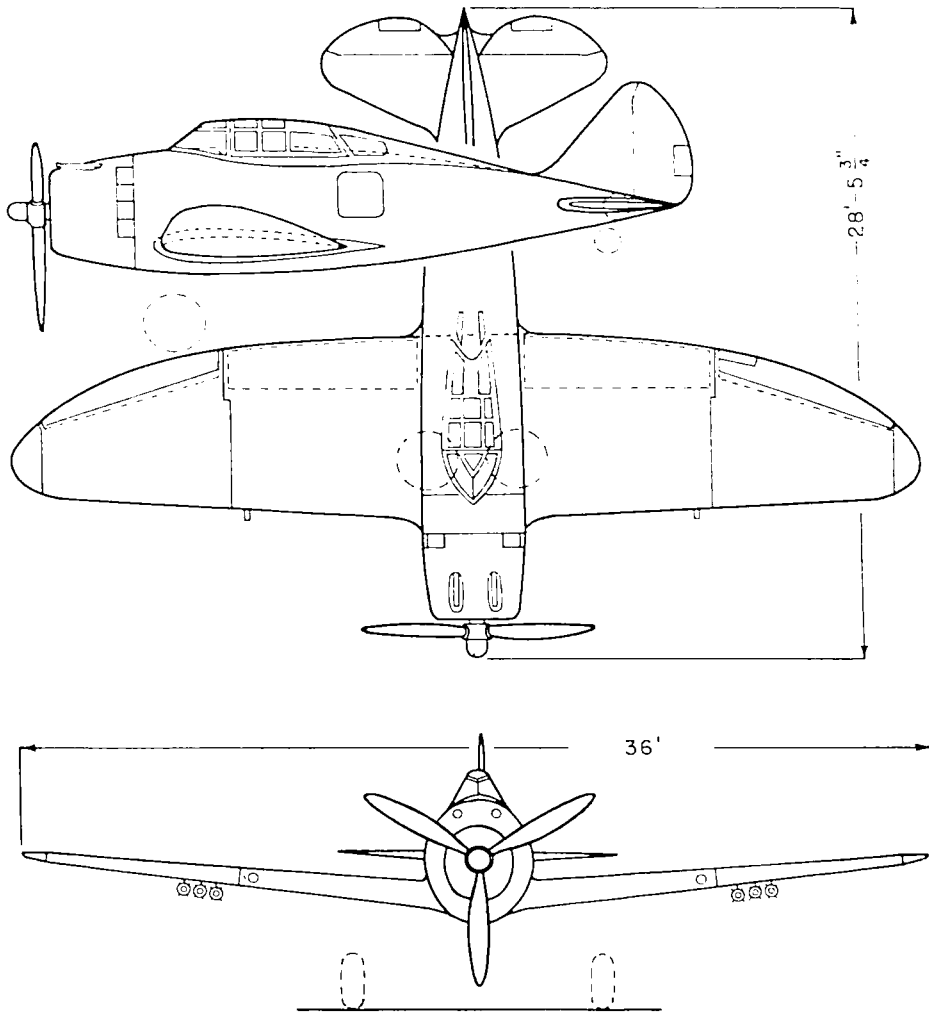
Porterfield Aircraft Corporation, Kansas City, Mo., had a new plant, consisting of three adjoining buildings, with 37,600 sq. ft. of production floor area. In 1940 it enabled Porterfield to more than triple production over that of 1939. Most popular of the Porterfield models was the Lycoming 65 h.p. LP-65 tandem trainer. Deliveries of the Continental-powered models, CP-55 and CP-65, tandem trainers, also were increased greatly. Although the Porterfield trainer models were designed primarily for private use, and thus incorporated many features not found in trainers, they were rapidly finding extensive use in the Government's program of flight training. During 1940 two new models were completed: the Franklin-powered, 65 h.p. FP-65 and the Continental-powered, 75 h.p. 75-C custom. Pre-

liminary work was completed to accommodate the installation of Edo float gear on the Model CP-65. The complete line of 65 h.p. models also were made available as ski-planes equipped with Federal all-metal skis. In 1941, Porterfield was planning an increase in gross weight on the CP-65 and LP-65; this increase to make possible more gasoline capacity and longer range. A version of the CP-65, including full blind flight training equipment, also was expected to be available. Porterfield was planning completion of a 2-place side-by-side model. The side-by-side model was designed with a power range of 65 to 90 h.p. and allowance for 100 lbs. of baggage.

Rearwin Aircraft & Engine Company, Kansas City, Kans., developed new models, the 3-place Cloudster, the 75 h.p. Skyrauger and an 80 h.p. Skyrauger which was completed and the approved type certificate obtained in March, 1941. The 80 h.p. Skyrauger was the same basic design as the 75 h.p. Skyrauger except that it was equipped with 80 h.p. Franklin or Continental engine. The Franklin engine also was equipped with a generator and starter as standard equipment. Another model was a 2-passenger, 120 h.p. instrument training ship. It resembled the 3-place Cloudster from outside appearance, was made in a tandem arrangement, having dual controls and duplicate blind flying instruments. The instrument panels were mounted on shock-proof Lord mounts, and the rear compartment in which the student worked his orientation problems could be closed off completely with regard to visual reference to the outside. That gave the instrument pilot plenty of room. By making an instrument training ship from the standard Cloudster dimensions, considerable space was obtained for mounting the blind flying instruments, and adequate payload was obtained for carrying two complete sets of blind flying instruments.

During 1940, the company completed negotiations with the Government of Iran to equip the newly formed Aero Club of Iran with 120 h.p., 2-place Rearwin Cloudster trainers as standard equipment, and 25 planes were shipped.

Republic Aviation Corporation, Farmingdale, N. Y., in 1940 increased from 1,300 to 2,550 employees and carried through an aggressive defense expansion program which accompanied the booking of more than \$60,000,000 in new business, for delivery in 1941 and 1942. The company continued to base all activities on production of single-seat military pursuit aircraft, principally of the high altitude, interceptor type. During 1940 nearly 200 planes were delivered. They were of the EP-1 and 2-PA "Guardman" types for the Royal Air Force of Sweden, and the P-35A, AT-12 and P-43 "Lancer" types for the U. S. Army Air Corps.



THE REPUBLIC P-43

A single-seat pursuit with a Pratt & Whitney 1,200 h.p. Twin Wasp power plant.

Substantial improvements and additions were made to the buildings of the company and the available productive floor area had been increased to 230,000 sq. ft. by the end of 1940. Complete plans were drawn during the year, contracts let, and work began, in December, on a new 500,000 sq. ft. building, adjacent to the existing plant, to be completed early in 1941.

Republic received a contract for \$56,499,000 worth of pursuit planes from the U. S. Government, which was the largest single order

placed with any company for this type of aircraft. In addition, a \$5,212,000 facilities agreement, for the erection of the new plant, was made with the War Department. Under the terms of this agreement, Republic Aviation was to be compensated for 20 per cent of the cost of the new facilities in each of the next five years. At the end of that period title was to pass to the Government unless Republic determined to exercise its privilege of acquiring the property at an agreed price.

Substantial investments in machinery and tooling were made by the company on its own account during 1940 in preparation for the anticipated expansion demands which were realized in the later months. All operations in the existing plant were promptly converted to permit expeditious transfer to the new structure, when ready, while production continued at an accelerated pace. Jigs and fixtures for the newer models were designed and erected to be readily removable and it was expected that the complete manufacturing activities of the company could be transferred from one building to the other in a matter of less than a month.

There were several outstanding characteristics in design and construction of all Republic airplanes in 1940, all of which were to be continued in 1941. All models employed Pratt & Whitney radial air-cooled engines, which were supercharged for extraordinary efficiency at high altitudes. The P-35 series of pursuits were equipped with Twin Wasp engines of 1,050 h.p. The P-43 "Lancer" had a 1,200 h.p. Twin Wasp installation and the P-47 "Warrior" had the 2,000 h.p. Double Row Wasp as its power plant.

Special Republic-engineered installations of the turbo supercharger gave the company's fighter planes flying qualities in the 30,000-foot altitude range, qualities which proved exceedingly desirable in the light of European developments. Such pursuit-interceptors were regarded by overseas observers as the sorely-needed answer to high-altitude bombardment attacks. The bomber squadrons of all belligerents, reports established, consistently operated at the highest practical altitudes in order to escape anti-aircraft fire from ground batteries and to put at a disadvantage enemy pursuits lacking the tactical ability to out-maneuver and out-speed their bomber adversaries.

Assisted by invaluable consultation with Army Air Corps technicians, Republic engineers successfully adapted the latest wartime developments to the newer models. These included greatly increased armament, self-sealing fuel tanks and effective armor for pilot-protection. With the completion of a large contract for the Royal Swedish Air Force, the company entered in 1941 a period of tremendous expansion, during which its entire production was earmarked for the



NEW RYAN ST-3 TRAINER

It is powered by a Kinner engine.

Army Air Corps and the nation's defense program. Deliveries under existing contracts were to continue until the end of 1942.

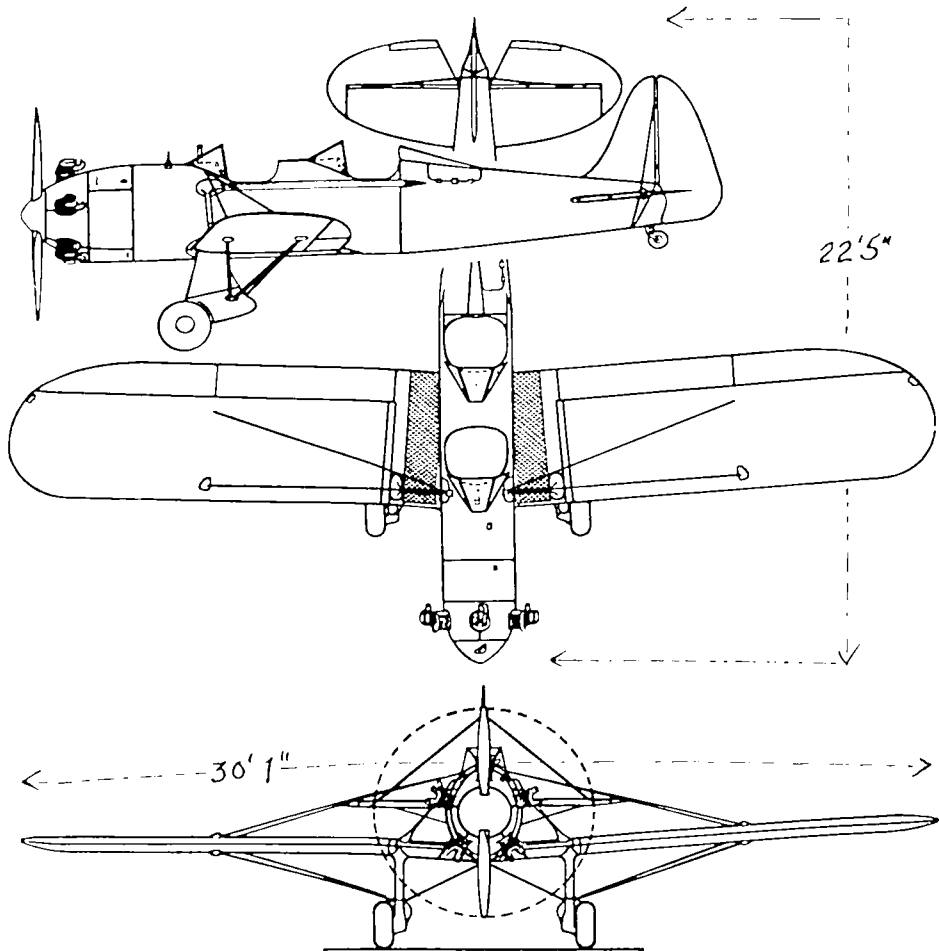
N. B. Rich Airplane Company, Springfield, Mass., was flight-testing a twin-engine private owner plane, the Rich-Twin.

Ryan Aeronautical Company, San Diego, Calif., vastly expanded its production facilities by frequent enlargements of its factory and had a backlog of \$11,000,000 in orders.

Although the Ryan company completed a new factory on Lindbergh Field, San Diego, in June 1939, it was necessary before many months to build an addition which more than equaled in floor area the other new factory. Production area included 160,000 sq. ft. but additional buildings under construction were to increase that another 100,000 sq. ft. In June, 1940, Ryan also completed a new administration building adjoining the aircraft factory. The new two-story modernistic administration and engineering building had become cramped and construction for additional office space was to begin in 1941.

In August and September, 1940, Ryan received from the U. S. Army Air Corps two large orders for its new ST-3 primary training plane—orders totaling \$7,425,000. They were sufficient to keep the plant running at high capacity for 18 months.

The new ST-3 trainer was the latest development of a long line of Ryan S-T trainers which were first built in 1934 and subsequently refined by engineering changes. Production also included a million dollar export order for Ryan S-T-M military training planes for export to a foreign government. Many were to be equipped with sea floats, the first time that Ryan trainers were used for naval pilots.



RYAN ST-3

A two-place plane for primary training with a choice of a Kinner or Menasco engine ranging from 125 h.p. to 160 h.p.

The company established an unusual record of test flying two new type trainers in a single day. One was the ST-3 land plane trainer, and the other was the first Ryan STM-2 military trainer to be equipped for water flying.

The Ryan factory had 1,500 employees on its payroll early in 1941, and an additional 1,000 were to be hired within the next six months in order that Ryan planes called for under the defense program could be delivered on schedule. Deliveries were being made at the rate of approximately two trainers per working day, and that rate was to be greatly accelerated when the company finished preparing tools neces-

sary for the Air Corps' type standardization mass production plan.

In 1940 Ryan delivered to the Air Corps a number of YO-51 "Dragonfly" observation planes for special flight tests. It indicated ability to take-off and land within extremely limited areas, and the capability of an unprecedented range in speed from almost a complete "hover" in mid-air to "stepping out" at a fast clip. The "Dragonfly" was able to make almost unbelievably quick take-offs, steep climbs over obstacles, and land at an approach angle that appeared to be nearly vertical and with an extremely short roll.

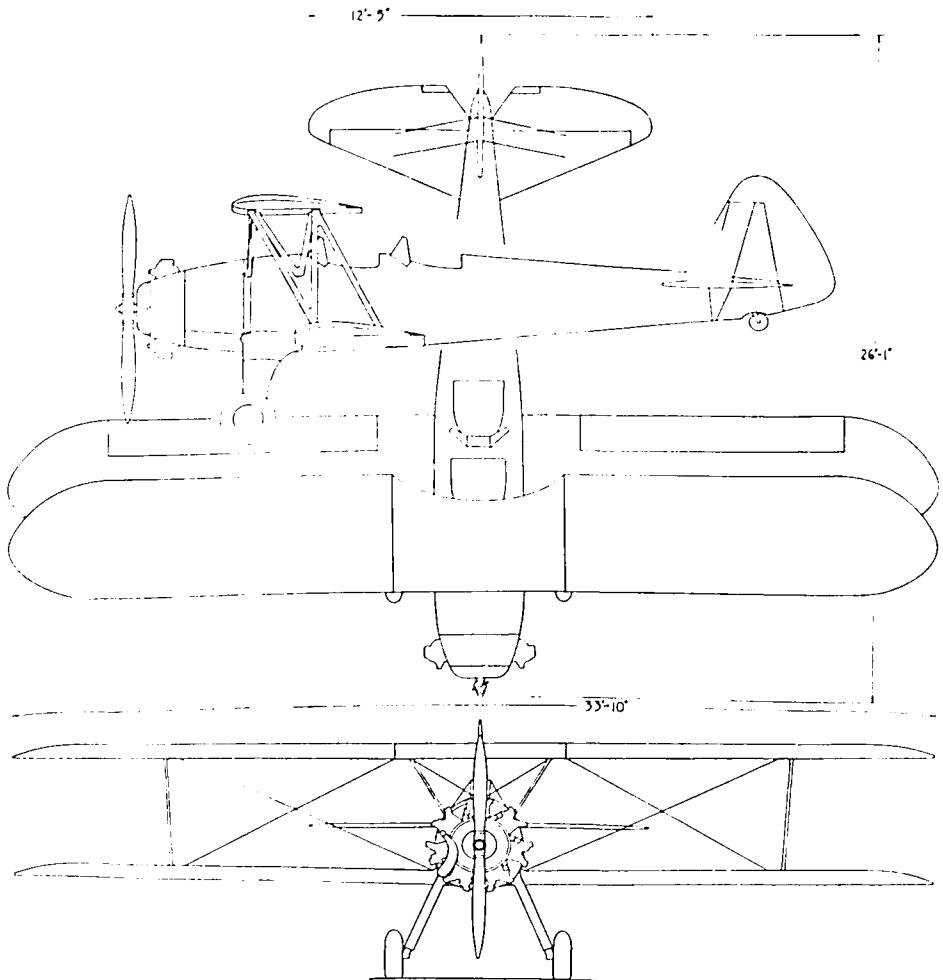
The new Ryan low-wing open cockpit trainer for 1941 had the familiar Ryan appearance, but otherwise it was an entirely new airplane. The new Ryan ST-3 was the commercial trainer version of a large number of new training planes produced for the U. S. Army Air Corps.

Confident in the belief that the ideal primary trainer should be a low-wing monoplane, the Ryan Aeronautical Company in 1934 produced the first Ryan S-T. For six years Ryan was a pioneer in the low-wing trainer field, retaining the basic S-T design, but making numerous refinements in engineering and construction. After years of much "sales resistance", Ryan, in 1940, was a successful winner of an Air Corps flight competition for primary trainers. The Ryan S-T then became the Army's first low-wing primary trainer, thus breaking away from a 30-year precedent of biplanes for initial flight instruction of Air Corps flying cadets.

A large number of Ryan trainers were in continuous operation by the Air Corps Training Detachment operated by the Ryan company's subsidiary, the Ryan School of Aeronautics at San Diego. As a result of this close contact between operator and factory, the Ryan organization enjoyed an outstanding advantage in having its own proving ground on which to base design and production improvements.

St. Louis Aircraft Corporation, St. Louis, Mo., in 1940 completed delivery of a service order of 13 PT-1 biplanes (Army PT-15) for the U. S. Army Air Corps. The company also produced for the Air Corps a considerable number of semi-experimental developments, such as C-6, C-8, and C-9 balloon cars, expandable type rudders for C-6 balloon, Type I and Type III retractable skis, test-stand tanks, bombing trainer and target, and centrifugal blowers for observation balloons. The company at the same time pushed forward its own development program, resulting in the completion of the PT-LM-4 airplane, a 2-seat acrobatic training ship.

Southern Aircraft Corporation, Garland, Tex., placed in production the company's Model BM-10, a 2-place, open cockpit, highly

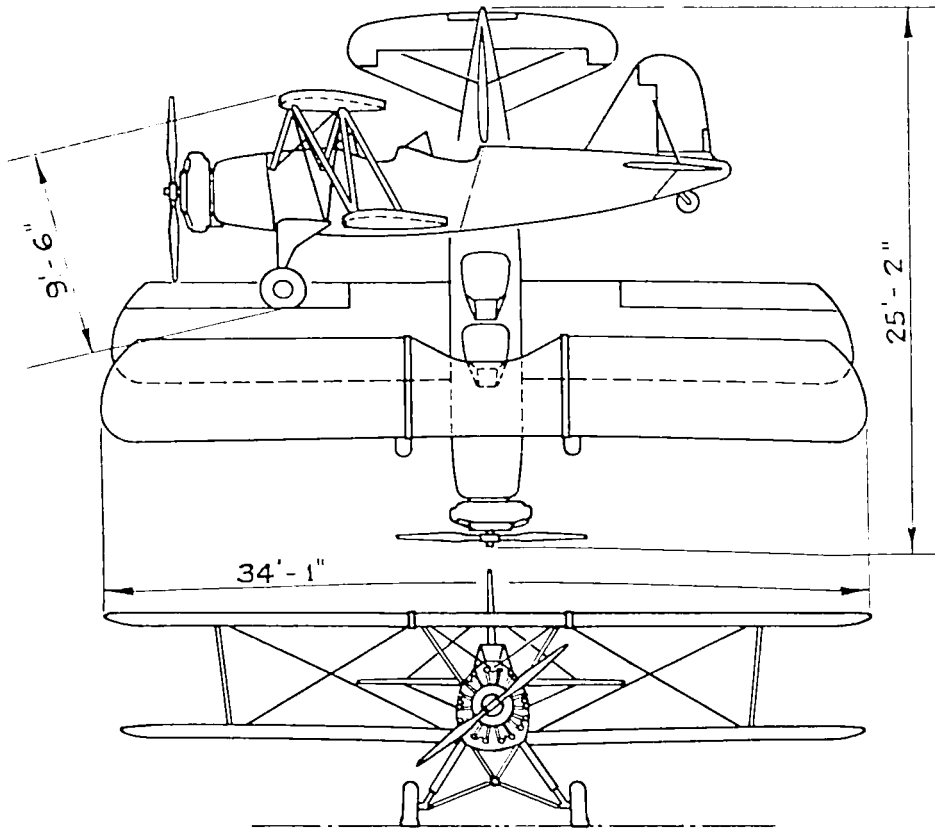


#### ST. LOUIS AIRCRAFT TRAINER MODEL PT-1

A two-place trainer for the Air Corps powered with a Wright Whirlwind 225 h.p. engine.

staggered biplane, specifically designed to the requirements of the U. S. Army Air Corps for the training of military pilots. During the latter part of 1940, contracts were let for the construction of a modern manufacturing plant, located on a 183-acre plant site and private airport at Garland, Dallas County, Tex. The first unit of the projected plant was scheduled for occupancy in the early part of 1941. Paving the way for this expansion was the acquisition of additional manufacturing machinery for the production of the BM-10 military



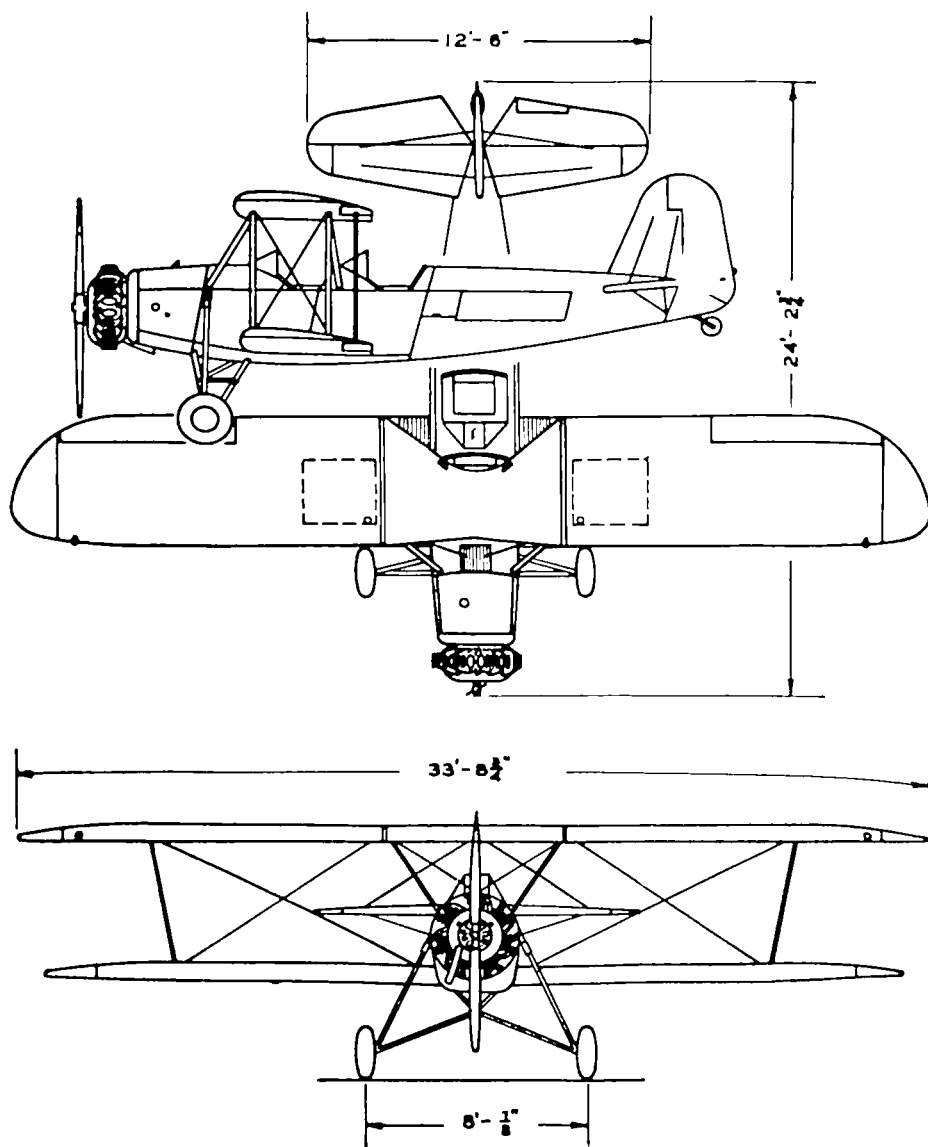


SOUTHERN AIRCRAFT BM-10

This two-place military primary trainer may be powered with a Continental, Jacobs, Lycoming or Wright engine.

primary trainer as well as for the subcontracting of component parts for other aircraft manufacturers.

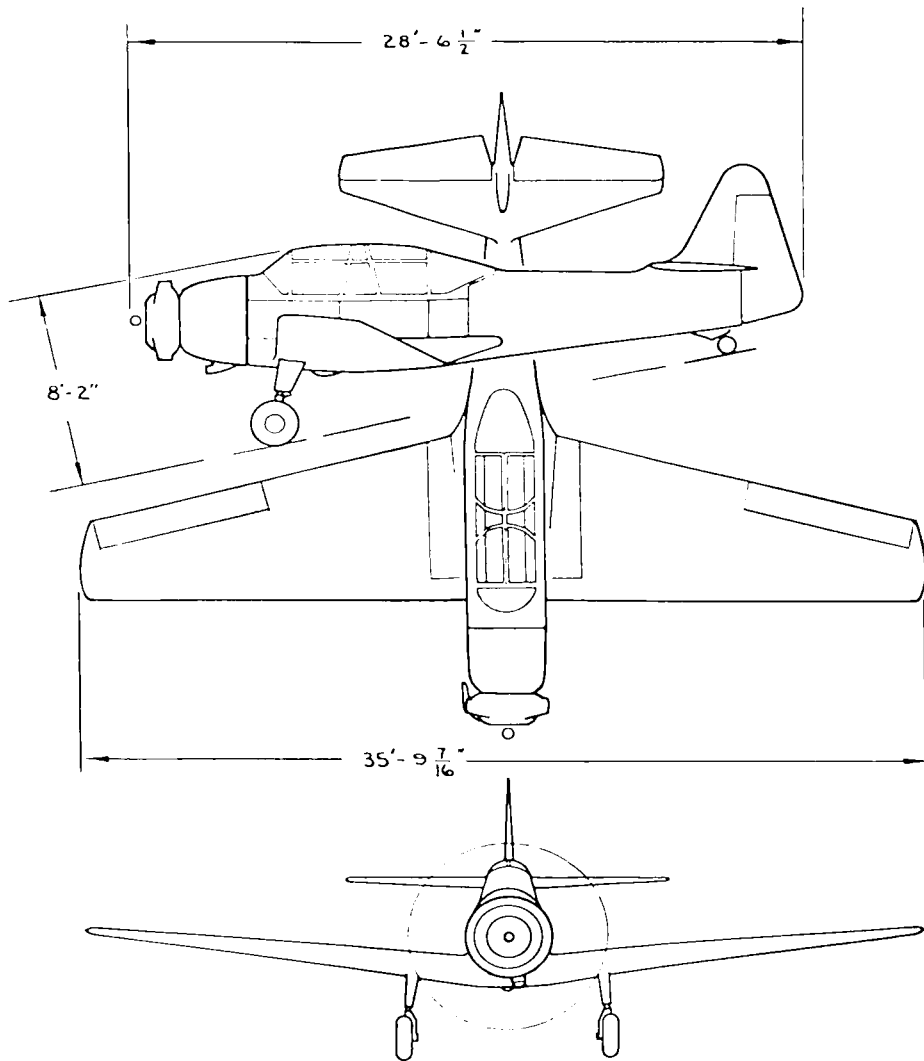
Spartan Aircraft Company, Tulsa, Okla., produced its NS-1 military primary trainer for the U. S. Navy. It was a 2-place biplane with a wing spread of 33 ft. 8 $\frac{3}{8}$  in., height 9 ft. 4 $\frac{1}{2}$  in., length 24 ft. 7 $\frac{3}{4}$  in., empty weight 2,080 lbs., useful load 720 lbs., gross weight 2,800 lbs. It had a welded steel fuselage frame, fabric covered aft of the rear cockpit; wing construction of laminated spruce spars, spruce ribs and drag struts, all fabric-covered with the exception of the removable metal tips; interplane and cabane struts of streamline steel tubing and ailerons of riveted aluminum alloy construction with fabric covering. The fin and stabilizer were of stressed skin aluminum alloy construction, and the elevator and rudder of riveted dural frame work,



SPARTAN NS-1

A two-place military trainer powered with a Lycoming 220 h.p. engine.

fabric covered. A single tab controllable from the cockpit provided horizontal trim. The landing gear, of the split axle type, and the swiveling tail wheel unit were equipped with oleo shock absorbers. The plane had a 220 h.p. Lycoming engine.



STEARMAN PRIMARY AND BASIC TRAINER

Model 90 is powered by a Lycoming 225 h.p. engine. The 91 is powered by a Pratt & Whitney 450 h.p. engine.

Stearman Aircraft Division of Boeing Airplane Company, Wichita, Kans., in March, 1941, delivered its 1,000th trainer under the defense program. In 1940 it had achieved a tremendous increase in production of primary training planes for the U. S. Army Air Corps and Navy. At the same time it was expanding its plants extensively to produce at a still faster rate in 1941. With the country in need of greatly enlarged fleets of primary training planes as a starting point

of the defense program, the Stearman plant was among the first to undertake substantial expansion and gear up to quantity production. By September, 1940, Stearman announced that it had reached a production rate of one airplane every three hours for the two main shifts of each day and that the rate was being accelerated steadily toward a future schedule of one airplane every 90 min.

The Stearman contracts from the U. S. Army and Navy comprised upward of 3,000 airplanes—the largest number of primary trainers ever ordered by the Government in peacetime from one manufacturer. Production of these planes drew a veritable stream of delivery pilots to Wichita to ferry the craft to the various training centers for use in schooling new Army and Navy flying cadets under the defense program. By early 1941, as many Stearman trainers were being delivered in a period of two weeks as were completed in the entire two years of 1937 and 1938.

Stearman started 1940 with 157,000 sq. ft. of floor area. By early 1941 this had been more than doubled, bringing the area of the Plant No. 1 to approximately 300,000 sq. ft. Meanwhile, an entire new factory comprising 438,000 sq. ft. was nearing completion close by, as Plant No. 2. Both factory units were located on the Wichita Municipal Airport. Plant No. 1 was devoted entirely to engineering and production of training planes. Plant No. 2, a 330 by 1,000-ft. modern structure, was to be devoted to the production of major sub-assemblies such as outboard wing sections and tail surfaces for four-engine Boeing Flying Fortresses, to be assembled at the main Boeing plant in Seattle. This new plant, designed to fit idealized production layouts, consisted of large clear working areas, flanked by a warehouse building along one entire side to feed materials direct to the production lines.

The personnel of the Stearman Division grew from 500 at the beginning of 1940 to 1,800 at the beginning of 1941, and was expected to reach more than 6,000 by late summer of 1941, including the new personnel at Plant No. 2.

Stearman's defense orders comprised six basically similar types of primary training planes, with varying engine installations. These were the Army PT-13B, PT-17, and PT-18, which employed Lycoming R-680-11, Continental R-670-5, and Jacobs R-755-7 engines, respectively; and the Navy N2S-1, N2S-2 and N2S-3, the first and third of which employed Continental R-670-4 engines, while the second incorporated a Lycoming R-680-8. The Lycoming and Continental engines used were rated at 220 h.p., the Jacobs at 225 h.p. All were 2-place biplanes featuring high maneuverability and rugged serviceability. They had a wing span of 32 ft., 2 in., height 9 ft. 4½

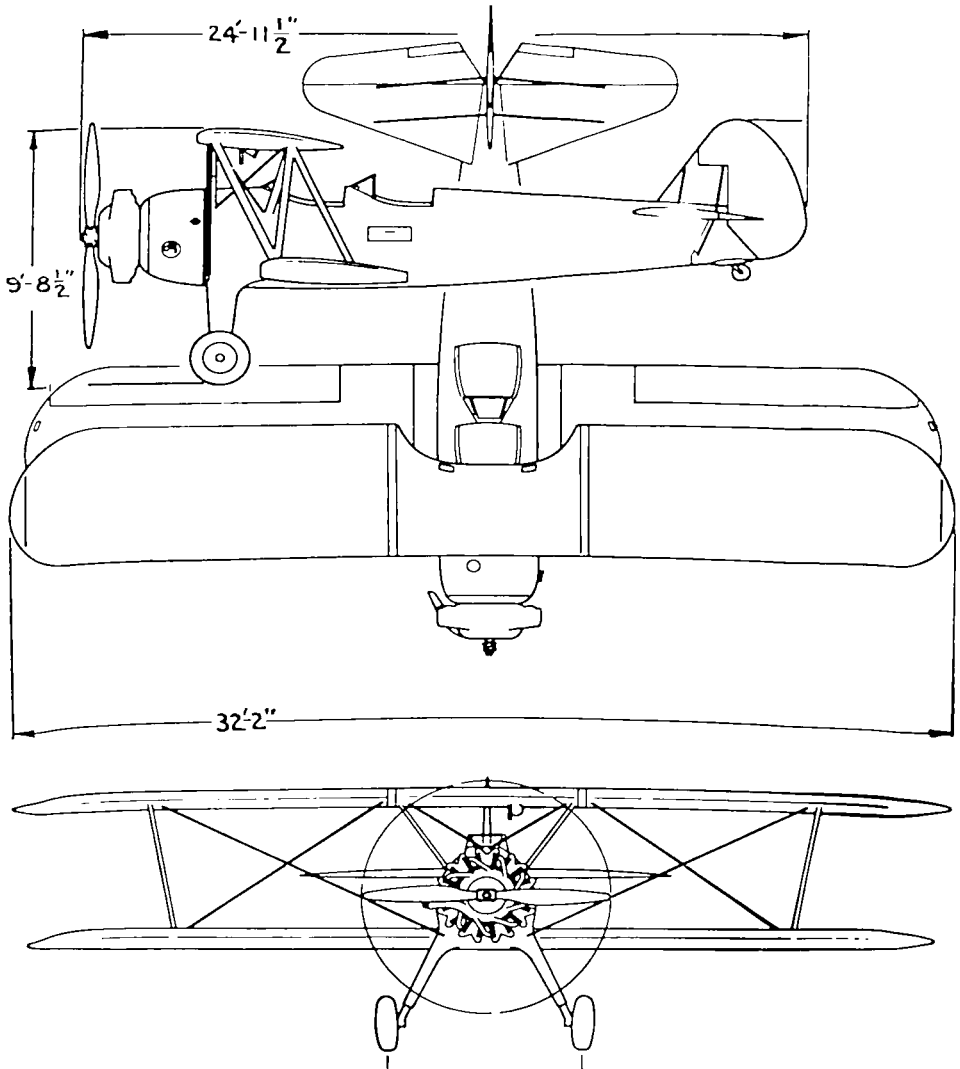
in., length 24 ft. 9 $\frac{1}{2}$  in., wing area 297.6 sq. ft., gross weight 2,700 lbs., varying slightly with different engine installations. Their stated high speed was 125 m.p.h., and cruising range from 400 to 425 mi.

These primary trainers had a fuselage of welded steel frame, fabric covered, wings of spruce spars, spruce ribs and aluminum alloy channel drag struts, all fabric-covered, interplane and cabane struts of streamlined aluminum alloy tubing and ailerons of riveted aluminum alloy construction, fabric-covered. Welded steel tubing construction was used in the tail group, with fixed stabilizers and with horizontal trimming provided by means of an elevator tab. Landing gear was of the full cantilever type, equipped, as was the tail wheel, with oleo shock absorbers.

Another Stearman type in 1940 was the experimental Air Corps Model NA-21 Stearman Model X-100) twin-engine attack bomber. It was equipped with 1,400 h.p. Pratt and Whitney R-2180 engines, using Hamilton Standard three-blade constant-speed full feathering propellers. It had a wing span of 65 ft., length 53 ft. 9 in., height 12 ft. 5 in., and gross weight 18,230 lbs. This airplane was an all-metal high-wing monoplane with fuselage of semi-monocoque construction, wings of the stressed-skin type, flush riveted, and with landing gear and tail wheel fully retractable.

Early in 1941 the Stearman Division brought out a new type monoplane trainer which company officials believed to merit an exceptionally bright future. The new airplane was designed for adaptation either as a primary or a basic trainer. As a primary trainer it was designated as the Stearman Model 90, equipped with a 225 h.p. Lycoming R-680-B4D engine and having a stated top speed of 140 m.p.h. with gross weight of 2,810 lbs. The basic trainer or advanced trainer version of the same airplane was designated Model 91, carrying a Pratt and Whitney T1B3 engine rated at 450 h.p. It had a gross weight of 4,150 lbs. and a stated high speed of 190 m.p.h., cruising at 160 m.p.h. and range of 800 mi.

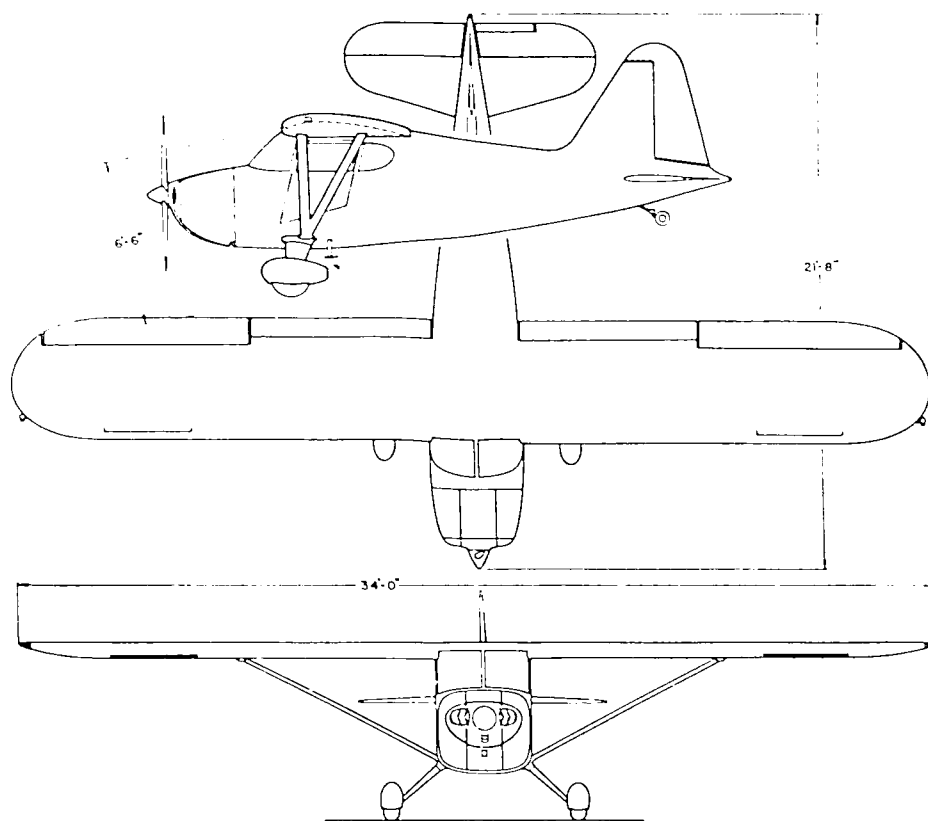
The new Model 90-91 in tests showed exceptional qualities as a training plane, and in addition the design had the advantage of having been planned from the outset with a view to mass production, officials of the company stated. The airplane employed all three current types of aircraft construction. The rear half of the fuselage was metal monocoque and the front half was steel tube, metal covered. The horizontal control surfaces and vertical fin were of plastic construction. All other movable surfaces were metal structure with fabric covering. The wing structure was of a novel construction employing plastic principles, through the use of spruce poplar plywood, resin-bonded. The wings were fabric-covered. The fuel tanks, integral



STEARMAN TRAINER PT-13B

The PT-13B has a Lycoming engine. The PT-17 has a Continental 220 h.p. engine. The PT-18 has a Jacobs 225 h.p. engine.

with the wing structure and located in the center section, had a plastic base which was sealed with a coat of synthetic rubber, a type of construction which combined inherent dependability with simplicity and economy for rapid production. Design for mass production was carried into many details. Instrument boards were made quickly de-

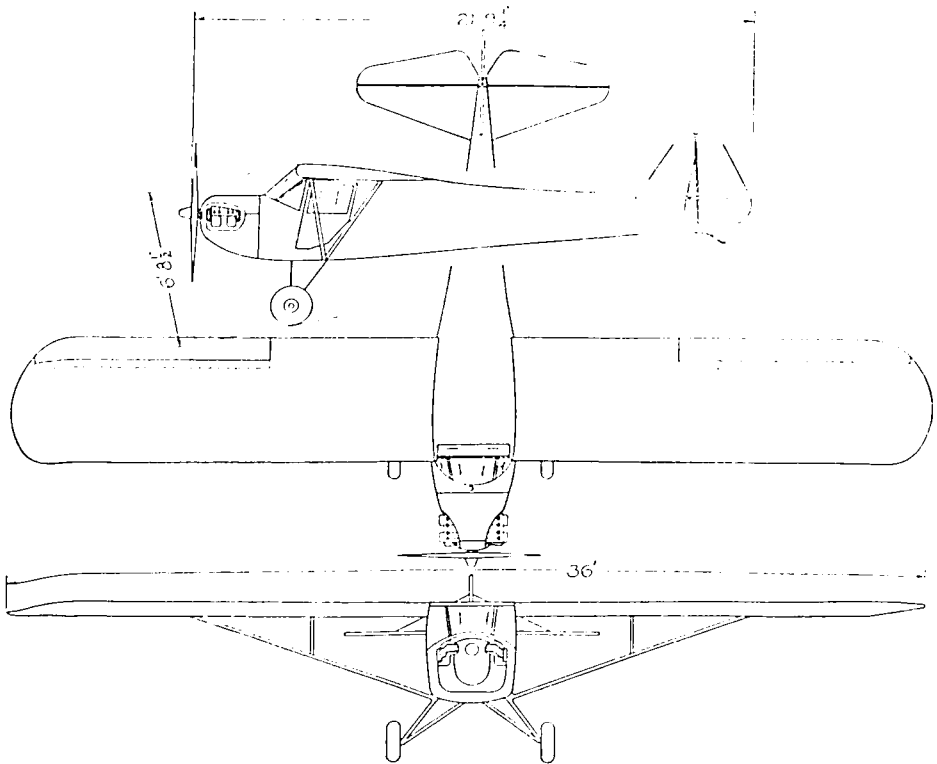


THE STINSON VOYAGER

A three-place plane for the private owner, powered by a Franklin 90 h.p. engine.

mountable and interchangeable; all accessory and control equipment in both cockpits was likewise interchangeable and of identical design, and standardization throughout the airplane was approached from the standpoint of eliminating right and left, front and rear and other unsymmetrical obstacles that militate against mass production, efficient servicing and relatively low cost. The cockpit was enclosed with Lucite, a transparent plastic, and supported by a heavy steel structure protecting the pilot and student in the event of turnover. The airplane was provided with landing flaps, in both models, and provision for retraction of the landing gear if desired. Into the new design was incorporated the result of Stearman's experience gained in the development and production of large numbers of training type airplanes for the Army and Navy during several years.

Stinson Aircraft, Division of Vultee Aircraft, Inc., Wayne, Mich.,



TAYLORCRAFT MODEL B

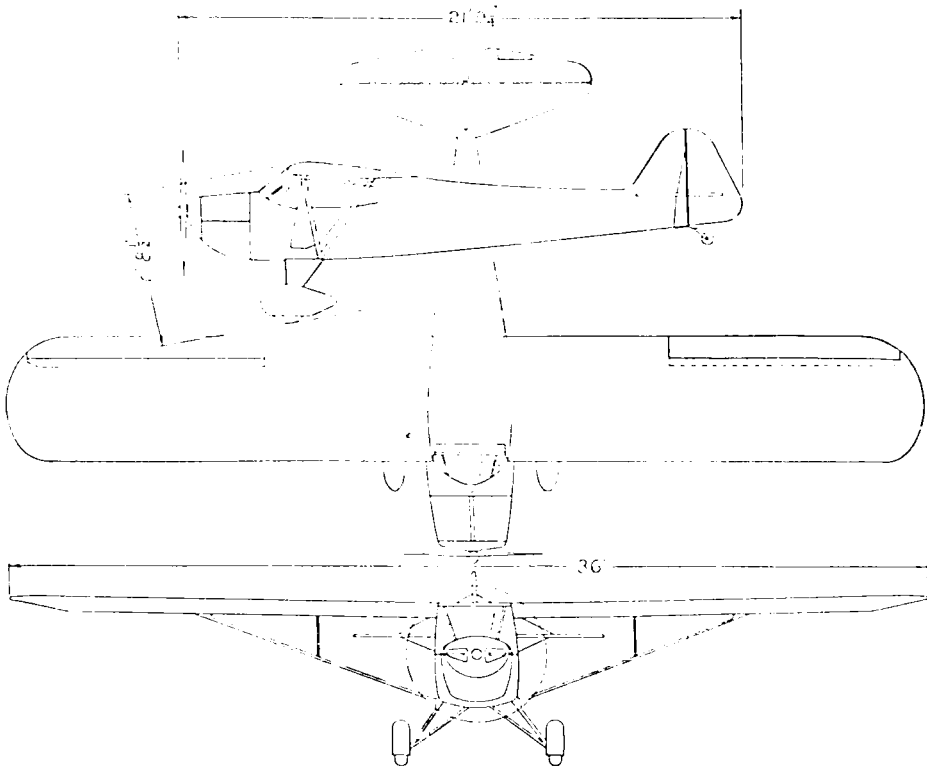
This two-place trainer is offered with a choice of Continental, Franklin or Lycoming 65 h.p. engines.

brought out a new plane for the private owner, known as the Voyager, it was an improved version of the Stinson 105, which had built-in slots and flaps. They were retained in the new Voyager model for 1941. The Voyager was a 3-place cabin monoplane powered by a 90 h.p. Franklin engine. It had a stated top speed of 115 m.p.h. Standard equipment included hydraulic brakes, parking brake, wheel pants, steerable tailwheel and bonding for radio. The Franklin engine developed 90 h.p. at 2,500 r.p.m. Take-off run with full load was 550 ft. The rate of climb was 600 ft. a min. Service ceiling was 13,000 ft.

Swallow Airplane Company, Inc., Wichita, Kans., developed a low-wing tandem trainer, the LT65, and early in 1941 was preparing for production in a new factory with 40,000 sq. ft. of floor space.

Taylorcraft Aviation Corporation, Alliance, O., in 1940 took orders for 1,017 airplanes as compared to 487 in 1939, an increase of 109





TAYLORCRAFT MODEL B12

Offered with a choice of 65 h.p. engines, Continental, Franklin or Lycoming, this private owner plane carries two.

per cent. Production totaled 924 planes, an increase of 92 per cent over 1939. Unfilled orders on December 31, 1940, amounted to \$225,348.39 against \$38,880.46 at the end of 1939.

In order to cope with a continually increasing backlog of incoming orders the company in 1940 erected additions to the plant and a new office building of the most modern type. The building program included an 80 x 100 ft. hangar and experimental department, two hard-surfaced runways 1,000 ft. each and two seeded runways of approximately 2,000 ft. each. Total floor area, including the hangar was increased from 22,000 sq. ft. to about 72,000 sq. ft. Considerable additional machinery and equipment were added and the enlarged plant laid out for more efficient flow of production. The productive capacity of the company was tripled, permitting the building of one plane an hour, or about 2,000 a year in one shift, or about 3,500 a year

in two shifts. Total costs of the expansion program was about \$225,000.

Taylorcraft planned the introduction of a new deluxe, side-by-side monoplane, containing a number of improvements over the 1940 model in design, color and equipment. Standard equipment included compass, wheel and parking brakes, auxiliary 6-gal. wing tank in addition to regular 12-gal. tank under the hood, full swivel tailwheel, dual ignition, and full navigation light wiring. For the first time Taylorcraft included in its line a tandem airplane. Designed ruggedly for student training, the new ship was to be offered with optional landing gear, orthodox or tricycle.

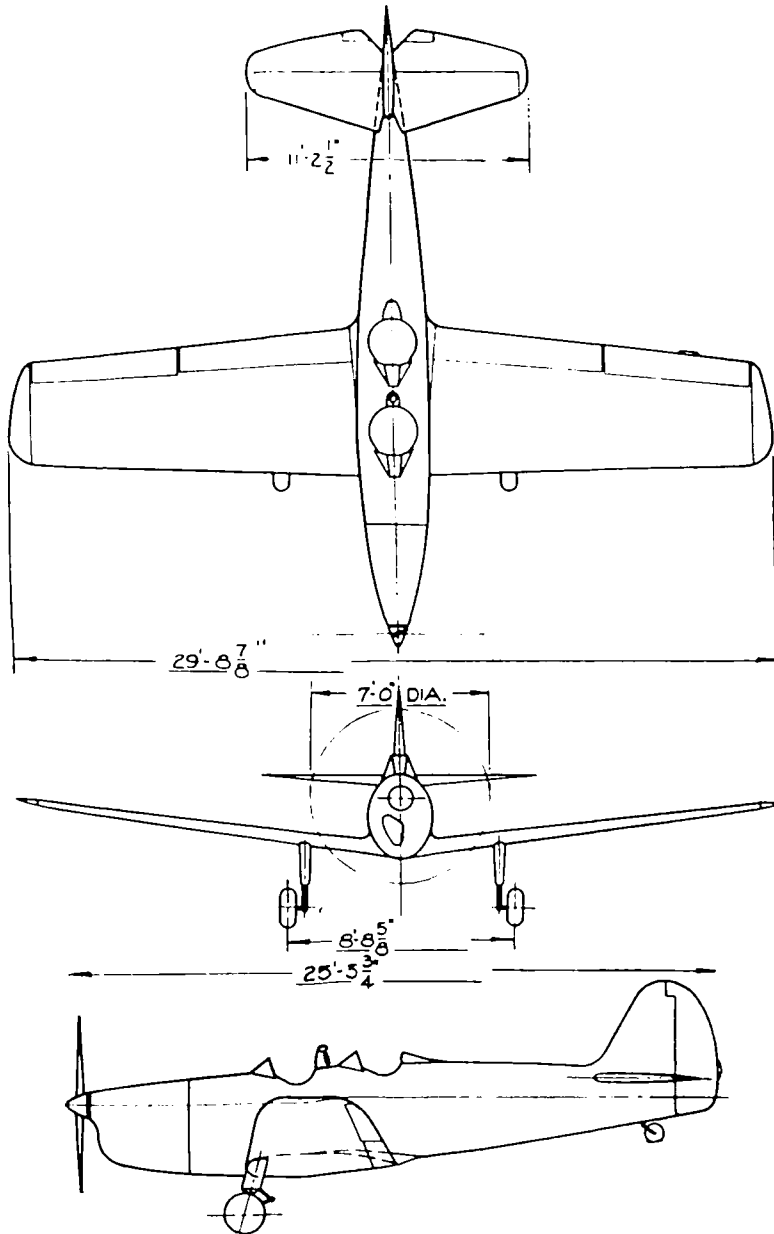
Timm Aircraft Corporation, Van Nuys, Calif., was developing a 2-place trainer, PT-175-K.

Vega Airplane Company, Burbank, Calif., was a subsidiary of Lockheed Aircraft Corporation. The new Vega plant on the edge of Lockheed Airport at Burbank was to become one of the nation's great reservoirs of aircraft equipment during 1941. It occupied 45 acres, with more than 1,000,000 sq. ft. of plant area, which combined with 250,000 sq. ft. in the older Vega plant, gave the company a million and a quarter sq. ft. Employment totaled 4,000 at the beginning of 1941. It was to be raised to 15,000 during the year. Vega's production was coordinated closely with that of its parent company, Lockheed. Also, Vega was going into production on its Model 35 primary-secondary trainer.

The Vega 35 trainer was a single engine, 2-place, tandem low-wing, all-metal monoplane. It had a wing span of 29 ft. 8 7/8 in., length 25 ft. 5 3/4 in., height 6 ft. 11 in., wing area 147.2 sq. ft., power loading 14.65 lbs. per h.p., wing loading 12.45 lbs. per sq. ft., weight empty 1,278 lbs., useful load 549 lbs., gross weight 1,827 lbs., fuel capacity 25 gal., stated maximum speed 124 m.p.h., cruising at 112 m.p.h., range 312 mi. The trainer was powered by a 125 h.p. Menasco Pirate, with alternates Kinner, Warner, Ranger or Menasco D4-B.

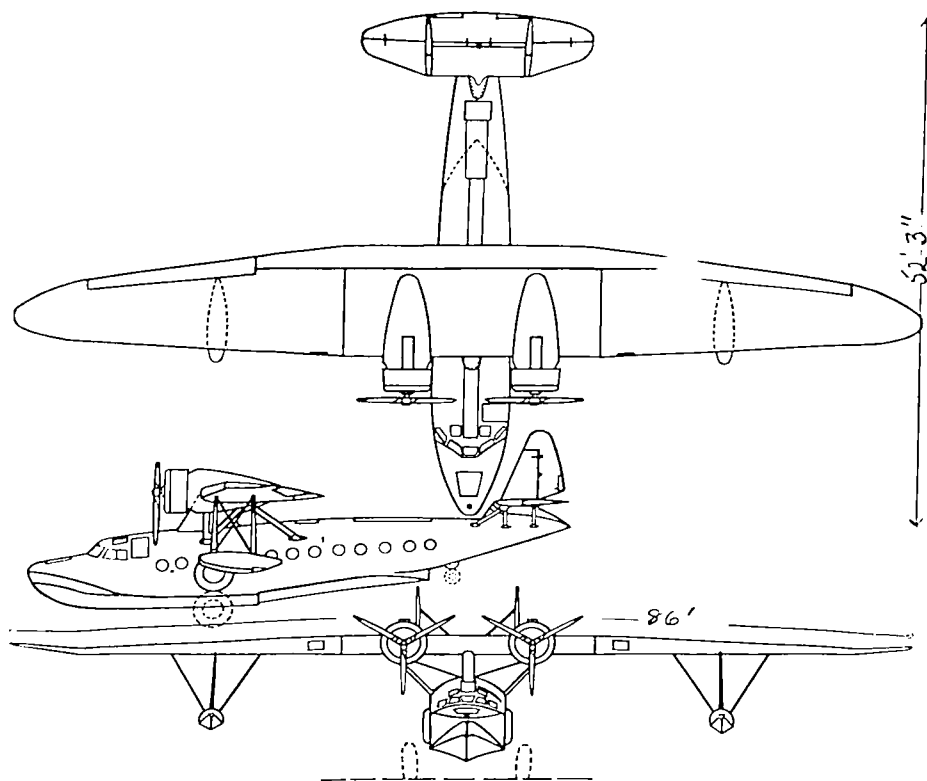
Vought-Sikorsky Aircraft Division of United Aircraft Corporation, Stratford, Conn., in 1940 completed an expansion begun the previous year, thus practically doubling its available floor space. Still another expansion was begun during 1940 and, when completed, this was almost to double again the previously-existing floor area. Similar increases in personnel were effected, raising total employment from 1,500 to 3,600 persons. Upon completion of its new facilities, Vought-Sikorsky expected to employ nearly 7,000 men and women and to have a total plant floor space of 630,000 sq. ft.

The activities at Vought-Sikorsky during 1940 consisted prin-



THE VEGA MODEL 35

This two-place primary-secondary trainer is available with a choice of engines in a horsepower range from 125 to 180.



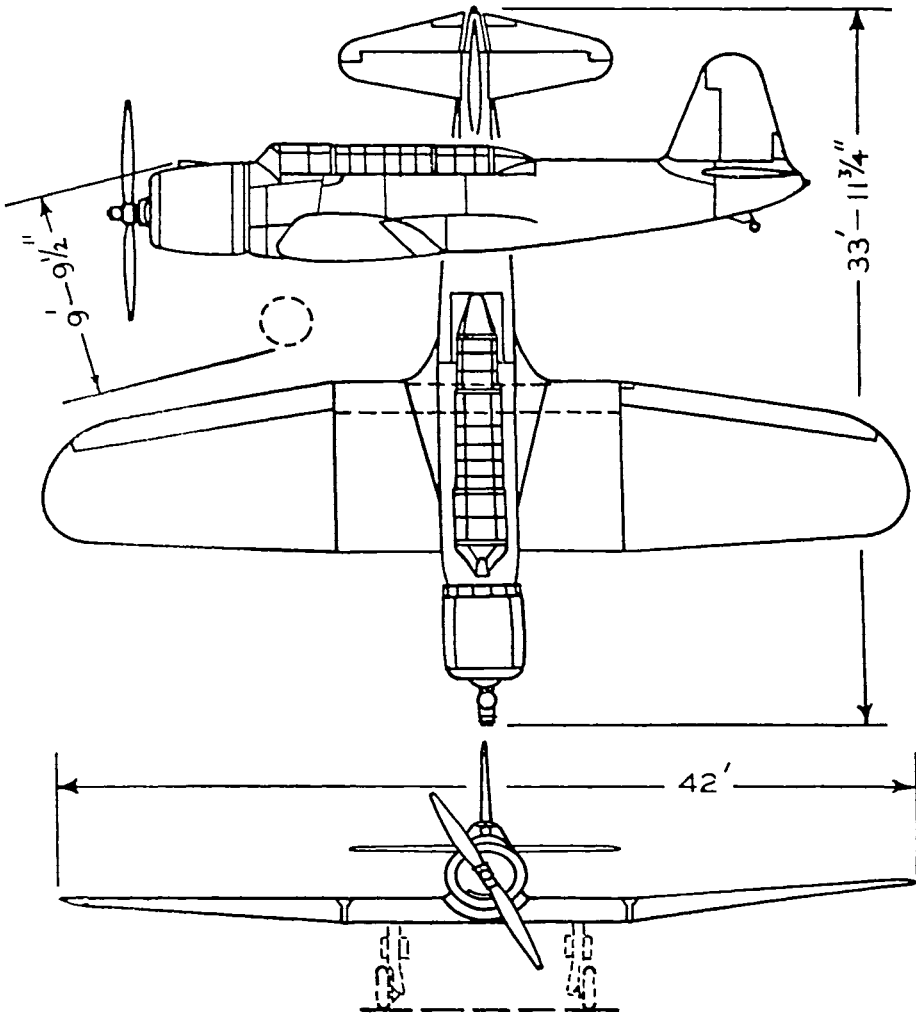
VOUGHT-SIKORSKY S-43

A 19-place amphibian powered with two Pratt & Whitney Hornets.

cipally of preparing for quantity production of airplanes for the U. S. Navy; completion of development on two new types of aircraft; manufacture of aircraft for the navies of the United States, England and France, and production of some commercial planes.

One of the two new types developed was the Vought XF4U-1 single-seat shipboard fighter, equipped with a Pratt & Whitney Double Wasp engine and a Hamilton Standard Hydromatic propeller. The Vought fighter underwent official Navy trials, in which it developed a high speed of over 400 m.p.h., according to the company. The Vought Fighter was a low-wing, all-metal monoplane of monocoque construction. It had a spot-welded fuselage, an inverted-gull type wing, and retractable landing gear.

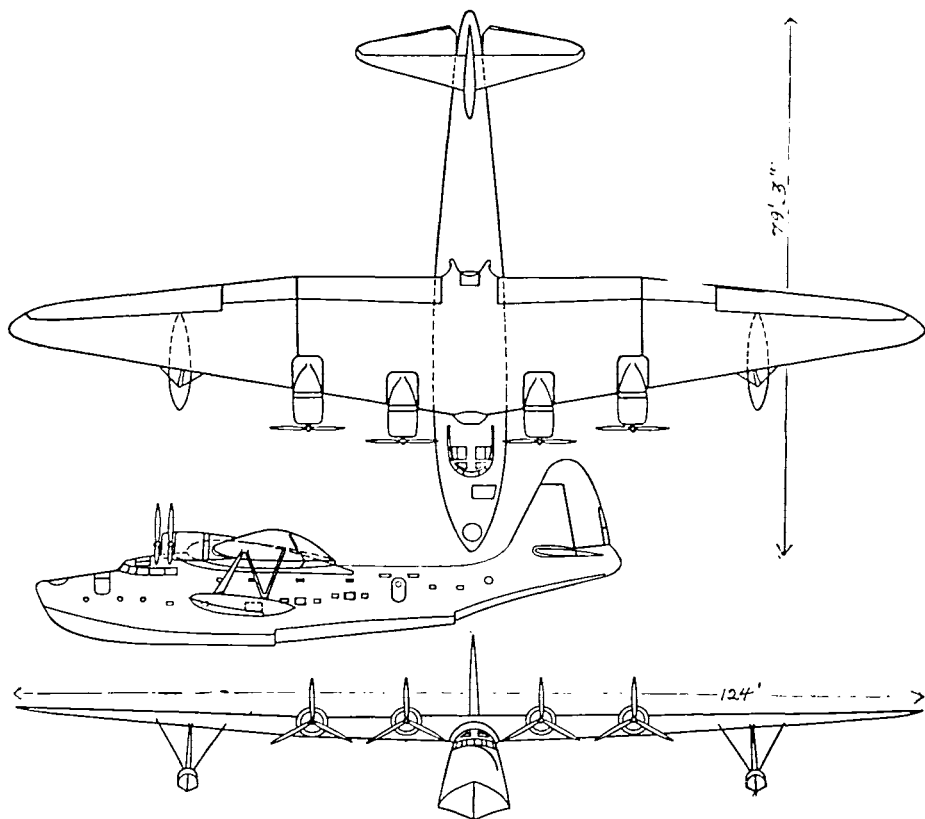
The other new type developed by Vought-Sikorsky was the Sikorsky VS-300 helicopter, an experimental rotating wing aircraft which in several hundred flight tests proved capable of rising straight



VOUGHT-SIKORSKY V-156

A two-place dive bomber with Pratt & Whitney Twin Wasp Junior 750 h.p. engine.

up from the ground, hovering motionless, flying forward, backward or sideways, and landing by vertical descent without any forward run. The helicopter was a single-place craft, equipped with a 90 h.p. air-cooled Franklin engine. The power developed by this engine was transmitted through a system of belts and shafts to drive a main rotor and three auxiliary rotors. The main rotor provided the forces necessary for ascent, descent, hovering, or level flight, while the



VOUGHT-SIKORSKY VS-44A

This 28 to 40 place ocean transport is powered with four Pratt & Whitney Twin Wasps.

auxiliaries governed the direction of flight. The VS-300 became the first successful main lifting rotor helicopter in the world and established the longest flight of a direct lift aircraft in the United States, it was believed, during its various flight tests. A record-making flight of the Vought-Sikorsky Helicopter VS-300-A, took place at Stratford, Conn., on April 15, 1941, with Igor I. Sikorsky at the controls of the ship. Mr. Sikorsky hovered over an area of less than an acre for 1 hour 5 min. 14.5 sec., after making a true vertical take-off with no ground run or angular climb. The descent and landing at the end of the flight were likewise vertical, with no glide or forward motion over the ground. This was the first officially recorded flight of the helicopter in the Western Hemisphere and it therefore established the first national record for this type of ship. The directing official of

the N.A.A. was William C. Zint of New York, and the two official witnesses were William H. St. John and Walter E. Goddard, of Stratford.

The gross weight of the ship at the time of the record flight was approximately 1,290 lbs. It had a three-bladed main rotor, 28 ft. in diameter, and three two-bladed auxiliary tail rotors, 92 in. in diameter. The pitch of all of the rotors was controllable, which provided control in flight. The power was transmitted in the experimental model through a multiple belt drive for purposes of flexibility in making alterations. Control was secured by the conventional throttle stick and rudder, plus a pitch control lever which governed the angle of attack of the main rotor blades.

The manufacturing activities at Vought-Sikorsky Aircraft during 1940 were devoted primarily to Vought SB2U-2 and SB2U-3 scout dive bombers and Vought OS2U-1 and OS2U-2 observation-scouts, all for the U. S. Navy, as well as Vought VS-156-F2 scout dive bombers for the French Navy and Vought VS-156-B1 scout dive bombers for the British Navy. Two Sikorsky S-43 commercial amphibians also were built for the Royal Dutch East Indies Airways.

The Vought scout dive bombers produced for the U. S. Navy were similar or improved versions of the SB2U-2 monoplanes already in service. Those built for the British and French navies were of the 2-place, low-wing, internally braced monoplane type, each equipped with a Pratt & Whitney Twin Wasp Junior engine and a Hamilton Standard constant speed propeller.

The Vought OS2U-1 and OS2U-2 observation scouts for the U. S. Navy were of the low-wing monoplane type, with metal monocoque fuselage employing extensive spot-welding. Each plane was powered with a Pratt & Whitney Wasp Junior engine and a Hamilton Standard constant speed propeller. They were convertible either as land planes or single-float seaplanes, but their main function was as seaplanes operating from battleship and cruiser catapults, and acting to direct gunfire or conduct long-range observation-scouting missions. More than 1,000 airplanes of this class were on order for the U. S. Navy.

In connection with its 1940 manufacturing activities, Vought-Sikorsky instituted a plan of subcontracting as much work as possible, and entered into agreements under which the Briggs Manufacturing Company began to make wings and Fleetwings, Inc., started to supply tail surfaces for Vought-Sikorsky airplanes.

In the field of commercial production, the two Sikorsky twin-engine S-43 amphibion transports delivered to K.N.I.L.M. were of the



#### VULTEE EXPANSION FOR DEFENSE

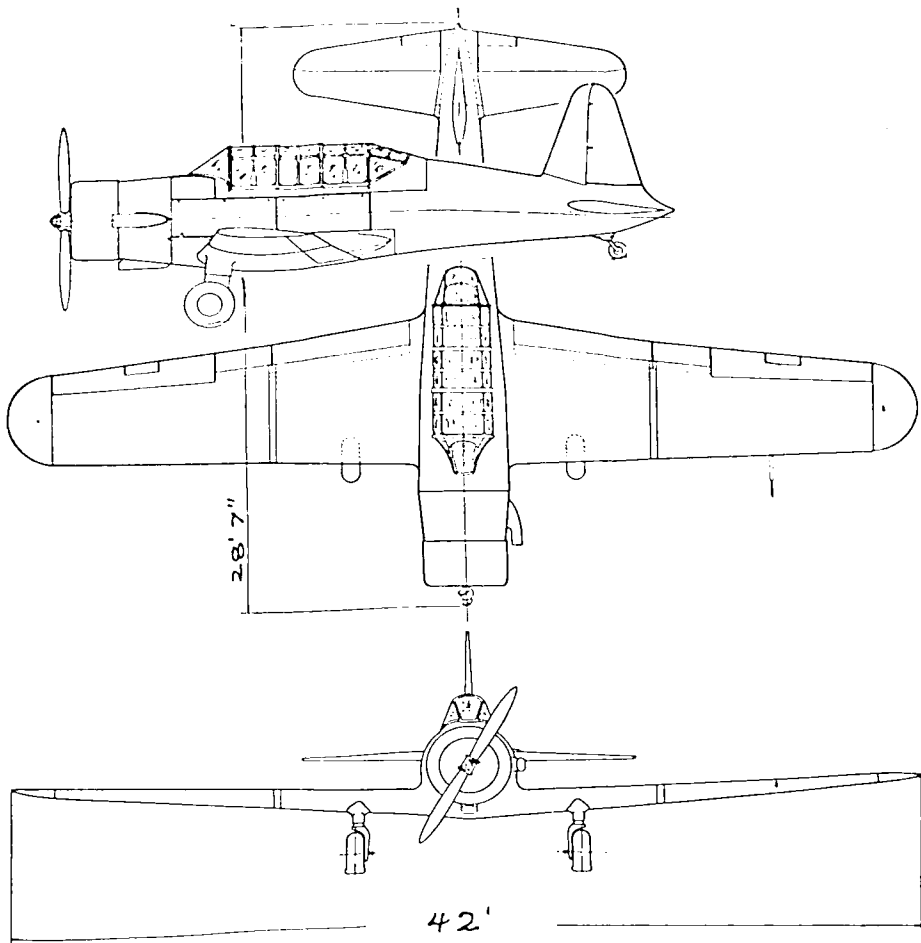
View of the large plant at Downey, Calif., one of the three factories of Vultee Aircraft, Inc.

latest twin-tail type. They were equipped with Hamilton Standard Hydromatic propellers.

Construction of the three long-range Sikorsky VS-44-A flying boats for American Export Airlines was in process during the year. The VS-44-A was the commercial version of the U. S. Navy's big Sikorsky patrol bomber and was a 4-engine, high-wing, cantilever monoplane with a semi-monocoque hull, the construction being of metal throughout. Equipped with four Pratt & Whitney Twin Wasp engines and Hamilton Standard Hydromatic propellers, it was designed to have every modern improvement, including accommodations for 16 overnight passengers and a crew of 11, plus a substantial load of mail and express. To meet modern requirements for transoceanic operation, the VS-44-A was to have a range of 3,800 mi. at a speed of 150 m.p.h., carrying a payload of 5,000 lbs.

Vultee Aircraft, Inc., Downey, Calif., during 1940 included production of basic trainers and private planes, the fabrication of parts for attack bombers, and preparatory work for the production of pursuits, bombers and observation-liaison planes. At the Vultee Field, Calif. Division, production centered around the BT-13, a basic trainer for the U. S. Army Air Corps. This trainer, known as the Valiant was a 2-place, single engine, low-wing monoplane, powered with a Pratt & Whitney Wasp Junior engine developing 450 h.p. An order for 300 of those trainers had been placed by the Air Corps in September, 1939, and by the end of 1940 only a few units remained



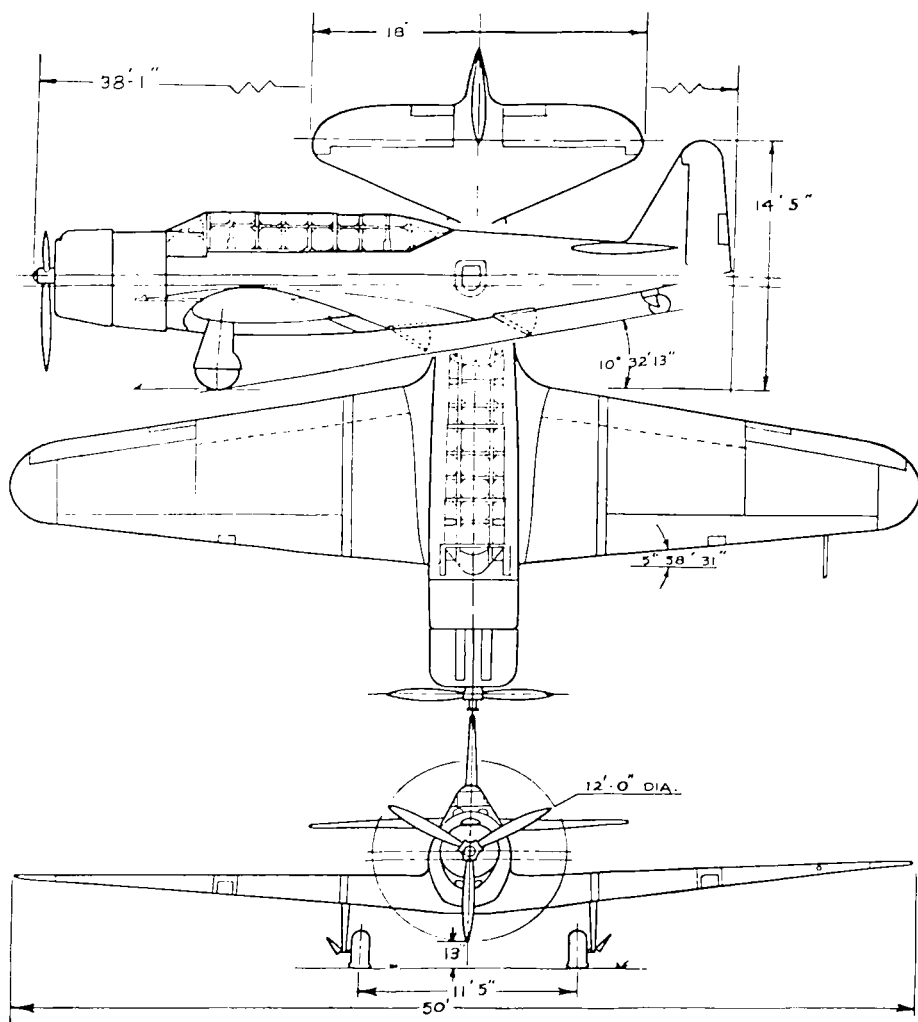


VULTEE VALIANT 54

A two-place basic trainer with Pratt & Whitney Wasp Junior 450 h.p. engine.

to be completed. During 1940 the Vultee Field Division also completed the fabrication of parts for attack bombers to be assembled in a foreign country. These bombers, known as V 12C and V 12D, were 3-place, single engine, low-wing monoplanes, incorporating tremendous firepower.

In August 1940, Vultee purchased the Stinson Aircraft Division of Aviation Manufacturing Corporation, with plants at Nashville, Tenn., and Wayne, Mich. The Nashville plant was being used by Vultee as a nucleus for greatly expanded facilities for military plane

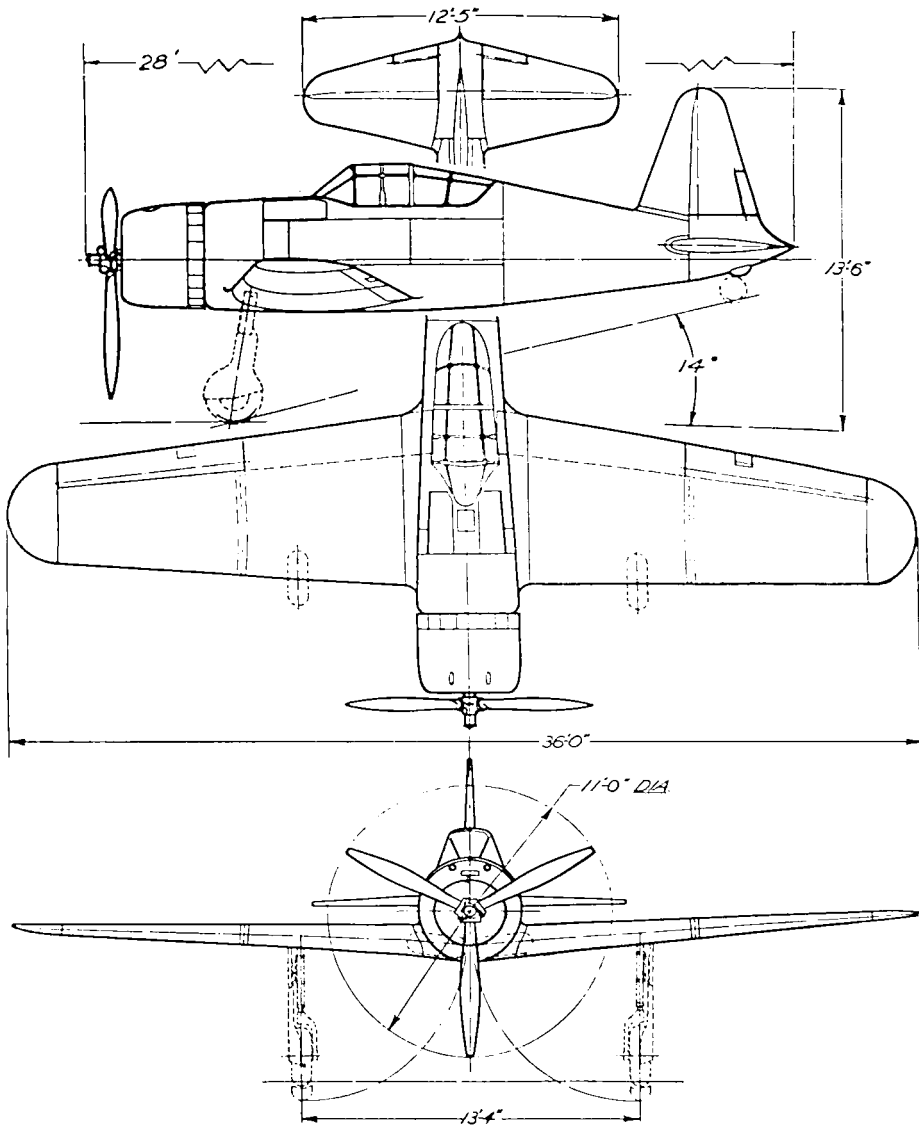


VULTEE ATTACK BOMBER

A 1,600 h.p. Wright Cyclone engine powers this model V-12D.

manufacture, and the Wayne plant was continuing with the production of private planes. (see Stinson.)

During 1940 the plant facilities of Vultee were greatly expanded. The company had 273,800 sq. ft. of space available at the beginning of the year. By the end of 1940, the area had been increased to 1,025,000 sq. ft., a rise of 239 per cent. When the expansion program was completed in April, 1941, the total facilities were 1,795,000 sq. ft. at the three Vultee Aircraft divisions.

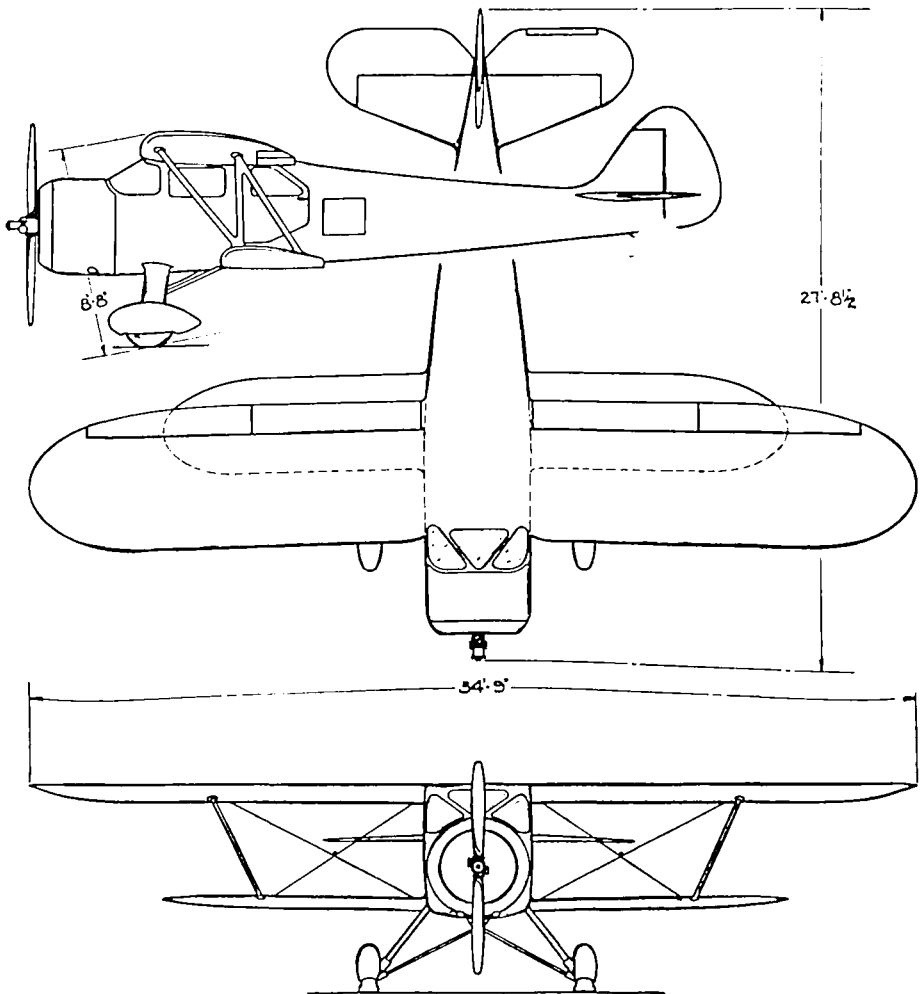


VULTEE VANGUARD

A one-place pursuit powered with a 1,200 h.p. Pratt & Whitney Twin Wasp engine.

Company personnel figures also rose sharply. At the beginning of 1940 there were 1,255 employees on the payroll, and by December 31 this number had increased to 6,800. Total employment at the three divisions was to be approximately 17,000 late in 1941.

In January, 1941, Vultee delivered to the Air Corps the final unit of

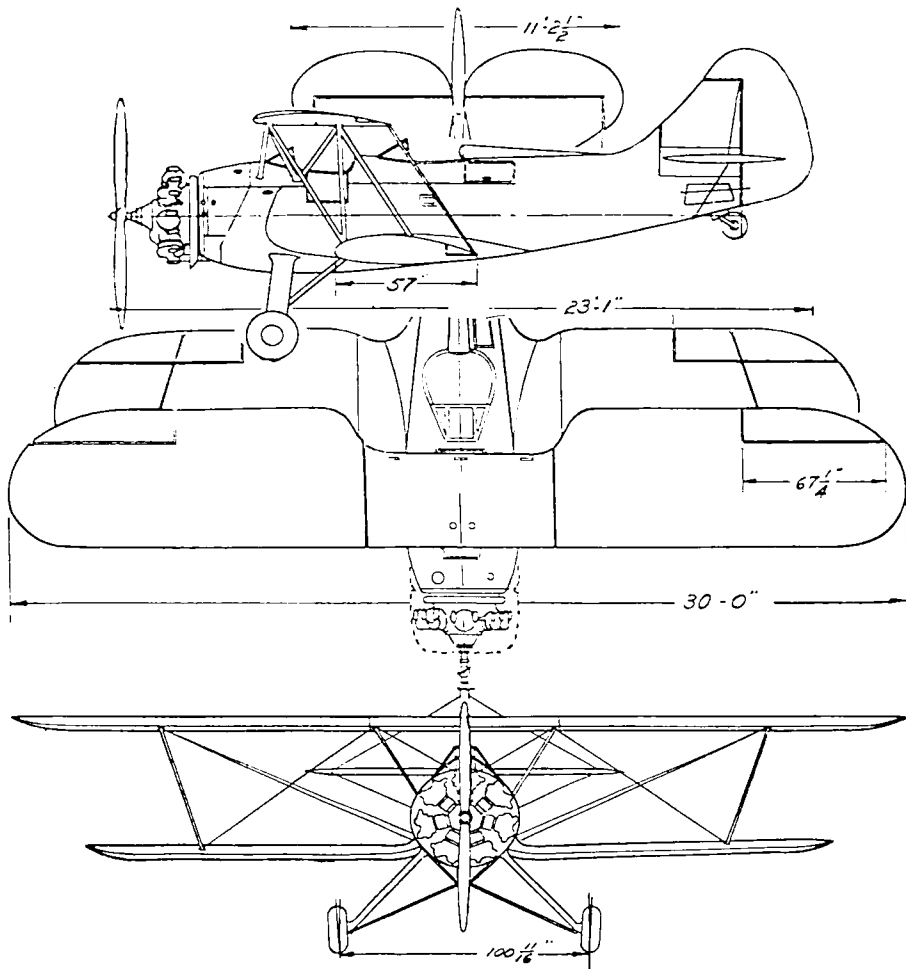


WACO MODEL E

A four-five place plane with a choice of Jacobs, Lycoming, Pratt & Whitney or Wright engine, ranging from 300 to 420 h.p.

an order for 300 basic trainers, completing the contract ahead of schedule. Production commenced immediately on a new order for trainers, known as the BT-15, basically the same as the BT-13, but powered with a Wright engine. This trainer was manufactured at the Vultee Field Division, and improved mass production methods increased output of this one model alone to 250 planes per month.

Production also commenced on an order for pursuits for the Canadian Government. This plane, known as the Vanguard P-48, had



WACO MODEL F-7

A two-place military trainer with a choice of Continental, Jacobs or Lycoming engines of 220 or 225 h.p.

a span of 36 ft. and was a single-engine low-wing monoplane. It was powered by a Pratt & Whitney Twin Wasp engine developing 1,200 h.p.

The Nashville Division began production of an observation-liaison plane for the Army Air Corps, the O-49, the export version being known as the Vigilant O-74. It was a 2-place, single-engine, high-wing monoplane of metal construction, mainly fabric-covered. It was powered by a 9-cyl. Lycoming engine developing 285 h.p.

The Stinson Division continued the production of private planes,

concentrating on the Stinson Voyager, and also completed a 125 h.p. artillery observation-liaison plane, incorporating tandem seating arrangement, plexiglas dome and full span slots.

Early in 1941, Vultee produced an original model dive-bomber, Vengeance, incorporating several new design and auxiliary features calculated to make it one of the fastest and most efficient dive-bombers in the world.

The Waco Aircraft Company, Troy, O., in 1940 was in production on its Model E Aristocrat and Model S cabin plane for the private owner. During the latter half of the year, however, Waco concentrated largely on production of the Model UP-F-7 (Air Corps YPT-14) trainer for flying schools operating under the CPT program. The trainer was for advanced classes. Waco produced 286 planes in 1940. A number of small Government contracts also were completed as were several subcontracting orders. The plant was rearranged to permit greater production. Quantities of machine tool and power equipment were installed. The company's policy was to maintain intact its large dealer and distributor organization while contributing in every possible way to the defense program.

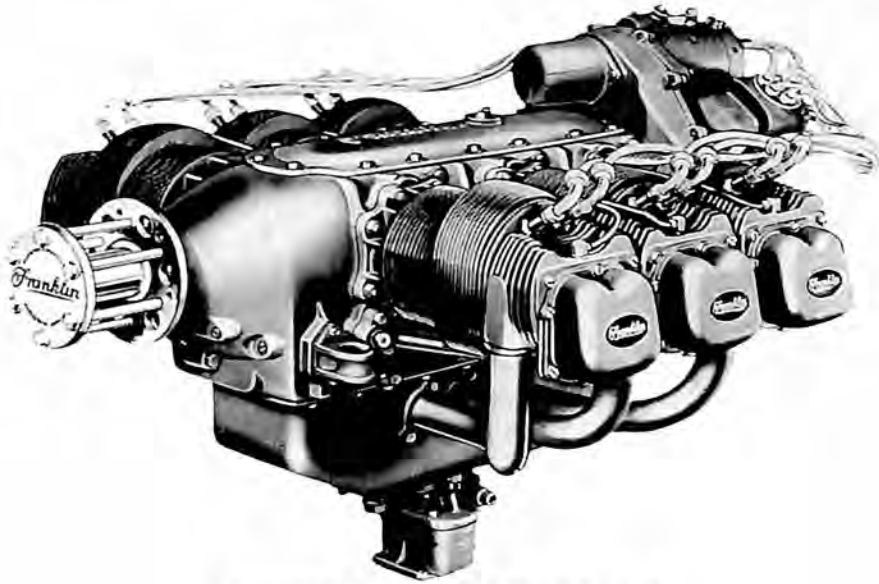
#### Aircraft Engine Manufacturers

Aircooled Motors Corporation, Syracuse, N. Y., was incorporated under the laws of New York State in January, 1936, under its old name of Doman-Marks Engine Company, Inc. It claimed to be the oldest engineering group producing aircooled engines, especially pressure aircooled engines, in the United States.

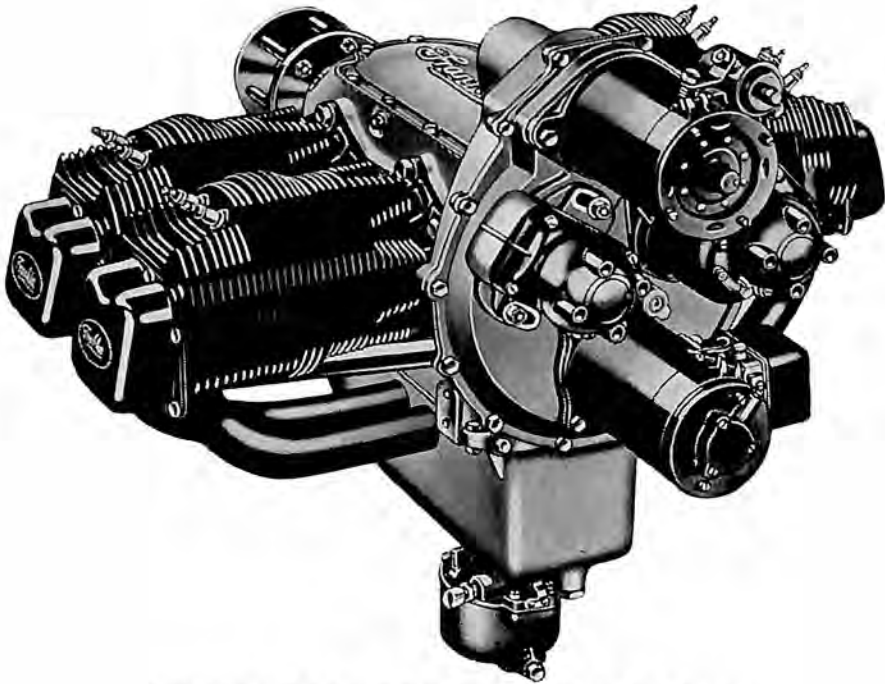
Many of the present key personnel of Aircooled Motors Corporation are former Franklin employees, who brought to this company their 40 years of aircooled motor experience. In 1937 new capital was obtained. The company acquired all the patents, the trade name, trade mark and good will, and changed its corporate name to the Aircooled Motors Corporation, applying the name Franklin to all engines of its design and manufacture.

From 1936 to 1940, inclusive, the company produced 6,300 engines from 45 to 100 h.p. It was in production on five models of aircraft engines with a range of 65, 80, 90, 120 and 130 h.p. The Franklin 65, 80 and 90 h.p. engines were 4-cyl. horizontally opposed, aircooled engines, the first two displacing 176 cu. in. and the latter displacing 199 cu. in. The Franklin 120 and 130 h.p. models were 6-cyl. horizontally opposed, aircooled engines displacing 264 and 298 cu. in., respectively.

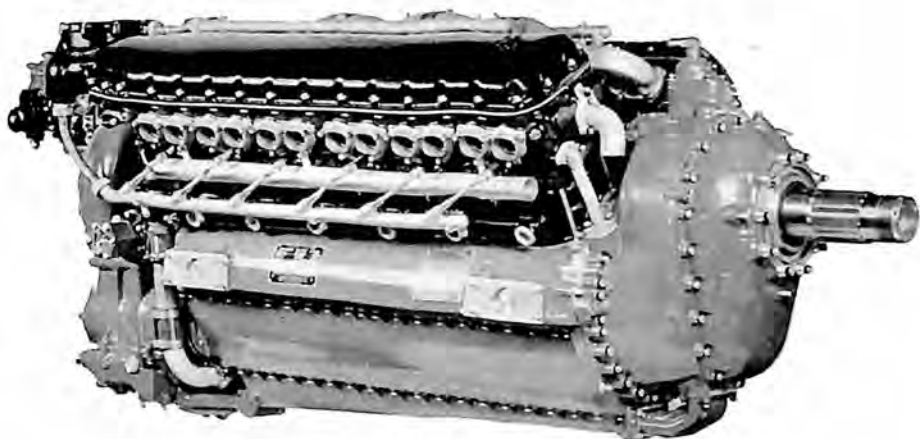
Allison Division, General Motors Corporation, Indianapolis, Ind., took on an extensive expansion program typical of the entire aircraft



AIRCOOLED FRANKLIN 6AC-298-F3



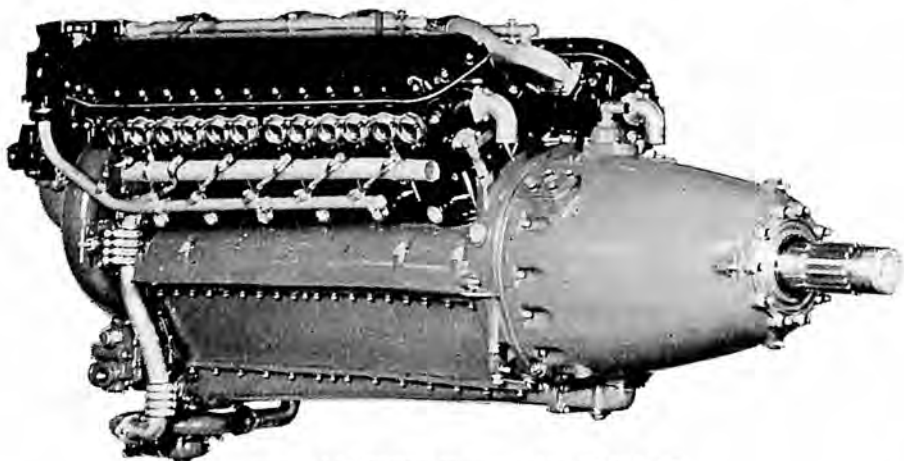
AIRCOOLED FRANKLIN 80 AND 90 H.P. ENGINE



ALLISON V-1710 F ENGINE

industry in 1940. These activities followed two broad directions of effort: first, expansion of production facilities and ability to produce in continually increasing quantities; second, expansion of engineering activities to provide for ability to produce, and in addition, also, provide for the increased tempo of development work made necessary by the new types of airplanes required and the early obsolescence caused by the intensive use of all aviation products under wartime conditions.

The initial direction of accelerated engineering activities was to provide for large production of the 12-cyl. V-type liquid-cooled engine in several different models. Different models were necessary to pro-



THE ALLISON V-1710-C15 ENGINE





ALLISON V-1710 E ENGINE

With separate gear box and extension shaft as used on the Bell Airacobra. The separate gear box permits shooting a cannon through the propeller hub.

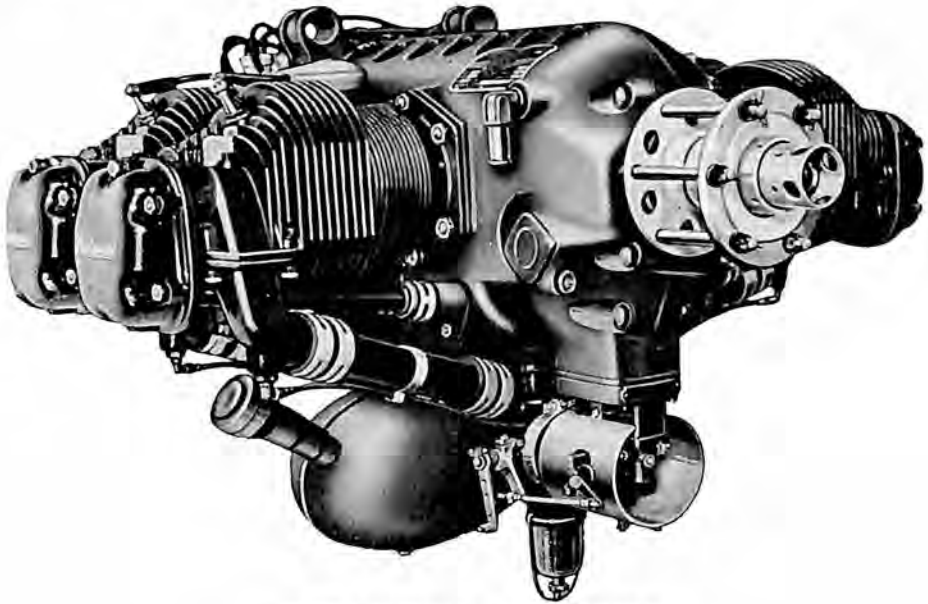
vide for the individuality and originality of fighter plane designs brought about by mandatory war requirements that certain types of fighter airplanes had to have a top speed of 400 m.p.h. or better to attain a superior military position. Prior to the defense program, aircraft engines had not been built in sufficiently large quantities to permit the extensive tool, gage and jig equipment that was necessary for production of thousands of engines under the program. Facilities for drawings, detailed specifications, manufacturing control and production routine had to expand rapidly to take care of the many thousands of detailed items which were required many months in advance of actual output.

At the beginning of 1940, Allison had in use 90,000 sq. ft. of floor space although 350,000 was under construction at that time. At the end of the year approximately 1,200,000 sq. ft. of floor space was available with well over half of that area in active use and the remainder being equipped with machinery as rapidly as it became available.

The personnel was increased to over 7,500 employees at Indianapolis, with 1,750 people at the Cadillac Division in Detroit, where approximately 140,000 sq. ft. of manufacturing space, with new machinery in operation on Allison engine parts. In addition, a new aluminum foundry was built and equipped at Delco-Remy Division at Anderson for the production of part of Allison's heat-treated aluminum alloy casting requirements. The Allison program called for 1,000 engines a month by late 1941, from the 350 a month level at the beginning of the year. It was to require personnel at the Indianapolis, Detroit, and Anderson plants of approximately 14,000 persons. All Allison's activities were devoted to the defense program. Supervisory and key personnel was obtained to a large extent from other General Motors organizations.

The experience of that trained personnel enabled Allison not only to meet the production demands but also develop new methods to perfect and improve the quality of engines produced.

An expanded program of continually proof-testing the many parts



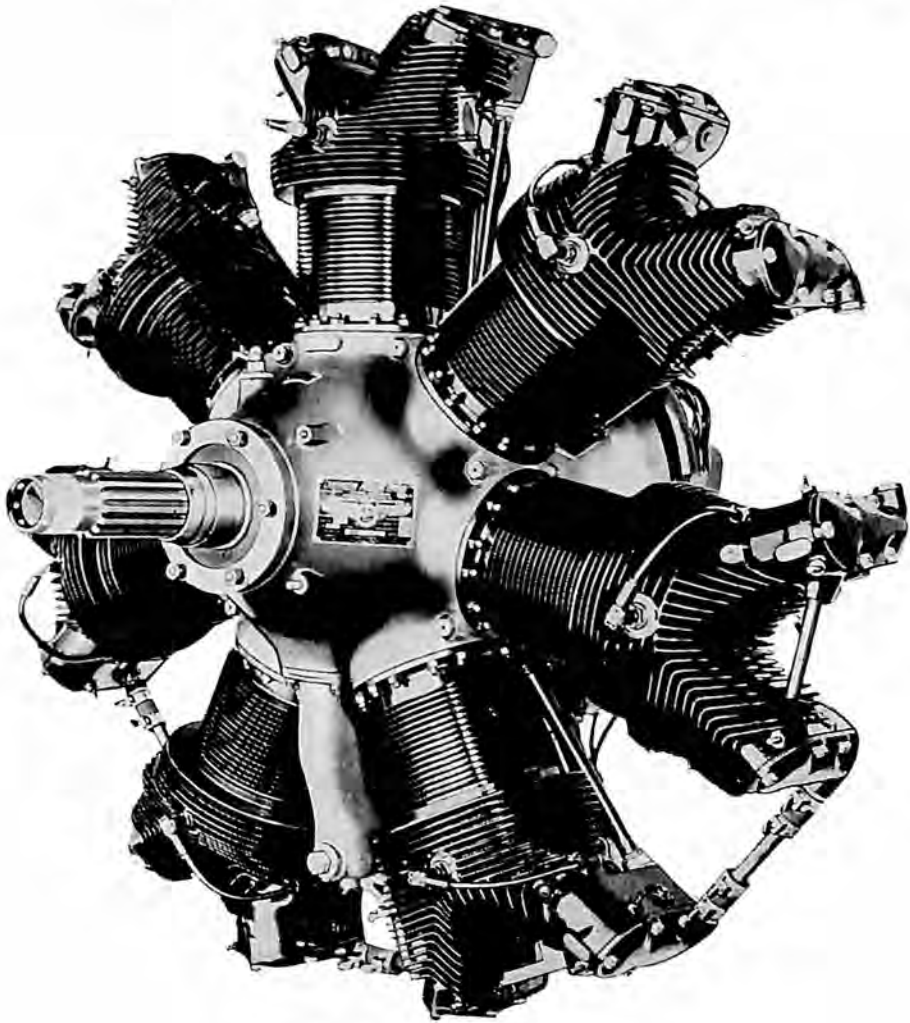
THE CONTINENTAL ENGINE

was adopted. Such a program permitted making minor modifications to facilitate production without the long delays of flight testing.

During 1940 accelerated tests were carried on with completely equipped airplanes. These planes were put into service to accumulate the maximum flying hours and military performance in the shortest period of time.

Other developments provided for higher altitude ratings of engines through the use of improved gear-driven superchargers. Work also was continued on designs to further the use of engines with extension shaft drives and various types of special reduction gears. Such extension shafts permitted locating the engine in the airplane quite independent of the propeller, thus resulting in more effective use of desirable armament, as well as providing more compact and more maneuverable, high-speed airplanes. A current example of the use of such a design was the Bell P-39, which in addition to the regular machine guns, carried a long-range cannon which fired through the axis of the propeller. This was made possible by the use of a separate gear box which became practically a part of the airplane nose structure. This separate gear box was driven by the engine by means of an extension shaft rotating at crankshaft speed.

A new engineering building, completely air-conditioned and acoustically treated for sound control was put into operation. The experi-

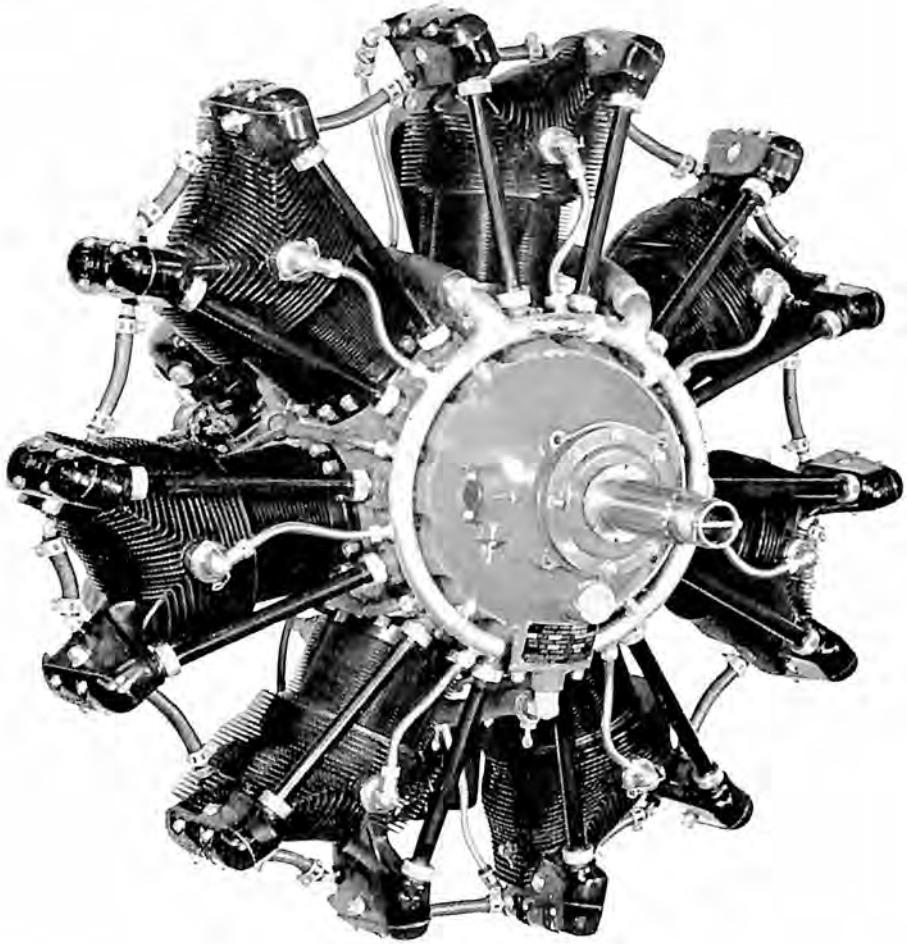


THE CONTINENTAL W-670

mental machine shop and test facilities that were a feature of the engineering department were expanded.

Military experience pointed to the necessity of faster and longer range airplanes, and Allison felt that the intensive development work on liquid-cooled engines would continue to grow at an increasing scale.

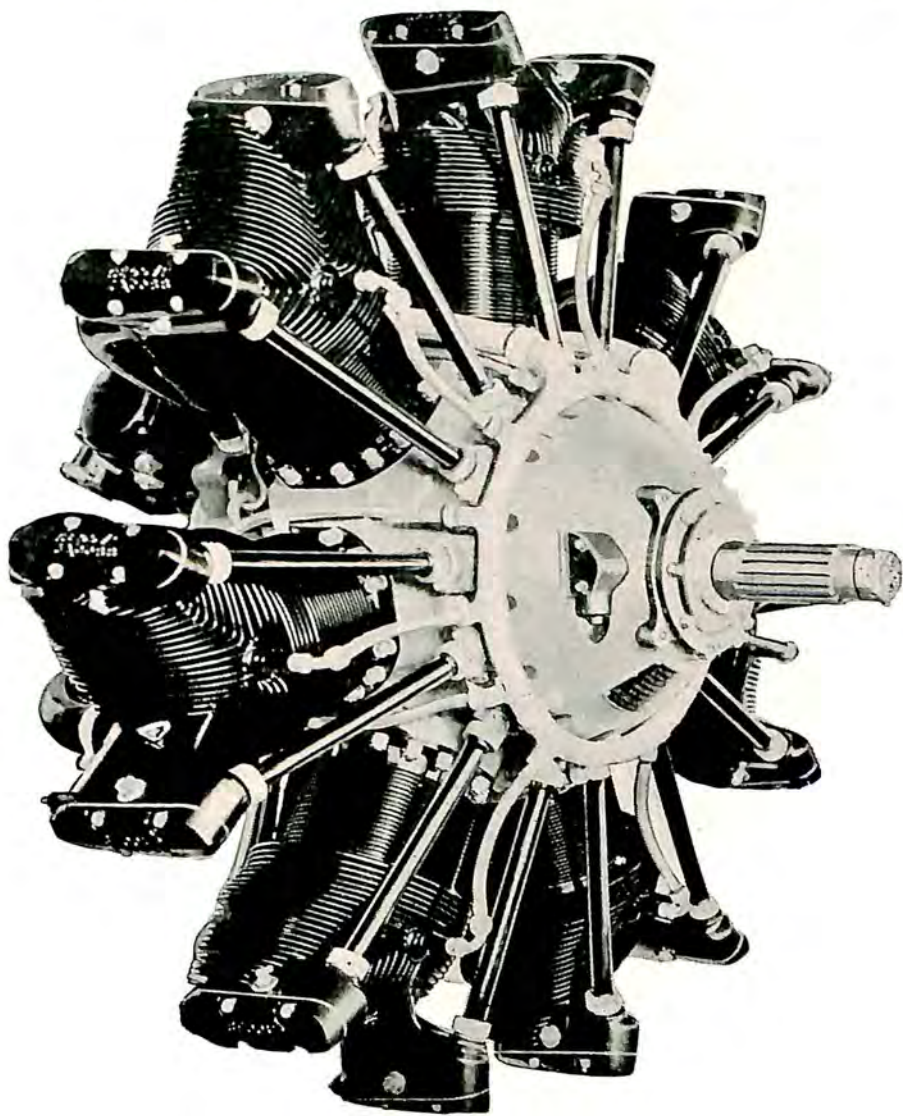
Continental Motors Corporation, Muskegon, Mich., extended the power range of its A engine to 80 h.p., making the A type available with ratings of 50, 65, 75 and 80 h.p. Continental also developed an



JACOBS L-5MB ENGINE

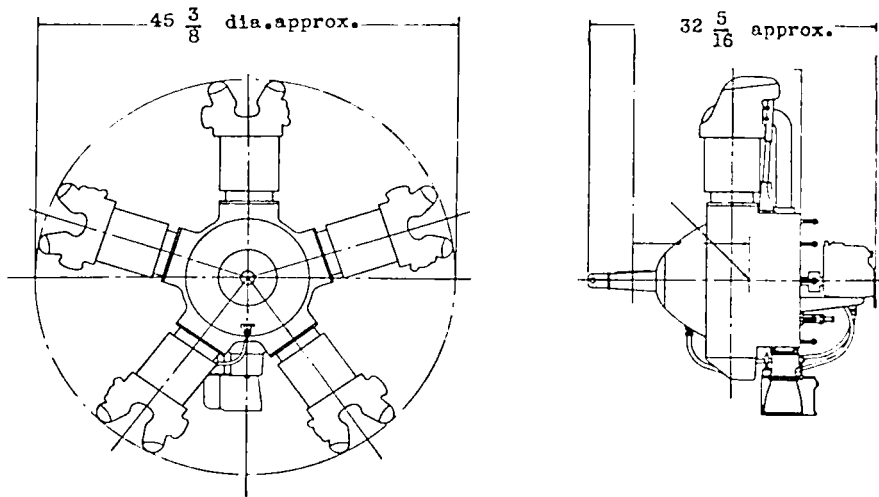
"exclusive" fuel injection system for the A engine. The fuel injector replaced the conventional carburetor, eliminated carburetor icing troubles, increased fuel economy, reduced fire hazards, permitted fast warm-up, and through its more uniform distribution of fuel added greatly to smoothness of operation. The Continental W670 aircraft engine carried no major design changes, but continued to live up to its long established reputation for dependable and economical operation in trainer planes and commercial aircraft.

Jacobs Aircraft Engine Company, Pottstown, Pa., continued production of its L-4, L-5 and L-6 series, 7-cylinder, aircooled, radial



JACOBS L-6MB ENGINE

engines. The MB models were equipped with one Scintilla magneto and one Scintilla battery distributor, while the M models carried two Scintilla magnetos. All models carried an Eclipse 15-ampere generator as standard equipment and could be equipped with various combinations of extra accessories, including direct electric starter, fuel



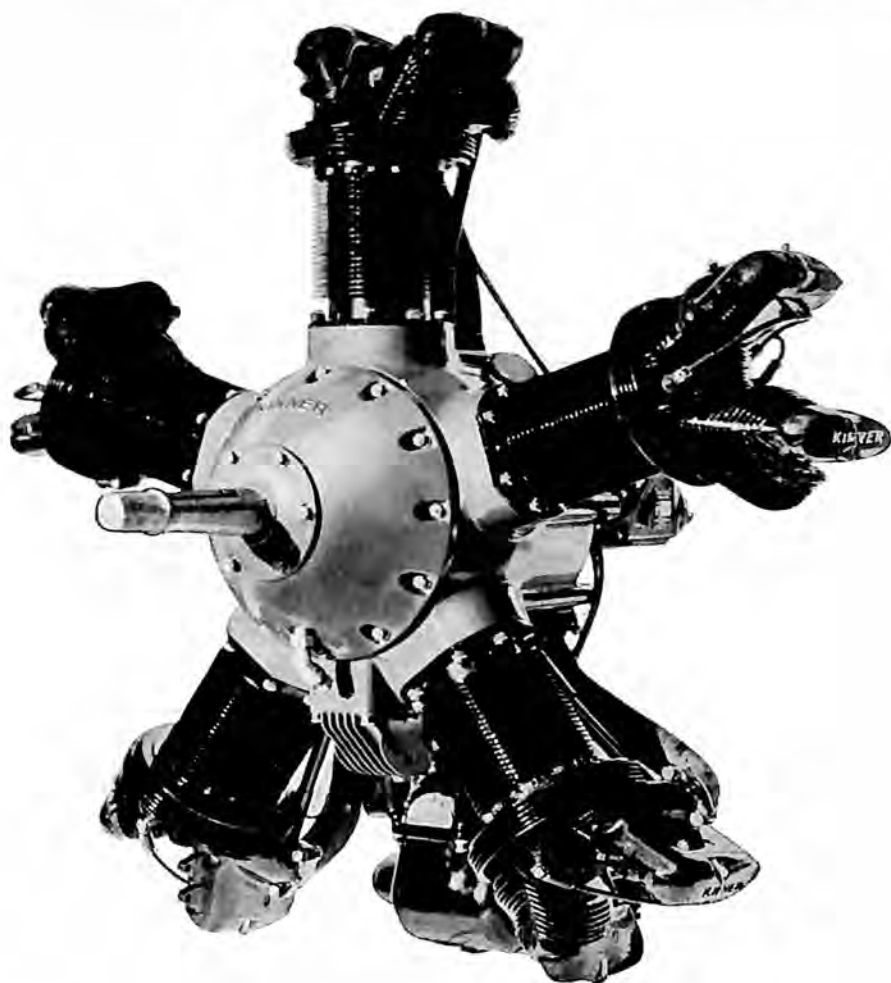
KINNER B-5 AND K-5

Model K-5 is rated at 100 h.p. and the B-5 at 125 h.p. Both are five-cylinder radial aircooled engines.

pump, vacuum pump, hydraulic pump and machine gun synchronizer. All models could be equipped for fixed pitch, controllable or constant speed propellers. All models had sodium filled exhaust valves, forged aluminum pistons and four crankshaft bearings, two roller and two ball. All crankcase sections were magnesium alloy castings, except the front half of the main crankcase which was an aluminum casting. No basic changes were introduced during the year, though various design improvements were incorporated in all models.

A new model of the Jacobs L-4 series incorporated automatic valve gear lubrication and other modifications to comply fully with the latest Army-Navy specifications, and the company received a contract from the Air Corps to supply a quantity of that new model for installation in Stearman PT-18 primary trainers.

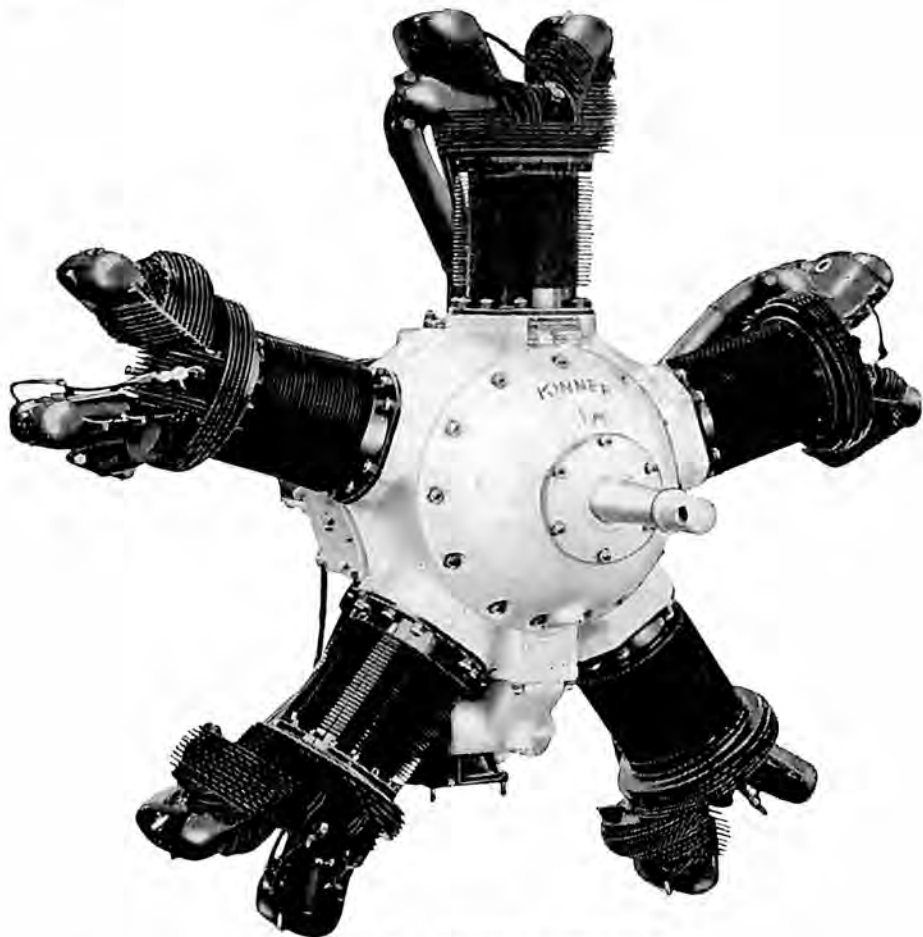
Kinner Motors, Inc., Glendale, Calif., a new company with new policies, was organized in January, 1939, for the purpose of purchasing the name and business of the former Kinner Airplane & Motor Corporation, Ltd. In July, 1939, Kinner Motors, Inc., took over the operation of the corporation. During 1940, the new Kinner B-54 125 h.p. engine was granted approval by the Civil Aeronautics Administration. This engine incorporated all latest improvements by Kinner engineers, including a No. 10 spline crankshaft. In addition to the customary test for A. T. C., the engine successfully passed the Army



KINNER B-5 R SERIES 2 ENGINE

Type Test at Wright Field, Dayton, O. That engine was used to power Ryan Primary Trainers purchased by the U. S. Government for training purposes.

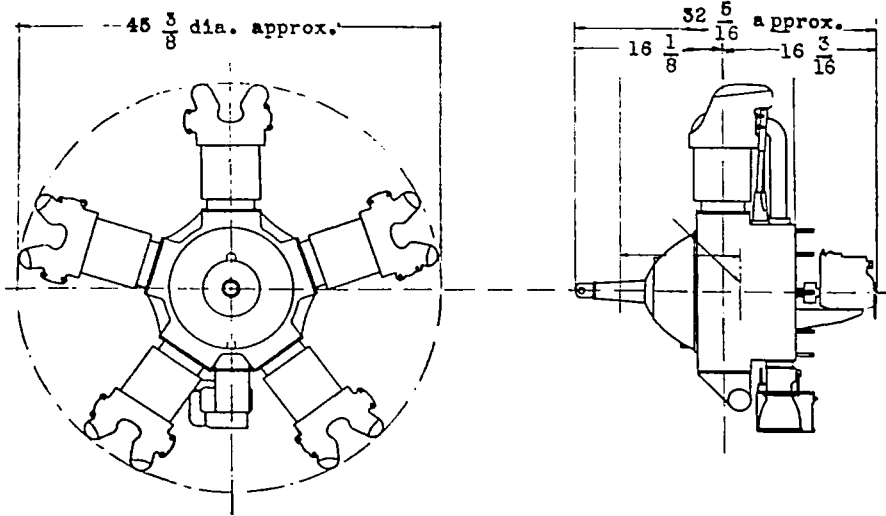
During the year Kinner also received an order for 509 of its B-5 model engines to be delivered to Canada for use in Fleet training planes. They were used as standard equipment for training pilots under the British Commonwealth Air Training Plan. The order referred to was partially filled in 1940 and was to be completed by March, 1941. A total of 511 engines was produced during 1940.



KINNER R-5 SERIES 2 ENGINE

Lycoming Division, Aviation Manufacturing Corporation, Williamsport, Pa., manufacturers of aircraft engines and hollow steel propeller blades, continued production on the R-680-E Series 265 to 300 h.p. engines, the R-680-D Series 245 to 260 h.p. and R-680-B41 225 h.p. 9-cyl. radial aircooled engines. Lycoming also continued production on the O-145 Series 50, 55, 65 and 75 h.p. 4-cyl. horizontally opposed aircooled engines for the light plane field. In addition, Lycoming, late in 1940, announced 4 new direct-drive engines of higher horsepower, two 4-cyl. and two 6-cyl. horizontally opposed aircooled engines of 100 and 125 h.p. and 150 and 175 h.p. The new Series were designated as Lycoming O-235, 100 h.p. and Lycoming O-290, 125 h.p., O-350, 150 h.p. and O-435, 175 h.p. series. The new 6-cyl.



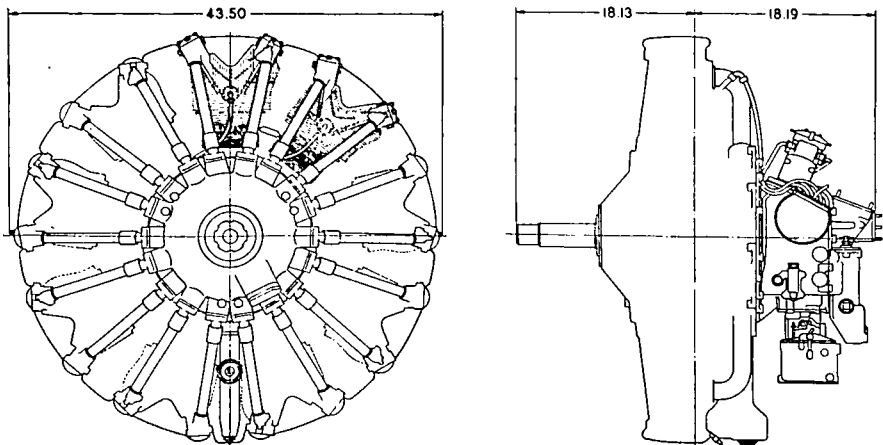


KINNER R-5

This five-cylinder aircooled radial engine is rated at 160 h.p.

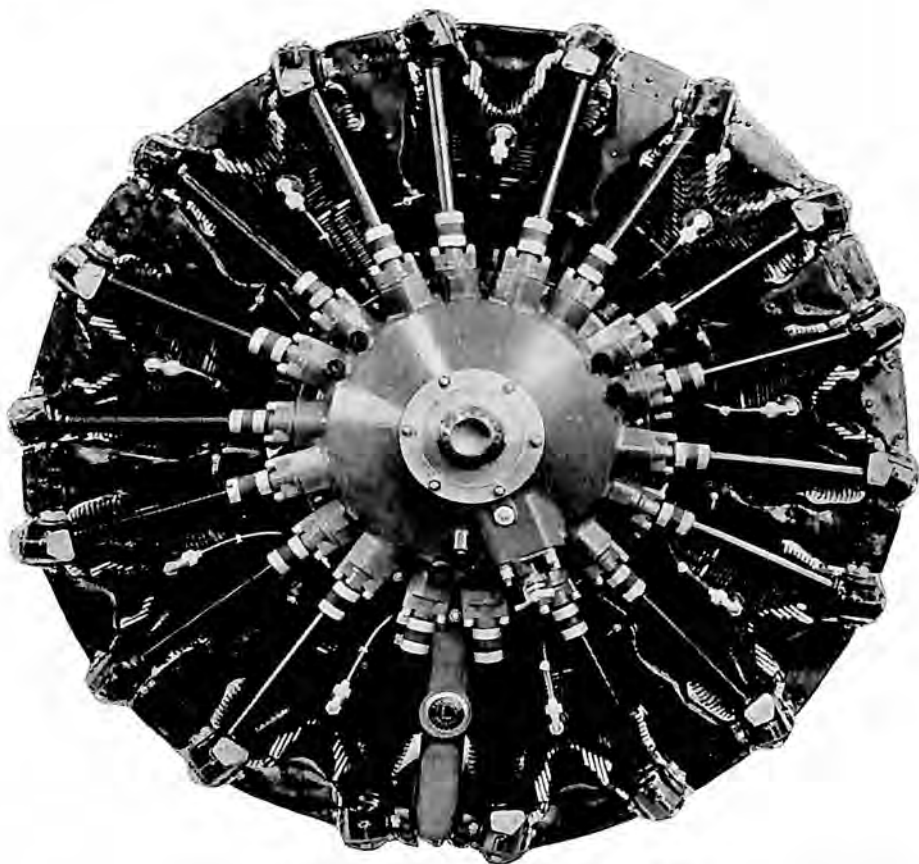
power plants had the same basic specifications as the new 4-cyl. engines excepting displacement.

With the addition of these higher horsepower engines, Lycoming offered plane manufacturers a power range of from 50 to 175 h.p. in engines of the horizontally opposed, aircooled type.



LYCOMING SERIES R-680-D AND R-680-E

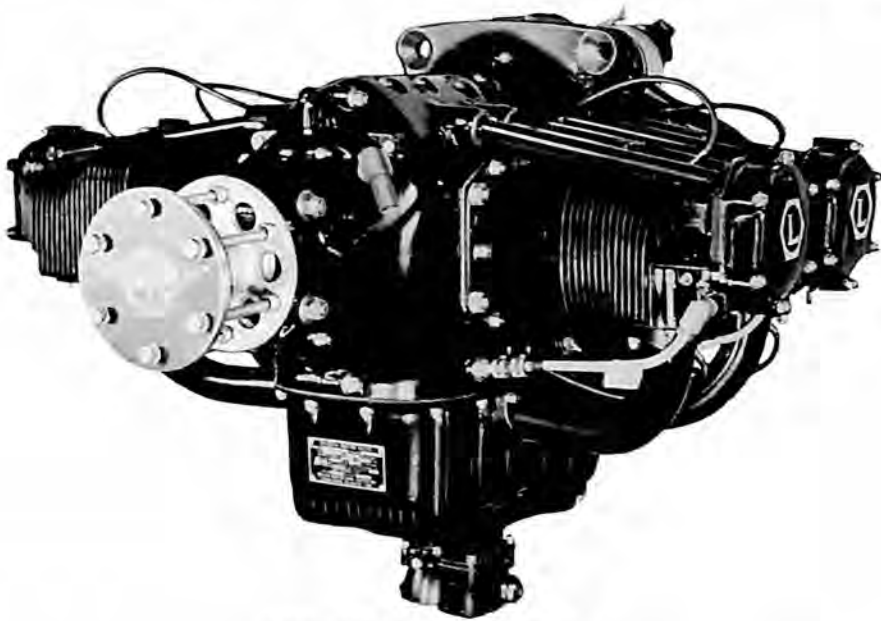
A nine-cylinder radial aircooled engine; D models are rated 240 to 260 h.p. for take-off; and E models are rated 280 to 300 h.p. for take-off.



LYCOMING SERIES R-680-D and E

The new Lycoming horizontally opposed engine in the higher horsepower brackets was a logical outcome of the lower manufacturing and maintenance costs of this cylinder arrangement. Both 4 and 6 cylinder models lent themselves particularly well to latest plane designs for both commercial and military training planes.

Careful consideration was given in designing the engines to obtain a maximum of interchangeability of parts from the standpoint of production and servicing. The stroke of all the engines was the same, being  $3\frac{7}{8}$  in. The bores of the 100 h.p. 4-cyl. and 150 h.p. 6-cyl. were both  $4\frac{3}{8}$  in., while the bores of the 125 h.p. 4-cyl. and 175 h.p. 6-cyl. were also the same, being  $4\frac{7}{8}$  in. This permitted interchangeability of cylinder assemblies as well as many other parts on engines having the same bore. Crankshafts on the 4-cyl. models were interchangeable, while the same was true of the crankshafts

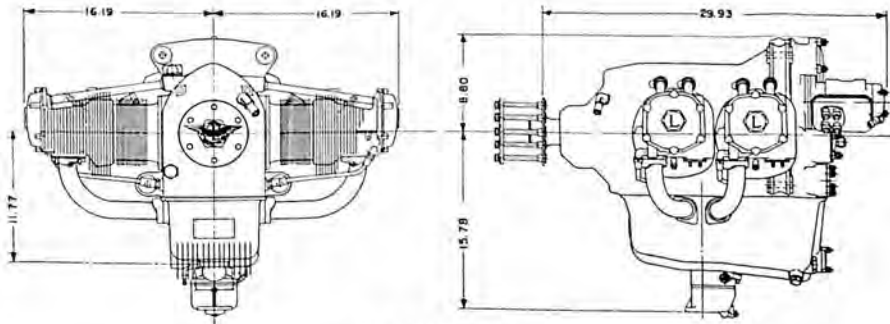


LYCOMING O-235 AND O-290

on the two 6-cyl. models. All connecting rods on both 4 and 6-cyl. engines also were interchangeable.

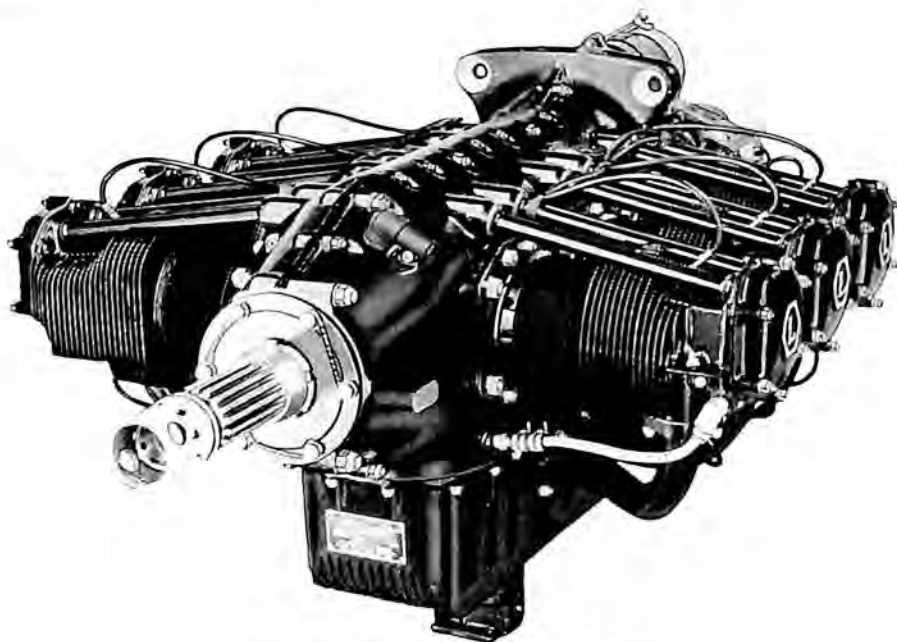
The Lycoming O-235, 100 h.p., the O-290, 125 h.p. and the O-350, 150 h.p. developed their rated horsepowers at 2,550 r.p.m. while the O-435, 175 h.p. engine developed its rated horsepower at 2,350 r.p.m.

Lycoming R-680-D, 260 h.p. engines installed in Stinson Reliants



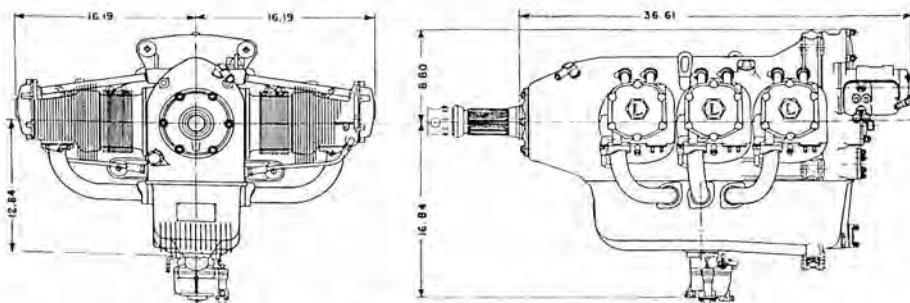
LYCOMING O-235

A four-cylinder horizontally opposed aircooled engine rated at 100 h.p. at 2,550 r.p.m. Model O-290 is rated at 125 h.p. at 2,550 r.p.m.



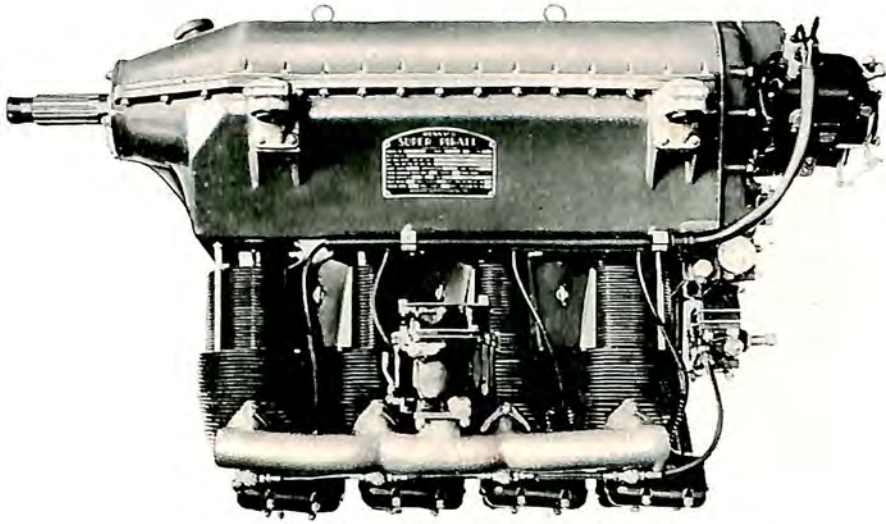
LYCOMING O-350 AND O-435

continued to be used in the airmail pickup service and also were installed in Stinson Reliants delivered to various air lines for instrument training of pilots. The Waco Aristocrat had a 300 h.p. Lycoming engine. Other new installations of military Lycoming engines were in the Beechcraft, Curtiss-Wright and Cessna twin-engine trainers, in the single-engine Stearman and Spartan trainers and in the Stinson O-49 Liaison plane. Production of military engines was increased tremendously. Additional new machinery was installed and



LYCOMING O-350

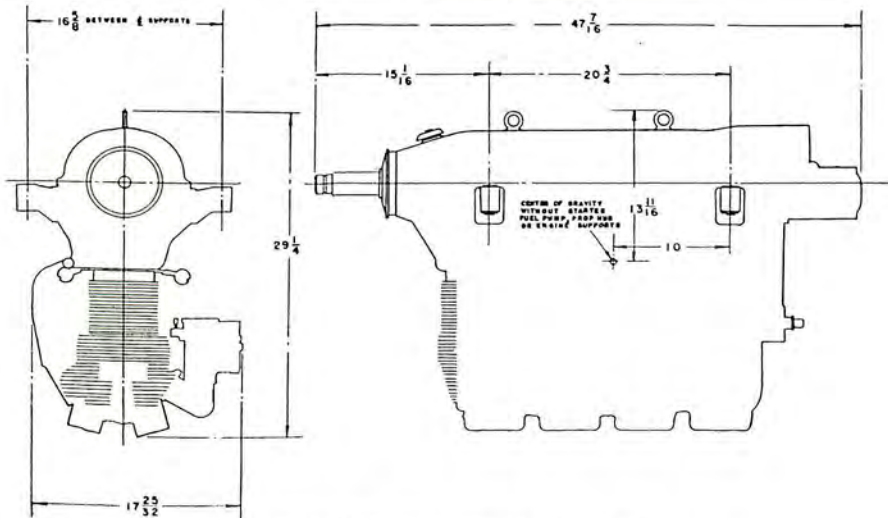
A horizontally opposed six-cylinder aircooled engine rated at 150 h.p. at 2,550 r.p.m. Model O-435 has a rating of 175 h.p. at 2,550 r.p.m.



MENASCO D<sub>4</sub> SUPER PIRATE

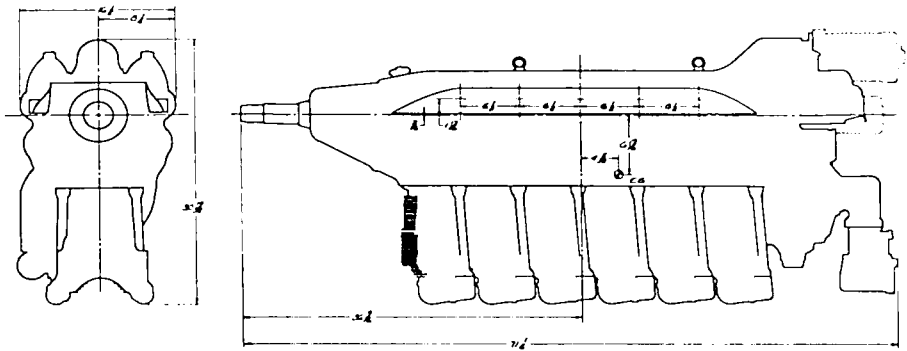
added floor space was taken over to meet the demand for the manufacture of military models.

Lycoming light-plane engine production for 1940 was the highest in the company's history, showing an increase of approximately 200 per cent over the same period in 1939. Highest production month



MENASCO D<sub>4</sub> SUPER PIRATE

A four-cylinder inverted in-line engine rated at 125 h.p.



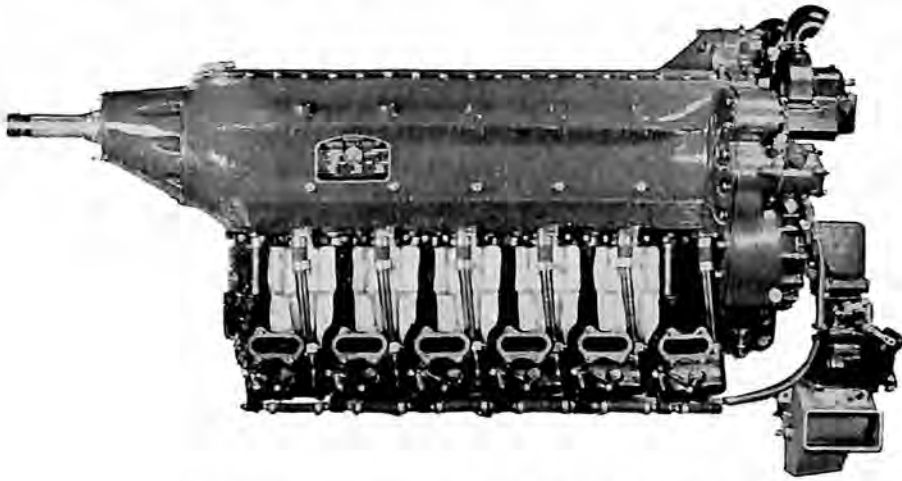
MENASCO C6S-4 SUPER BUCCANEER

A six-cylinder inverted in-line aircooled engine developing 260 h.p. at 2,300 r.p.m. at 7,500 ft.

was October when more than 500 Lycoming 50 to 75 h.p. engines were delivered. They were installed in Taylorcraft, Aeronca, Piper, Luscombe, Porterfield and Funk airplanes, and also were used extensively by operators participating in the C.P.T. program. The Lycoming GO-145, 75 h.p. geared engine, the first of its kind in the light plane field also was continued in production. It was installed in production type Piper Cruisers and Funk airplanes and other experimental types of aircraft. Production facilities for all the light plane engines also were augmented late in the year, making it possible for Lycoming to manufacture more than 800 engines of the 50 to 175 h.p. type a month. Production was started on a new type of Lycoming hollow steel propeller blade in the 8 ft. 6 in. size. These propeller blades were used on the Army Stearman training planes and the Navy Spartan trainers.

Menasco Manufacturing Company, Burbank, Calif., during 1940 greatly expanded its facilities by the construction of a new plant and administration building located on a 14-acre tract. In the new Burbank plant were housed the two largest divisions of the Menasco Manufacturing Company, the aviation engine division and the hydraulic strut division, as well as the general offices. The plant was equipped with the latest types of machine tools and designed for quantity production of both engines and hydraulic landing gear struts.

Engine production during 1940 was increased over previous years, and business was marked by the receipt of several large orders for export engines as well as contracts for the production of "Menasco Hydraulic Shock Struts." During 1941 Menasco offered mainly four engine models: the Model D4, 125 h.p., the Model D4-B, 160 h.p.,

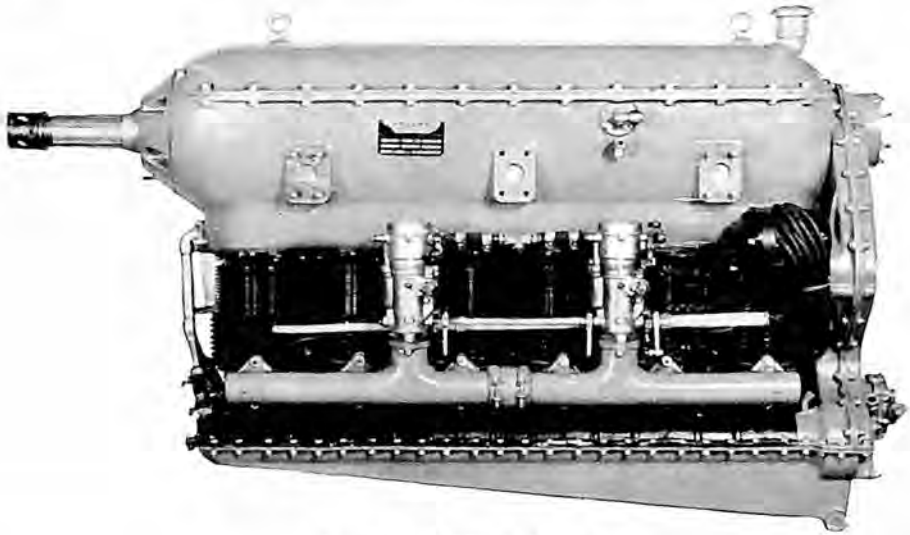


MENASCO C6S-4 SUPER BUCCANEER ENGINE

the Model C6S-4, 290 h.p. and the Model D6S-G, 390 h.p. Many new engineering improvements were incorporated in these series, to increase both power and reliability.

The company's former headquarters in Los Angeles were occupied exclusively by the company's foundry division which produced nonferrous castings by the Antioch process. This process was developed by Antioch College at Yellow Springs, O., and perfected during the last 10 years, and last year was purchased by General Motors. Aluminum or bronze castings made by this process combine the finish and accuracy of die-castings with the physical properties of the best sand castings. Also, it is possible by means of the Antioch process to mold and pour aluminum or bronze castings which formerly were impossible to make by other recognized processes.

Phillips Aviation Company, Van Nuys, Calif., produced the Phillips 333, a 4-cyl. inverted in-line aircooled engine. This engine originally was designed by Louis Chevrolet and subsequently developed and tooled for production by the Glenn L. Martin Company under Department of Commerce Approved Type Certificate 59. Production Certificate 19 was issued by the C.A.A. to Phillips Aviation Co. after examination of tooling and manufacturing facilities. The Phillips engine was rated 120 h.p. at 2,100 r.p.m., showing an exceptionally high b.m.e.p. of 136 lb. per sq. in. at 5.3 to 1 compression at 2,100 r.p.m. The bore was 4.5 in., the stroke 5.25 in., and the displacement is 333 cu. in. The weight was 269 lbs. or 2.20 lb. per rated h.p. The fuel and oil consumption were .48 and .01 lb. per



#### PHILLIPS 500 ENGINE

A six-cylinder inverted inline rated 180 h.p. at 2,100 r.p.m.

h.p. hr., respectively. The extreme overall dimensions were length 45.75 in., width 17.75 in., and height 34.25 in.

The Phillips Model 500 was an aircooled inverted 6-cyl. in-line engine employing the same cylinders, cylinder heads, pistons and valves as the 333. The piston displacement was therefore 500 cu. in. This engine is rated 180 h.p. at 2,100 r.p.m. and weighed 365 lbs. The fuel and oil consumptions were .520 and .010 per lb. per h.p. hr., respectively. The overall dimensions were: length 56 in., width 17.75 in., and height 34.25 in. The construction of this engine was similar to that of the 4-cyl. model and most of the parts were interchangeable.

Pratt and Whitney Aircraft, East Hartford, Conn., one of the three manufacturing divisions of United Aircraft Corporation, celebrated its fifteenth birthday on August 1, 1940. Of particular significance during 1940 was the operation in full production of the new factory addition built during 1939 to meet the growing requirements for aircraft engines abroad. As a result of this expansion Pratt and Whitney engine production in terms of horsepower was already four times greater than in early 1939, thus anticipating the vital need for increased productive capacity created by the unprecedented demands of the defense program.

Further to meet the combined requirements at home and abroad for dependable engines, 3 new plant additions were completed during late 1940, one of which was undertaken for the defense program in



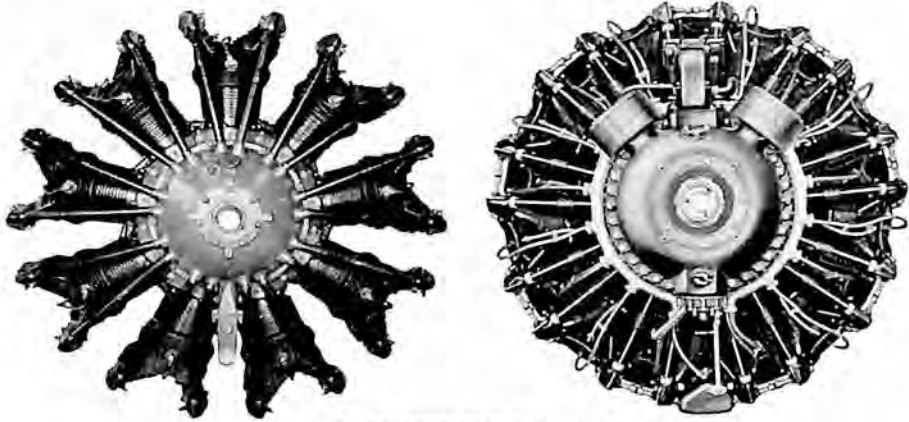


#### PRATT & WHITNEY ENGINE INSPECTION

Steadily increasing production of Pratt & Whitney Wasps, Twin Wasps and Wasp Junior aircraft engines made this huge inspection department necessary in the new assembly building of the company's plant at East Hartford, Conn.

advance of formal plant facility contracts, which increased the total Pratt and Whitney plant floor space to more than 1,500,000 sq. ft. At the end of 1940 nearly 15,000 men and women were employed in 3 regular shifts, as against 3,000 in early 1939, and 20,000 were expected to be employed when full production with the new facilities was reached.

Thus, with a monthly output of more than 1,000,000 horsepower at the end of 1940, Pratt and Whitney Aircraft, despite heavy shipments abroad, actually delivered in 1940 a quantity of engines well above the requirements of American airplane manufacturers using Pratt and Whitney engines. Development of the subcontracting system on a large scale contributed in great measure to the rapid expansion of productive capacity. In cooperation with the automotive industry to provide additional manufacturing facilities for the duration of the emergency, a license agreement was concluded late in 1940 with the Ford Motor Company on a nominal royalty basis of \$1.00 per engine for the production of thousands of Double Wasp engines for the U. S. Army Air Corps. Negotiations also were begun during 1940 with the Buick Division of General Motors Corporation, leading to a simi-



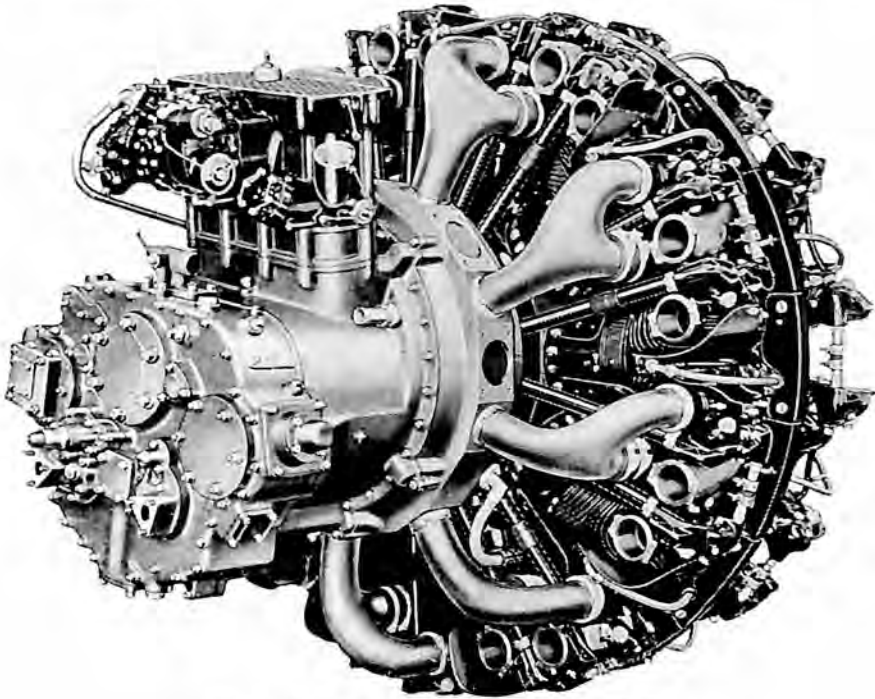
ENGINE PROGRESS IN 15 YEARS

Two Pratt & Whitney engines of the same diameter. Left—The 400 h.p. Wasp of 1925. Right—The 2,000 h.p. Double Wasp of 1940.

lar license agreement for the increased production of Twin Wasp engines.

The most recent plant addition, which approximated the size of the entire Pratt and Whitney factory of early 1939 was devoted exclusively to engine assembly, and was equipped with a conveyer system and other new features to allow straight line assembly, a distinct innovation in the production of aircraft engines in the United States. The conveyer system was nearly a mile long and was of the continuous and automatic type with a maximum capacity of 65,000 lbs. It traveled at speeds up to 35 ft. per min. The conveyer delivered parts to various subassembly stations where on completion subassemblies were transferred to one of 2 "green" assembly lines, one for single-row engines and one for double-row engines. Plans also were announced for an enclosed passageway containing a power driven overhead monorail conveyer system connecting with the monorail system in the assembly building and serving to transport engines back and forth between assembly plant and test houses.

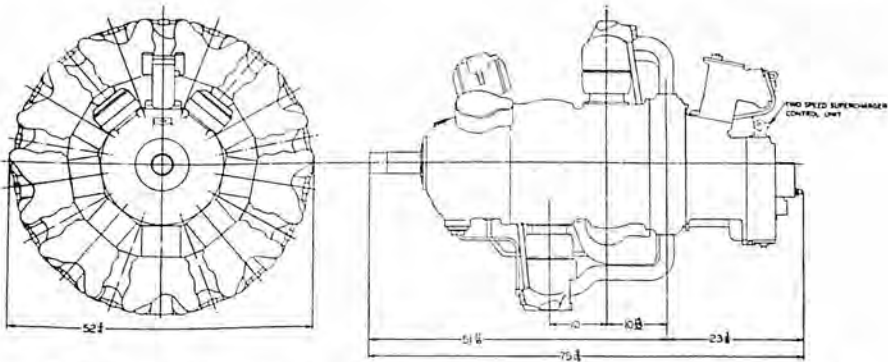
In view of the need for skilled labor encountered in connection with this tremendous expansion, Pratt and Whitney Aircraft late in 1940 opened a specialized training school for machine tool operators. Inaugurated in conjunction with the State of Connecticut, it proved highly successful. Operating in 3 shifts, 24 hours a day, 6 days a week, the school had an initial enrollment of 350 students, each of whom underwent approximately 200 hrs. of training. During the last two months of 1940, nearly 800 of the trainees were graduated and placed at work in the Pratt and Whitney factory. At the turn of the



PRATT & WHITNEY DOUBLE WASP

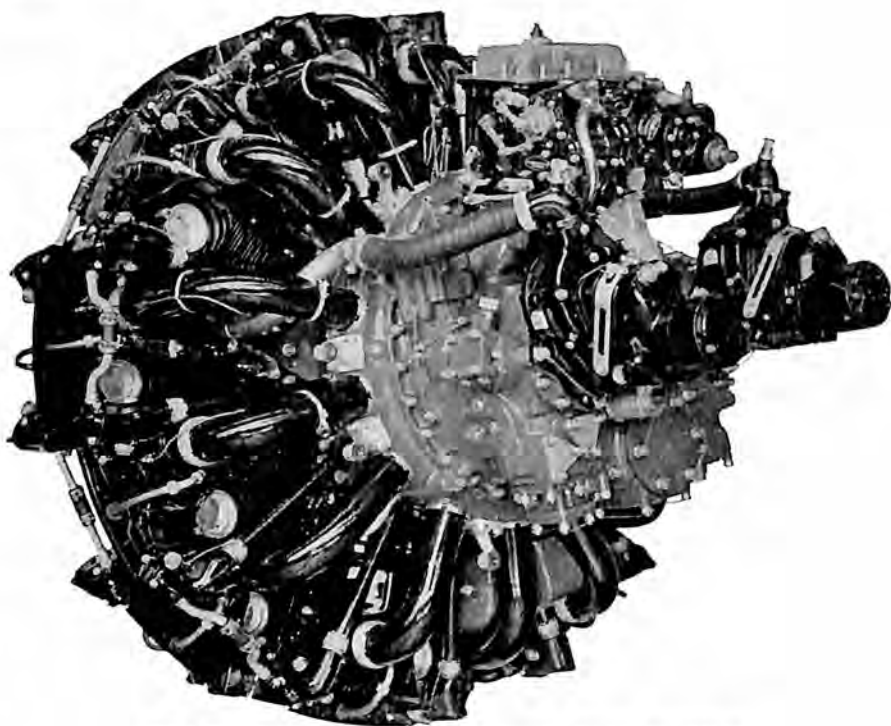
year, the school facilities were being expanded to permit an enrollment of 1,500.

At the East Hartford plants United Aircraft Corporation expanded the facilities of its school for customers' personnel. It was known as



PRATT & WHITNEY DOUBLE WASP SERIES A4-G AND A6-G

A 1,850 h.p. 18-cylinder double row radial aircooled engine.

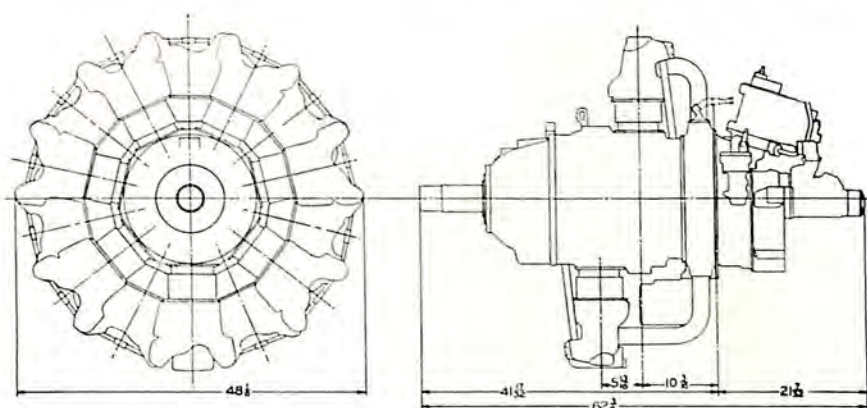


PRATT & WHITNEY C4-G TWIN WASP ENGINE

the Pratt and Whitney and Hamilton Standard Engine and Propeller School, and it was unique in that its equipment and instructors provided further familiarization of United products by permitting the customers to disassemble, assemble and study the latest engines and propellers. A great deal of emphasis was placed on the study of design, operation, servicing and maintenance of United Aircraft equipment, which proved a mutual advantage to the company and its customers. Experienced personnel of the military services, air lines, manufacturers and export field took advantage of the facilities. In the last category were included representatives of many of the South American republics, the British Empire and China.

During 1940 Pratt and Whitney Aircraft continued its policy of continued research and development as well as progressive refinement and improvement of existing types. Plans were announced late in 1940 for additions to the engineering building, and construction was scheduled to begin shortly on additional test houses and laboratory facilities.

The quantity production of engines for foreign governments, side



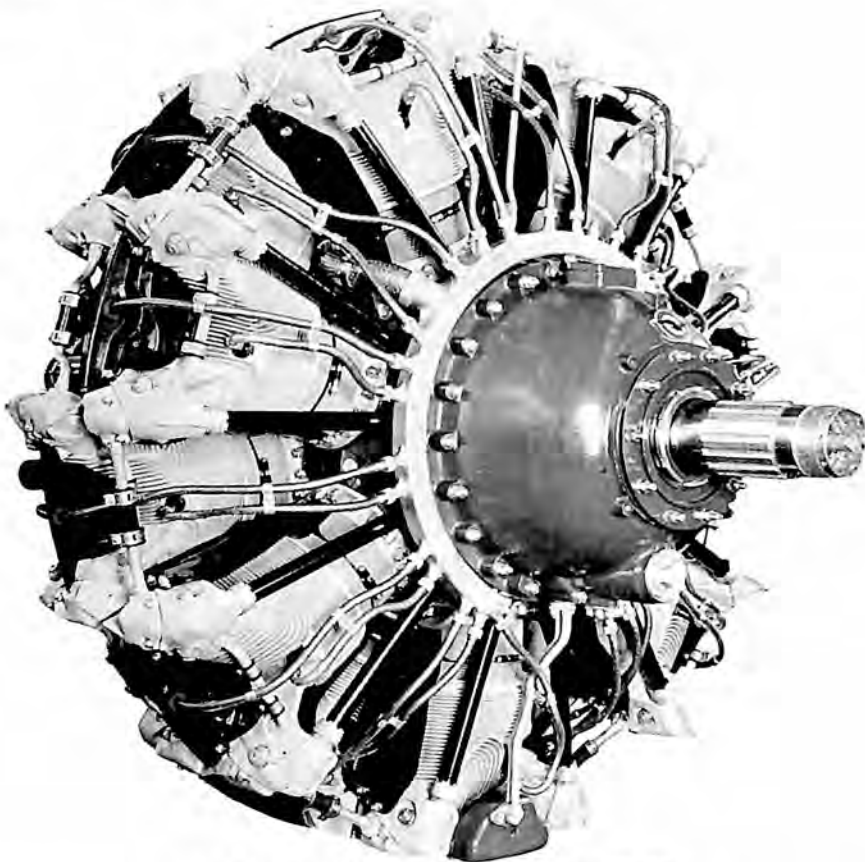
PRATT &amp; WHITNEY TWIN WASP SERIES C4-G

A 1,200 h.p. 14-cylinder double row radial aircooled engine with two-speed supercharger.

by side with those scheduled for the U. S. military services and for the air lines, emphasized the necessity for standardization of manufacturing processes to the end that a greater number of engines, built to standardized specifications, could be produced in the shortest possible time. To permit the concentration of manufacturing facilities on increased output of other types selected for the defense program, and at the same time to release all engineering effort for the continued development of the higher powered engines scheduled for military combat airplanes the Hornet and Wasp Jr. engines were withdrawn from production.

Two basic types of radial aircooled engines were continued in production: the single-row 9-cyl. type including the Wasp Jr. and Wasp with maximum ratings of 450 h.p. and 600 h.p. respectively; and the double-row type represented by the 14-cyl. Twin Wasp with a maximum rating of 1,200 h.p. and the 18-cyl. Double-Wasp with an initial rating of 1,850 h.p. Announcement was made late in 1940, with respect to the Double Wasp, of the successful completion of the grueling military type test at 2,000 h.p. for take-off and military rating. This was followed by approval of the U. S. military services for quantity production of this engine at the higher rating.

Another engineering achievement by Pratt and Whitney added its timely contribution to the defense program during 1940. This was the 2-stage 2-speed engine-driven supercharger, pioneered by Pratt and Whitney in cooperation with the U. S. Navy. With a background of many thousands of hours of development testing over a period of 7 years, both on the dynamometer and in flight, this integral auxiliary

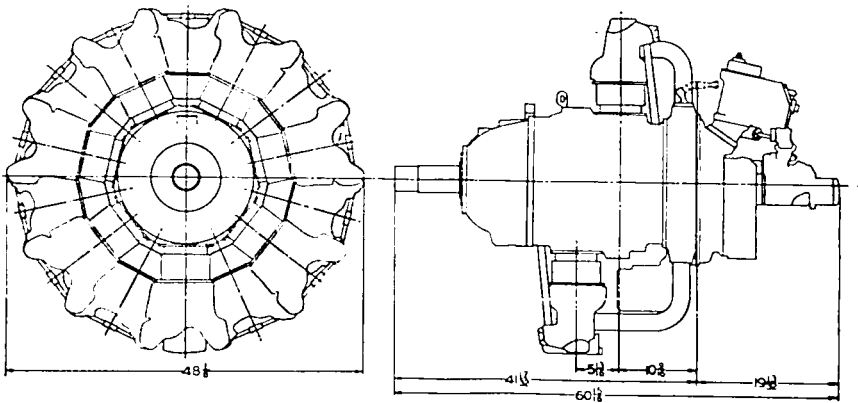


PRATT & WHITNEY C3-G TWIN WASP

supercharger, fitted to the standard Twin Wasp engine with 1,200 h.p. for take-off, was released to production for U. S. military requirements, and was installed in the Navy's latest airplanes of the fighter and multi-engine bomber class, notably the Grumman F4F-3 and the Consolidated PB2Y-2.

An outstanding example of the performance attained with a 2-stage supercharger in an airplane designed for high altitude was that of the Vought-Sikorsky XF4U-1 prototype Navy fighter equipped with a Double Wasp engine. Complete performance figures were not released, but the XF4U-1 was officially recognized as being one of the fastest Navy airplanes.

The direct drive Wasp Jr. was continued in production in the B2 series to meet ever-increasing requirements in the commercial and military field for dependable engines in the 450 h.p. class. Continued



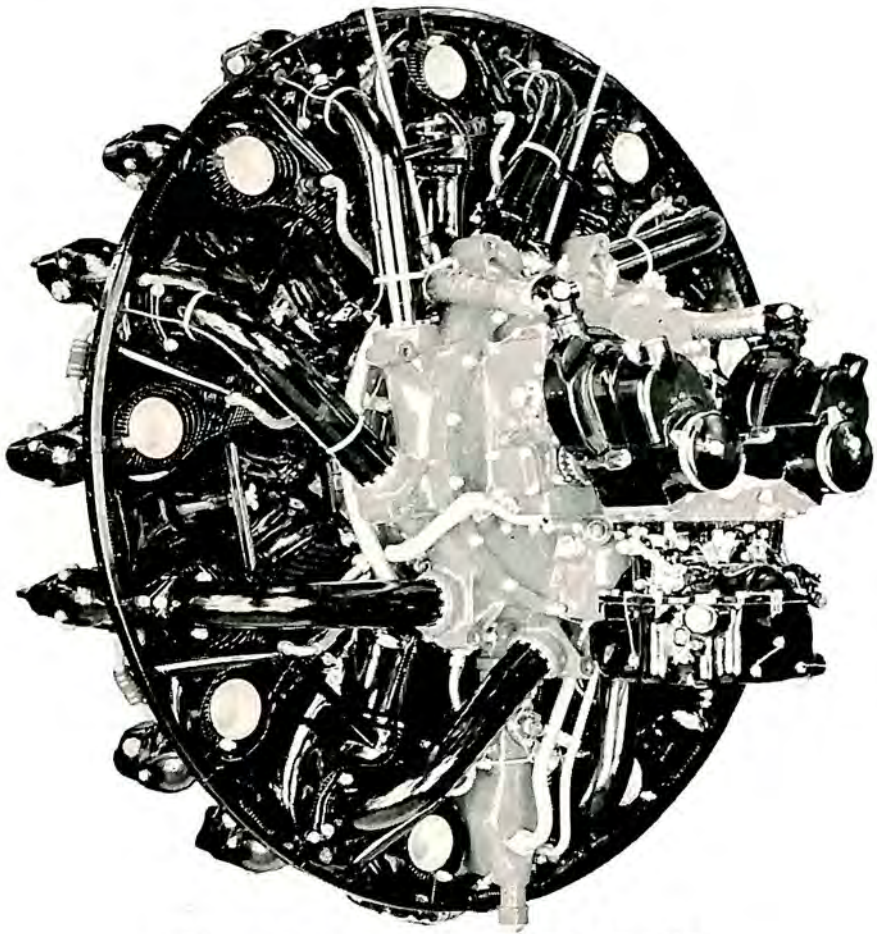
PRATT &amp; WHITNEY TWIN WASP SERIES C3-G

A 1,200 h.p. 14-cylinder double row radial aircooled engine.

refinement in design resulted in the announcement during the year of the B3 series. Similar in construction to its predecessor and superseding the B2 series in production, the new Wasp Jr. included many features introduced with the Wasp series H1. The Wasp Jr. was produced in quantity for Vultee and North American basic training airplanes for the U. S. Air Corps as well as Vought-Sikorsky observation scouts for the Navy. Other planes in which Wasp Jr. engines were installed were trainers built by Stearman, Fleetwings and Aircraft Research Corporation; Beech 2-engine advanced trainers and transports for the Army; single and 2-engine Beech, and Grumman amphibion utility planes for the Navy; as well as Lockheed, Waco, Stinson, Howard, Grumman and Beech planes in the private owner field.

The Wasp H1 series, in addition to normal commercial and export requirements for the geared H1-G series, was manufactured in large quantities in the direct drive H1 Series for installation in the standard advanced training type airplane built by North American Aviation for the U. S. Army and Navy and in the same type of airplane for the British Royal Air Force.

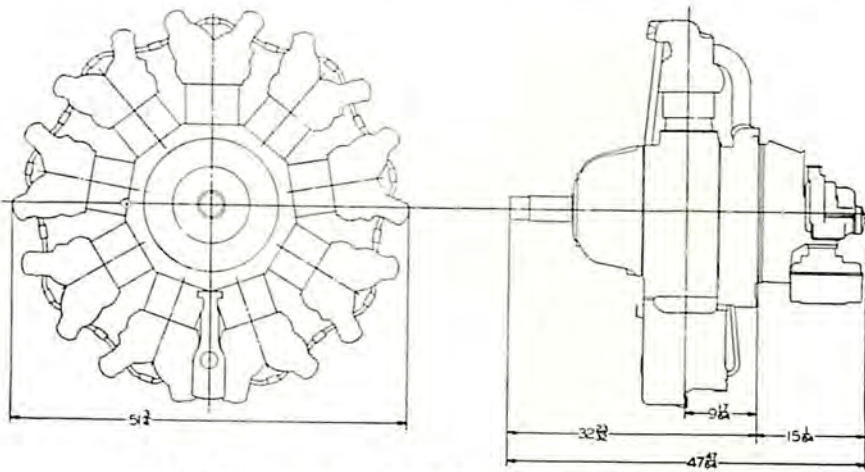
The Twin Wasp, manufactured in the C3-G and C4-G series with single and 2-speed supercharging respectively, continued to maintain traditional Pratt and Whitney standards of dependability, performance and economy founded on the established success of the double-row principle inaugurated by Pratt and Whitney Aircraft. Deliveries increased rapidly during 1940 for installation in a wide range of military and commercial airplane types. These included the new Consolidated 4-engine long-range bombers and Republic pursuits for the



PRATT &amp; WHITNEY 600 H.P. GEARED WASP

Army; fast Grumman shipboard fighters and mighty fleets of 2 and 4-engine Consolidated patrol bombers for the Navy; Douglas DC-3's and fast Lockheed Lodestars for an increasing number of domestic and foreign air lines and four-engine Vought-Sikorsky flying boats for transatlantic service with American Export Airlines. Deliveries also increased rapidly for installation in Douglas and Martin bombers, Vultee pursuits and many of the foregoing American military types for the Royal Air Force, as well as several British bomber types. Development of the Twin Wasp was continued during 1940, with the result that Twin Wasp engines of increased capacity and performance with 1,300 h.p. for take-off were selected on the basis of competitive





PRATT & WHITNEY GEARED WASP SERIES H1-G

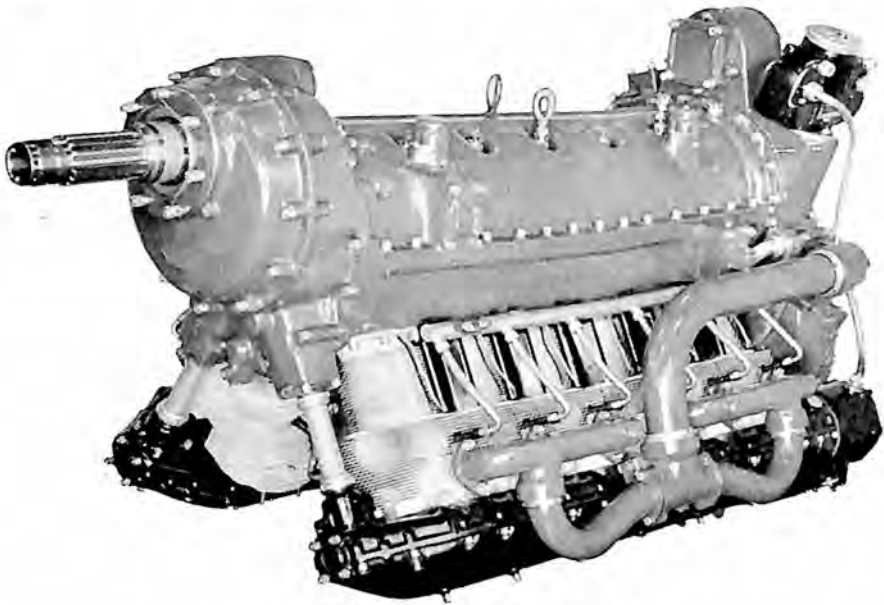
A 600 h.p. nine-cylinder radial aircooled engine.

design to power the giant new 4-engine Douglas DC-4 land transport, evolved from the Pratt and Whitney powered prototype developed with the cooperation of 5 major air lines, and scheduled for production subject to national defense priorities.

The Double Wasp deliveries were under way for installation in the Army's fast new Martin twin-engine B-26 medium bombers and for the accelerated British bomber production program, as well as the latest and most powerful version of the famous Lockheed Hudson bomber for the Royal Air Force; also for many of the most outstanding new prototypes, including the Curtiss-Wright Army Cargo version of the CW-20 and the latest Republic Pursuit, North American bomber and other advanced new prototypes designed around the 2,000 h.p. Double Wasp. Particularly significant was the superior performance demonstrated by the Vought XF4U-1 Navy fighter equipped with the high supercharged version of the Double Wasp, and the availability of the 2,000 h.p. Double Wasp for immediate production to power that formidable new weapon.

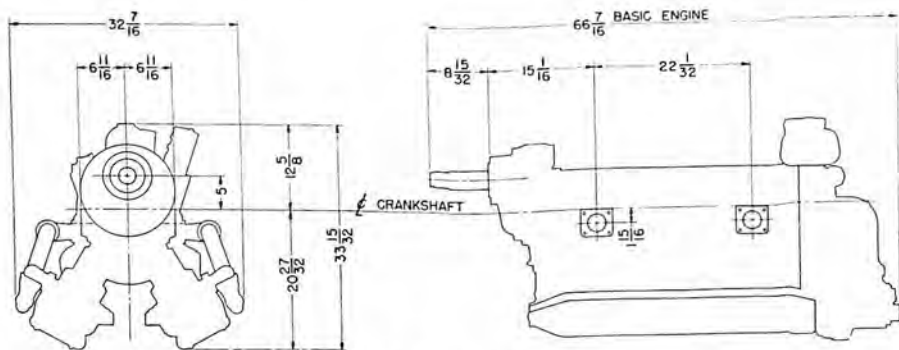
Ranger Aircraft Engines, Farmingdale, N. Y., a division of the Fairchild Engine and Airplane Corporation, centered production on the new 6-440C series during 1940. This new series of the Ranger 6-cyl., aircooled, in-line type engine was available in 4 models.

The major part of the total business of Ranger Aircraft Engines for the year was in fulfillment of Government contracts with both the Army and Navy. Approximately 400 6-440C-2 model engines were manufactured for the Army M-62 Fairchild trainers, while de-



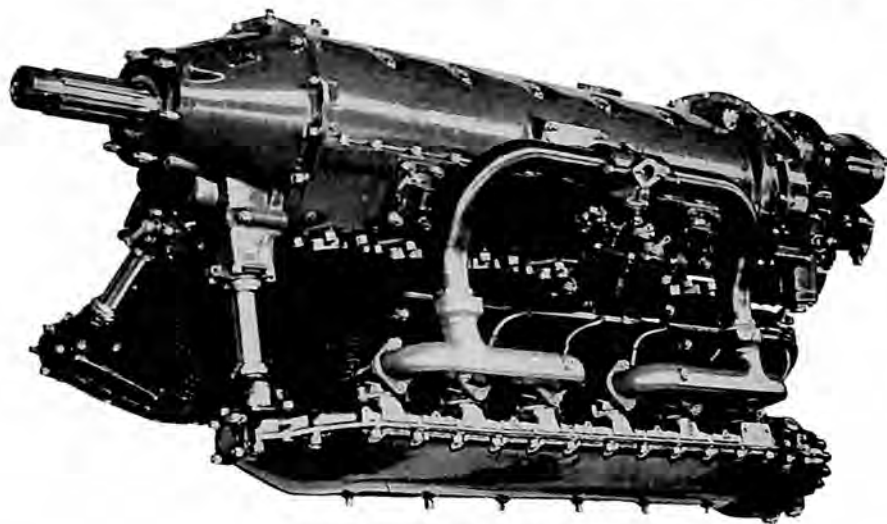
RANGER SGV-770B-7 ENGINE

velopment and experimental production of the SGV-770B-7 and SGV-770C-1 series engines took place for the Navy scout-observation planes manufactured by Curtiss and Vought-Sikorsky. The SGV-770B-3 model engine also was installed in the Bellanca YO-50 liaison observation plane for the Air Corps. Ranger 6-440C engines powered the Grumman "Widgeon" amphibion, the Colgate-Larsen amphibion and the St. Louis Aircraft Corporation's new trainer.



RANGER MODEL SGV-770

A 12 cylinder, inverted 60 degrees V, in-line, aircooled engine rated at 420 to 450 h.p.

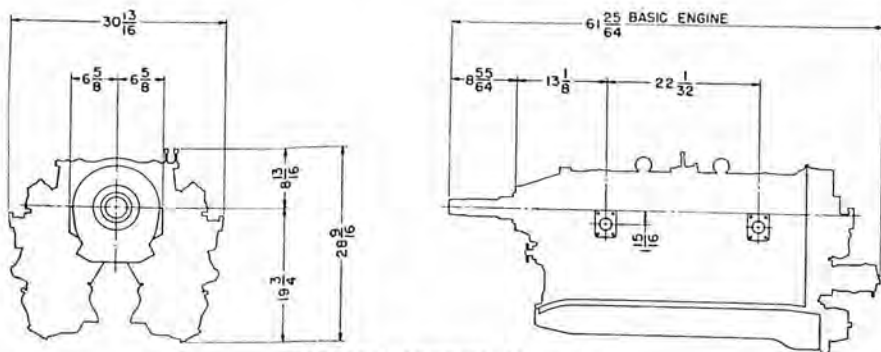


THE RANGER V-880C-1

Production facilities for Ranger aircraft engines were increased greatly during 1940. At the close of the year floor-space was 304 per cent of what it was September 1, 1939. When the whole program of expansion was completed this figure was to be 417 per cent.

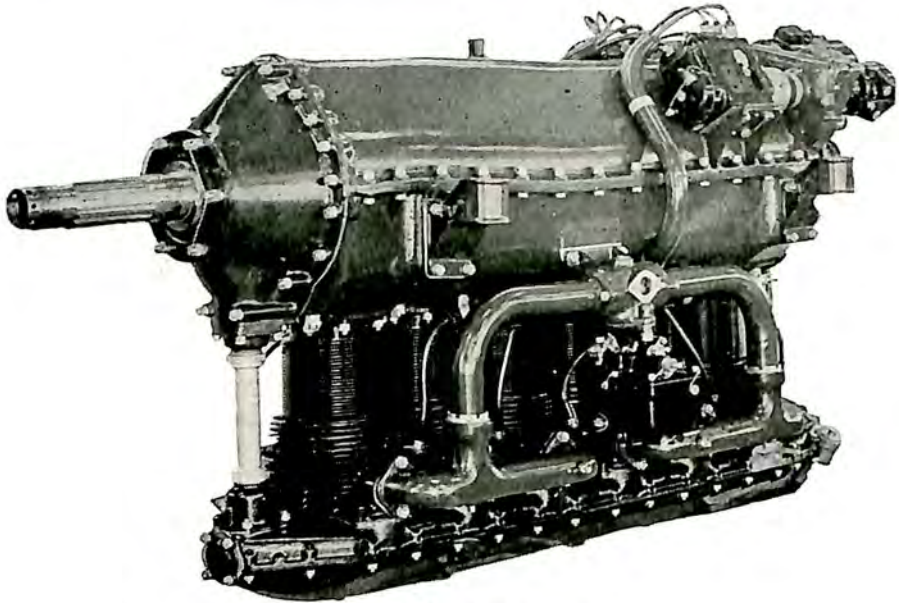
Ranger's new test house and research building was completed in June, 1940. Five test cells, including 2 single-cylinder dynamometer test cells, surrounded a single sound-proofed control room.

Facilities were provided for compressing, measuring and refrigerating carburetor air in this building, so that routine testing could

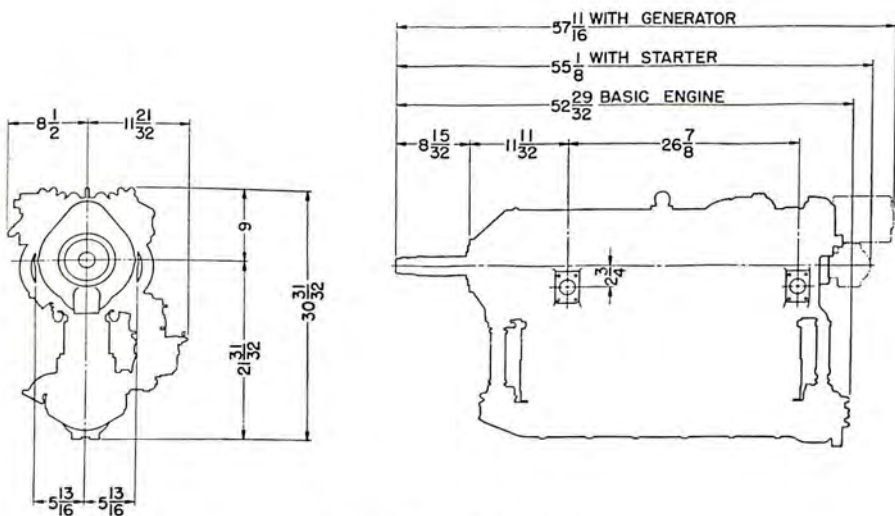


RANGER MODEL V-880C-1

A 12-cylinder, inverted, 60 degrees V, in-line, aircooled engine rated at 405 h.p. at 2,400 r.p.m.

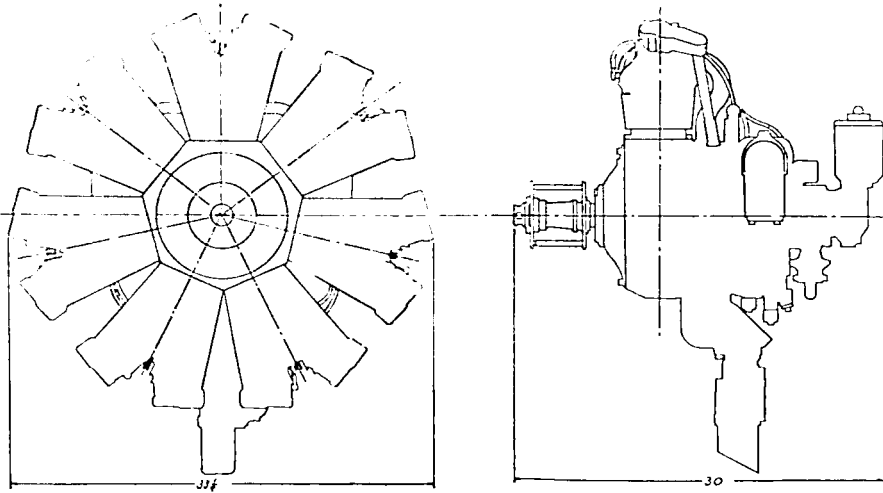


THE RANGER 6-440C



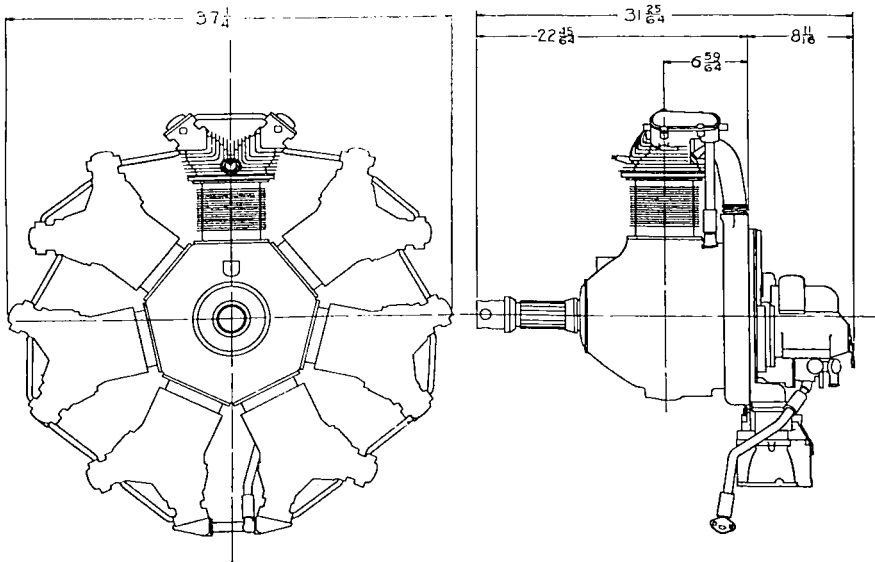
RANGER MODEL 6-440C

A six-cylinder, inverted, in-line, aircooled engine rated at 175 to 200 h.p.



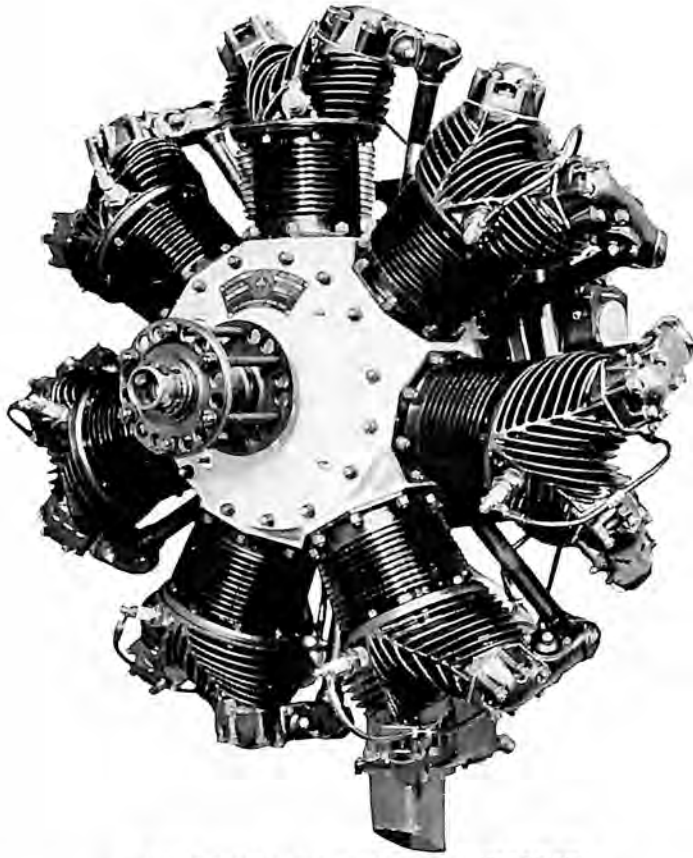
REARWIN KEN ROYCE 7G ENGINE.

A seven-cylinder radial aircooled engine rated at 120 h.p. at 2,225 r.p.m.



WARNER SUPER SCARAB MODEL 165

A seven-cylinder radial aircooled engine rated at 165 h.p. at 2,100 r.p.m.

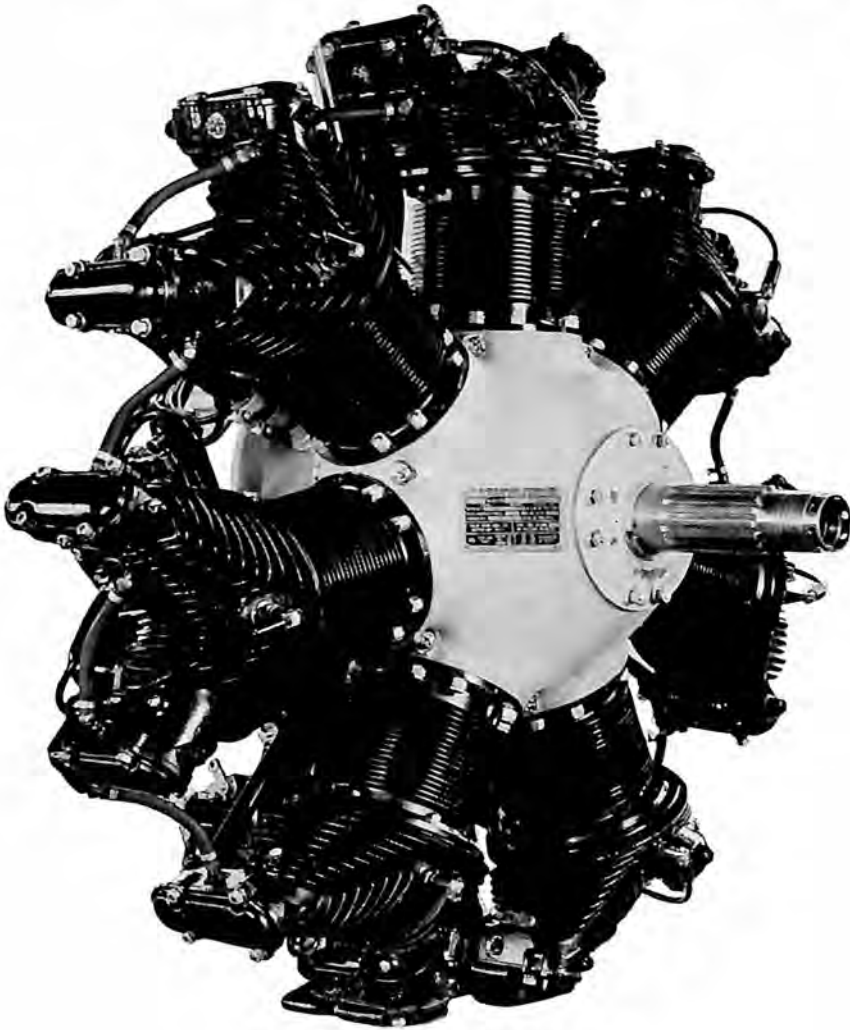


REARWIN KEN-ROYCE 7G ENGINE

be done under standard atmospheric conditions regardless of the temperature, pressure or humidity of the outside air.

An experimental room housed apparatus for the endurance testing of magnetos, valves, valve springs and other engine-driven accessories. Installed in this room was complete Sperry-M. I. T. equipment including oscillograph, integrating amplifiers and pickups for visual measurement and photographic recording of both torsional and linear vibrations; and a harmonic wave analyzer permitting instantaneous analysis of any vibration to determine the relative amplitudes of all frequencies present.

Laboratory facilities were increased materially. The metallurgical department included four laboratories—the spectroscopic laboratory, the chemical laboratory, the metallographic laboratory and the physical laboratory. The metallurgical department devoted its time to



WARNER SUPER SCARAB 165

development work and to the supervision of processes and the maintenance of high quality materials.

Rearwin Aircraft and Engine Company, Kansas City, Kans., produced 3 models. The Ken-Royce Model 5E was a direct drive air-cooled engine with C.A.A. rating of 70 h.p. at 1,950 r.p.m. The Ken-Royce Model 50 had a rating of 90 h.p. at 2,250 r.p.m. Ken-Royce Model 7G had a rating of 120 h.p. at 2,225 r.p.m.

The Warner Aircraft Corporation, Detroit, Mich., continued the



#### FOR VASTLY INCREASED ENGINE PRODUCTION

The huge new plant at Cincinnati, O., where the Wright Aeronautical Corporation, in April, 1941, started production of high-powered Wright Cyclone engines only 142 working days after ground was broken, supplementing the already large output at other Wright plants.

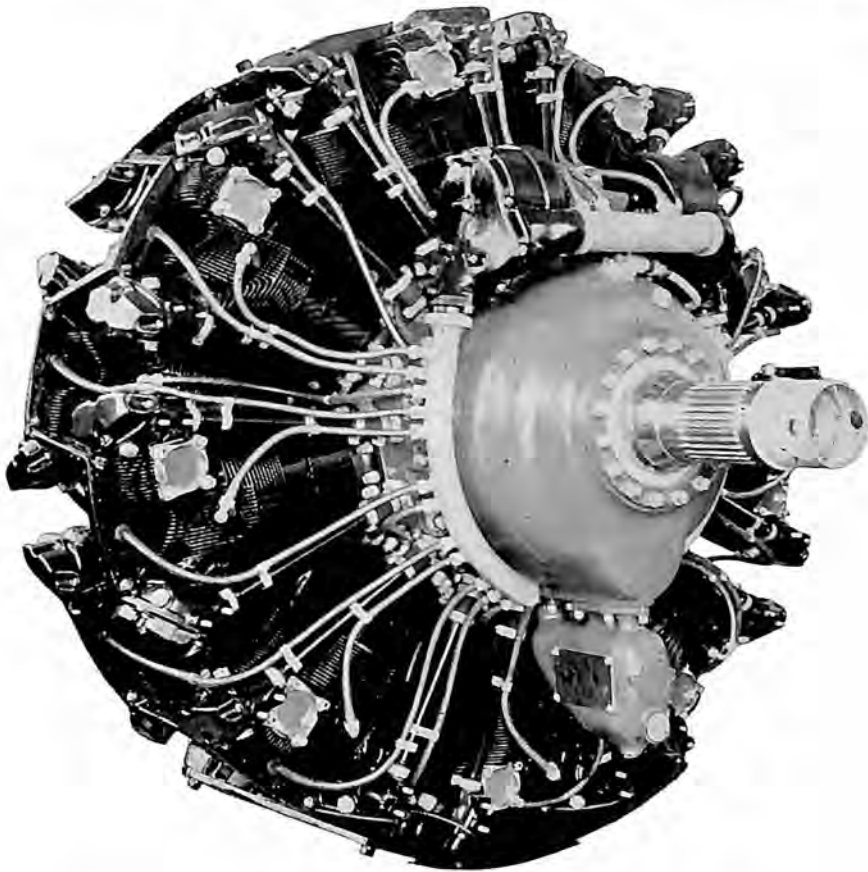
production of the Scarab and Super Scarab engines Series 50 type rated at 125 and 145 h.p. respectively.

The Scarab Jr. 5-cyl. radial aircooled engine was discontinued. In addition to the Scarab and Super Scarab Series 50 engines, production was continued on the Super Scarab Model 165, 7-cyl. aircooled engine rated at 165 h.p. This engine also was rated at 175 h.p. for take-off when a controllable pitch propeller was used.

The Super Scarab Model 165 engine was purchased for installation in the Wackett training planes which were manufactured in Australia. The Super Scarab Model 165 engine was supplied for the Fairchild Model M-62-B trainer.

Wright Aeronautical Corporation, Paterson, N. J., was well under way with a gigantic expansion program from a company with one plant of approximately 900,000 sq. ft. of floor space and employing about 6,000 personnel into an organization with 5 plants in operation and a sixth under construction and plans for increasing its personnel to approximately 30,000 employees, all in the interest of the national defense program.

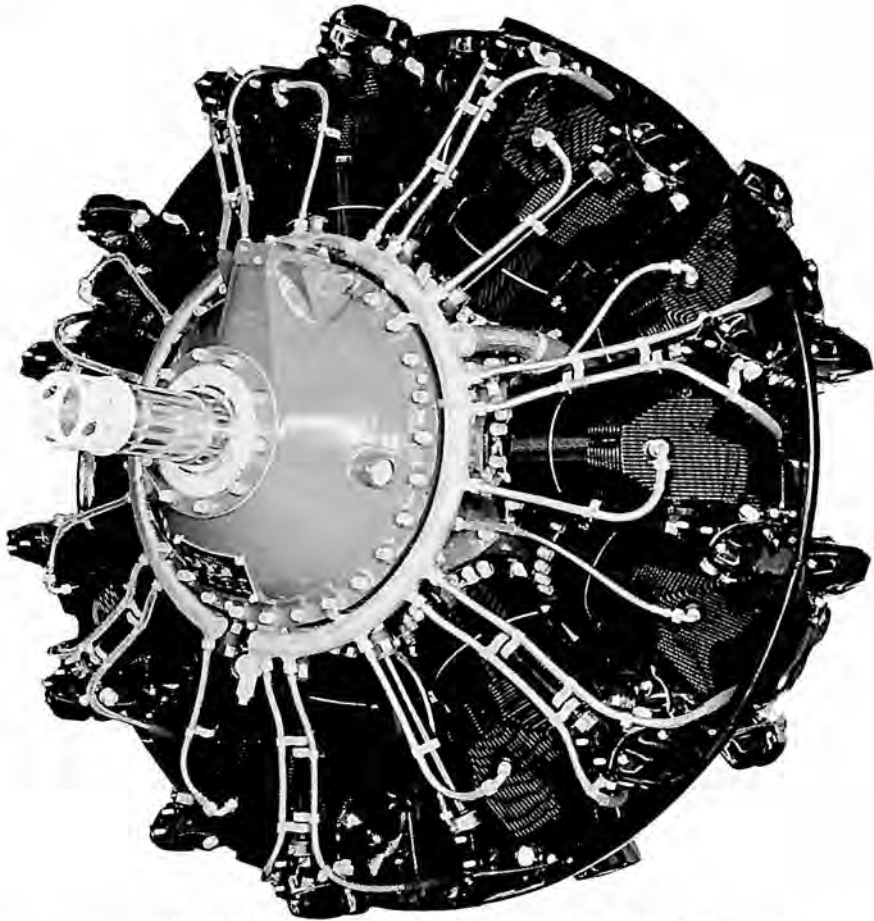




#### WRIGHT DUPLEX CYCLONE

An 18-cylinder double-row engine with a rating of 2,000 h.p. for take-off.

Late in 1939 the main plant at Paterson, N. J., (Plant No. 1) had about 900,000 sq. ft. of floor space. On June 14, 1940, Plant No. 2 on Getty Avenue, Paterson, which was built in the remarkable time of only 57 working days, was dedicated, adding 520,000 sq. ft. to the manufacturing space. The company acquired a former textile mill in Fair Lawn, N. J., (Plant No. 3) which provided an additional 450,000 sq. ft. Then another textile mill in East Paterson, N. J., (Plant No. 4) was acquired. This contains 450,000 sq. ft. of floor space. A new magnesium foundry was built at Fair Lawn, N. J., containing 118,000 sq. ft. With other additions to the Northern New Jersey facilities and the renting of Plant No. 5 on McLean Boule-

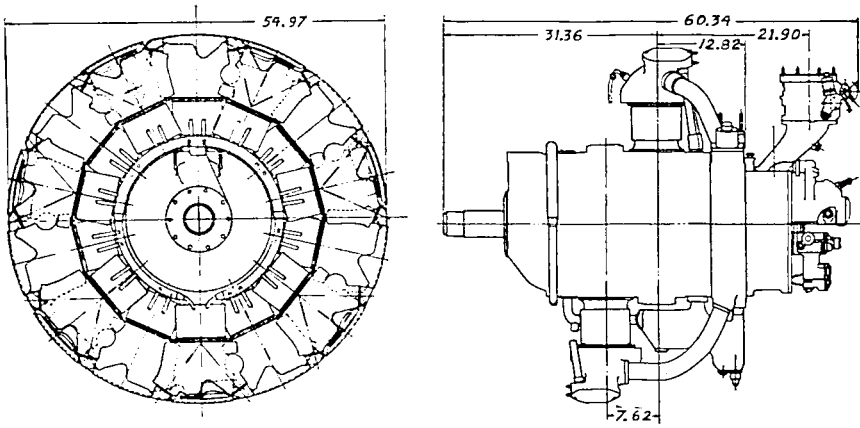


WRIGHT DOUBLE-ROW CYCLONE ENGINE

yard in Paterson (45,000 sq. ft.) the entire space in the 5 North Jersey plants totaled 2,842,000 sq. ft.

At Cincinnati, O., the largest single-story building in the United States was constructed for the production of Wright Cyclone aircraft engines. It will contain 2,120,000 sq. ft. divided as follows, 1,640,000 sq. ft. in machining and assembly building; 161,000 sq. ft. in the aluminum foundry; 118,000 sq. ft. in the magnesium foundry; 74,000 sq. ft. in the office building; 11,000 sq. ft. in the power house; 116,000 sq. ft. in test cells. The total floor space of all Wright facilities when the Cincinnati plant was completed would be 4,962,000 sq. ft.

Employment in the latter part of 1939 was approximately 6,000.

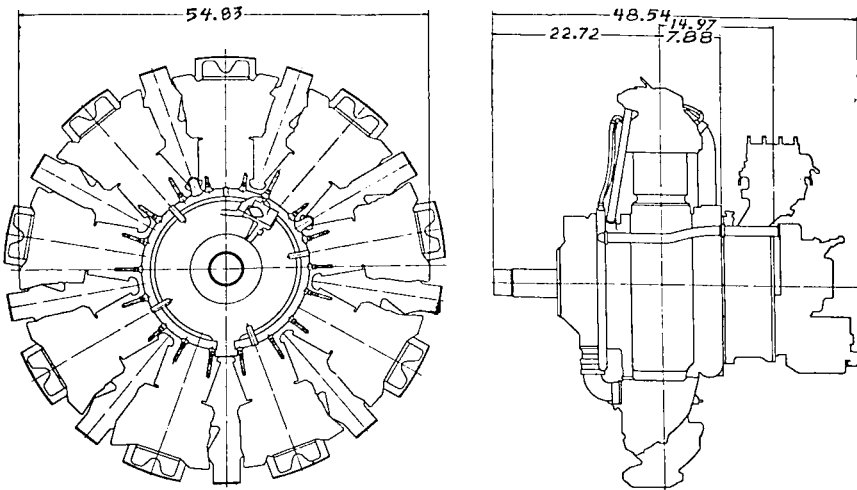


WRIGHT DOUBLE ROW CYCLONE 14

A 14-cylinder double row aircooled engine with a rating of 1,600-1,700 h.p. for take-off.

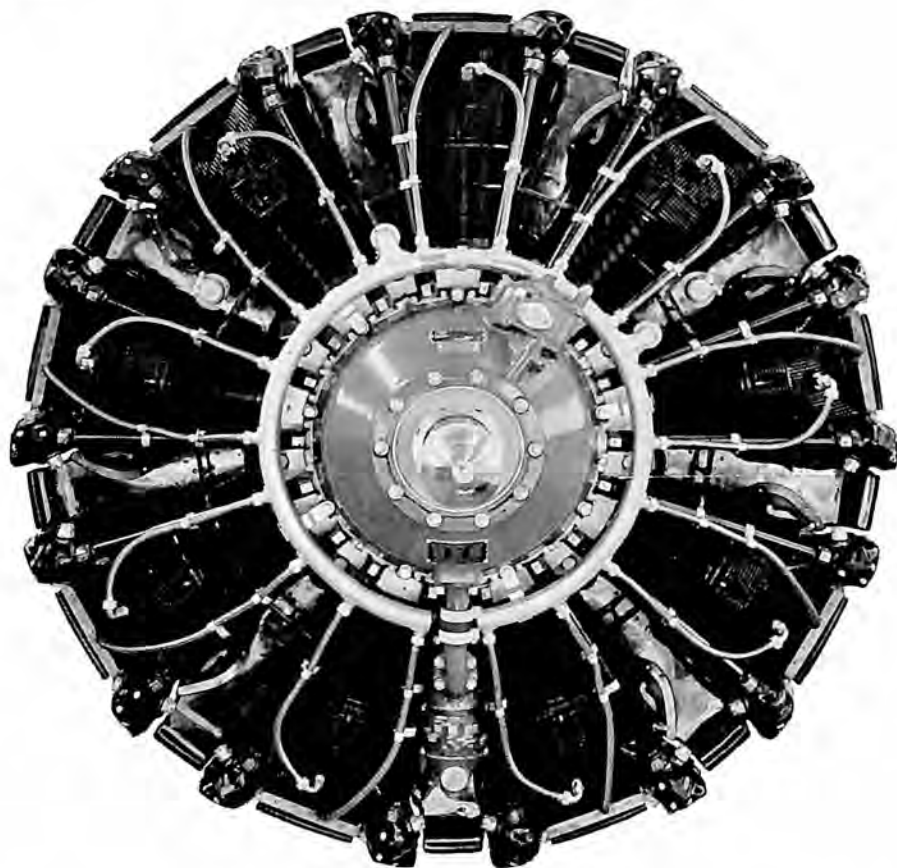
In March there were 16,000 persons employed. By the end of the year 18,000 were to be on the payroll. By March, 1942, an additional 12,000 to 15,000 employees would be in the Cincinnati plant.

During 1940, the Wright Aeronautical Corporation continued production of high-performance Wright Whirlwinds of 7 to 9-cylin-



WRIGHT CYCLONE G 100

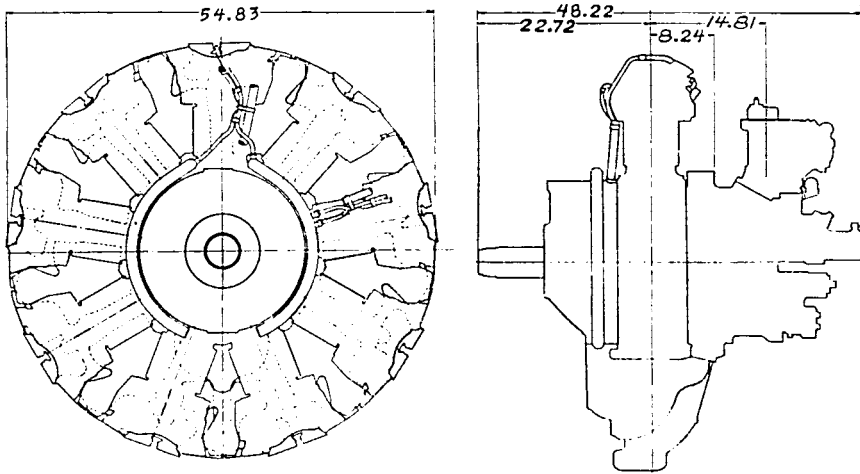
A nine-cylinder radial aircooled engine with a rating of 1,100 h.p. for take-off.



WRIGHT G-100 CYCLONE

ders covering a power range of 235 to 420 h.p., Wright Cyclones of 9-cylinder construction covering a range of 770 to 1200 h.p. for take-off; Wright Double-Row Cyclone 14's of two-row, 14-cylinder construction covering a range of 1600 to 1700 h.p. for take-off, and the Wright Duplex-Cyclone, a two-row, 18-cylinder engine rated at 2000 h.p. for take-off.

As was the case in 1939, the majority of engines produced were Wright Cyclones ranging in power from 1000 to 1200 h.p. which were used extensively in the naval and military fields in Douglas twin-engine bombers, Boeing B-17 four-engine Army bombers, North American Army O-47 observation ships, Curtiss Hawk pursuits, Grumman Navy fighters, Curtiss Navy SBC-4 scout observation ships, Lockheed Hudson twin-engine bombers, and the Douglas



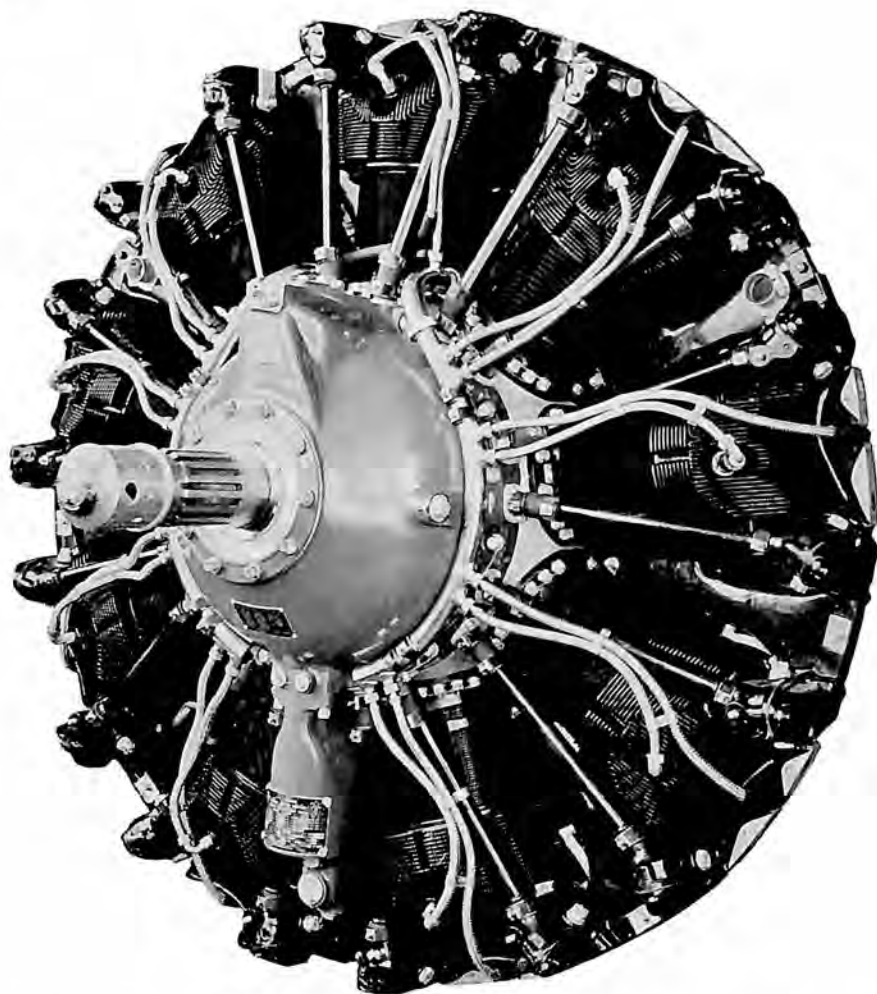
WRIGHT CYCLONE G 200

A nine-cylinder single-row radial aircooled engine with a rating of 1,200 h.p. for take-off.

Northrop Attack bomber; and commercially in the Douglas air liners in service on American Airlines, Eastern Air Lines, Transcontinental and Western Air, Braniff Airways, Pennsylvania-Central Air Lines, Chicago and Southern Air Lines, Royal Dutch Airlines, Pan American Airways System, and other leading air transport companies throughout the world. Cyclones rated at 1100 h.p. were installed in the new Boeing 307 Stratoliners which were placed in service by Pan American Airways and Transcontinental and Western Air in 1940.

The 1200 h.p. Wright Cyclone, designated as the G-200 Series, was approved by the Civil Aeronautics Authority for the highest power rating ever accorded a 9-cylinder radial aircooled aircraft engine. First commercial installation of the G-200 Cyclone was made in a new fleet of Douglas DC-3 transports placed in service by Chicago and Southern Air Lines between Chicago and New Orleans. An outstanding military use of the same engine was its installation in the twin-engine Grumman F5F-1 fighter.

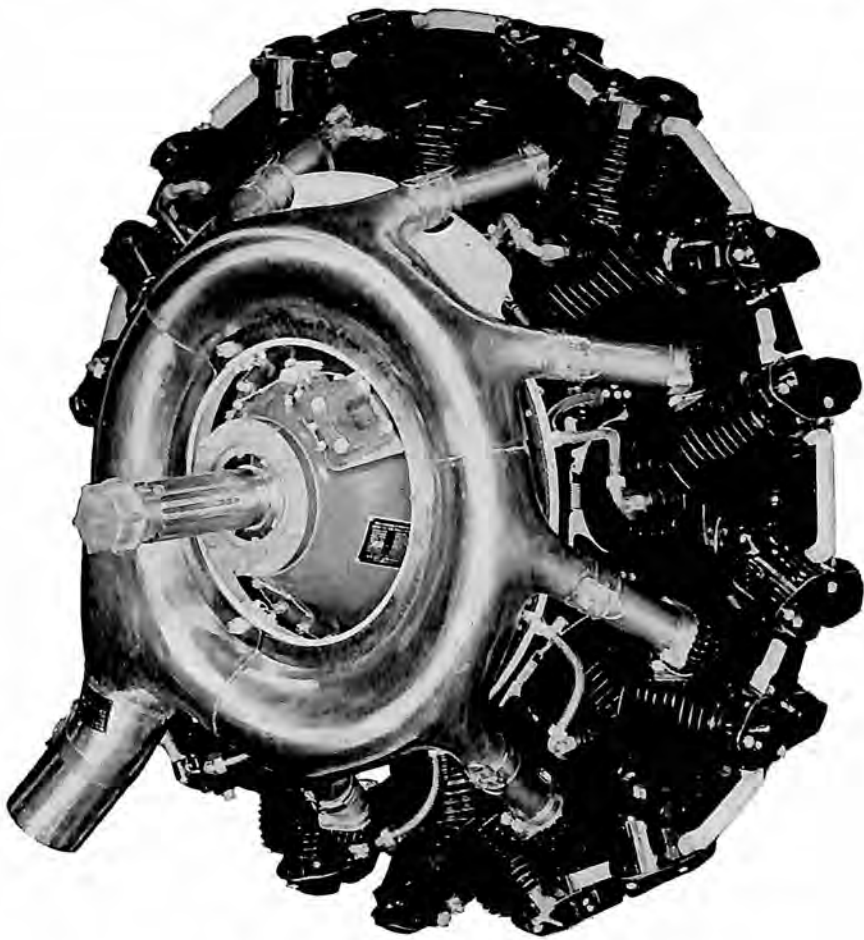
The Wright Double-Row Cyclone 14, which powered the four-engine Boeing 314 Clipper ships of the Pan American Airways System on its transatlantic and transpacific routes, turned in a spectacular record of performance for continuous operation of that type. The Double-Row Cyclone 14 also was selected to power such outstanding military and naval types as the North American B-25 Army twin-engine bomber, one of the most advanced types in the Air



WRIGHT G-200 CYCLONE ENGINE

Corps expansion program; the Douglas Army B-23 bomber, the Douglas Army A-20 twin-engine attack, and the Martin Navy twin-engine patrol bomber.

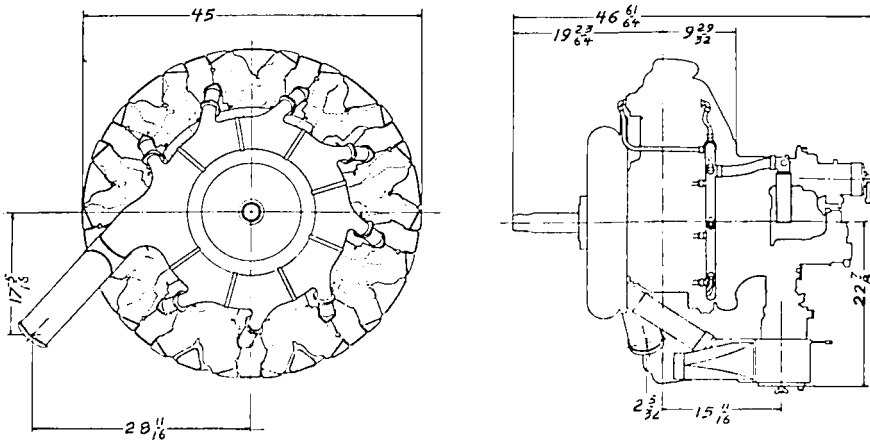
The 18-cyl. 2,000 h.p. Wright Duplex-Cyclone, which had the highest C.A.A. approved rating of any two-row radial aircooled engine then manufactured in the United States, was developed with the cooperation of the U. S. Army Air Corps. It was selected to power the 4-engine Douglas B-19 bomber. It also powered the Consolidated twin-engine Model 31 long-range flying boat.



WRIGHT WHIRLWIND R975 ENGINE

Both the G-100 and G-200 Cyclones had steel main crankcase sections. All Cyclones were equipped with the Wright Dynamic Damper crankshaft, nitrided cylinder barrels, internal valve gear lubrication, full pressure baffling, and provision for either constant speed or full-feathering propellers. All the single-row Cyclones were basically similar in design. They had a displacement of 1823 cu. in., a bore of 6.125 in. and a stroke of 6.875 in.

The use of the Wright Two-Speed Supercharger, which might be applied to any single or double-row Cyclone, provided the above



WRIGHT WHIRLWIND NINE CYLINDER

A nine-cylinder radial aircooled engine rated at 450 h.p. for take-off.

engines with higher performance characteristics at high altitudes. This device, which was developed by Wright engineers with the cooperation of the Army Air Corps, provided two blower gear ratios, making possible the use of a moderate degree of supercharging for take-off and sea level operation and the higher degree of supercharging required for high performance at high altitudes. The Two-Speed Supercharger mechanism added only a few lbs. to engine weight. It replaced the solid lay shaft used in the conventional supercharger mechanism. Changing from low to high blower or high to low could be accomplished by a simple control installed in the pilots cockpit.

#### Manufacturers of Accessories

The Acrotorque Company, Cleveland, O., developed in 1940 two hydraulic devices, the All Weather Windshield Wiper and the Fast Feathering Control Valve. The Acrotorque Fast Feathering Control Valve, approved for use with the Hamilton Standard Hydromatic Propeller, was designed to assist in the fast feathering of the propeller in emergencies. Purely hydromatic in its action, it imposed no additional load on the airplane's source of electrical energy. Light, weighing less than 3 lbs., it could be installed by numerous methods and in various locations suitable to convenient operation. The Acrotorque All Weather Windshield Wiper was a safety device to enable the pilot to fly contact during rain, snow and icing conditions. Blades incorporated an alcohol dispensing system. Of non-magnetic construction the wiper was hydraulically operated, transmitting an abun-





#### AIRCRAFT WINDSHIELD WIPER

Developed by the Acrotorque Company in cooperation with American Airlines.

dance of power to the wiping blades. Simple in construction and light in weight, it was further flexible with respect to various mounting locations, and adaptable to almost all types and sizes of windshields. Users included the Army Air Corps, Royal Air Force, American Airlines, Pan American Airways, Transcontinental & Western Air and The Glenn L. Martin Company.

Adel Precision Products Corp., Burbank, Calif., suppliers of hydraulic equipment to the aircraft industry, carried out an expansion program equipping it for a production capacity of \$1,000,000 a year, as contrasted to 1938 capacity, when the company occupied less than 200 sq. ft. of rented garage space. In the Fall of 1940, although some expansion already was complete, unprecedented orders made new production facilities necessary. Accordingly, a 10-acre tract was purchased adjacent to the airport in Burbank, where a completely modern steel and brick, air-conditioned plant, occupying some 40,000 sq. ft. of floor space, was erected. In December, 1940, complete facilities for practically every operation required in the manufacture of hydraulic equipment, anti-icing pumps, and similar items, was placed under this one roof. In addition to materially facilitating production, installation in the new plant permitted numerous production economies because of single cost operations made possible where precision

machining, grinding, heat-treating, anodizing and general finishing was placed under a single management.

The year found Adel with a backlog considerably in excess of \$1,000,000, covering hydraulic selector valves, hand pumps, electrically driven pumps, filters and similar items. As in the past, production was maintained only on proprietary items based upon exclusive Adel designs and/or patent rights owned by Adel. Original line of Adel Dual Purpose Line Support Blocks and Clips, accepted by practically every American and many foreign manufacturers, was continued with sufficient facilities to increase output to the necessary level for meeting the entire requirements of the national defense program. Over 2000 different items were represented in that particular Division.

Aero Instrument Company, Cleveland, O., in 1940 continued manufacturing instruments for the aircraft industry.

Aero Supply Mfg. Co., Inc., Corry, Pa., manufactured a complete line of engine controls, hand and power drive fuel pumps, fuel valves, strainers and armament accessories.

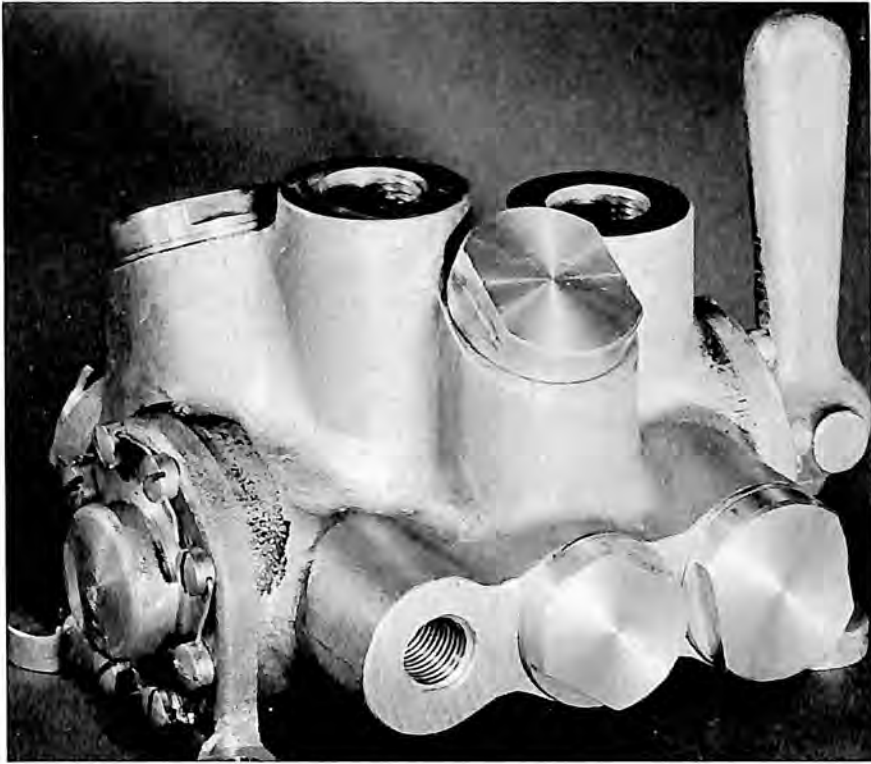
Aeromarine Instrument Company, Bronx, N. Y., manufactured aircraft instruments, including altimeters, airspeed indicators and compasses used on light planes. They were a contributing factor in bringing the price of a small plane within reach of the average man, the company stated.

In the company's A-N standard instrument department, instruments were built to A-N Standards to prevailing government specifications for domestic and foreign military requirements. The whole organization was geared up to meet rapid changes in instrument developments.

Aeroproducts Division, General Motors Corporation, Dayton, O., manufactured a product that was on the confidential list of the U. S. Army Air Corps. For that reason, no account of the company's aircraft manufacturing activity was available.

Air Associates, Inc., Bendix, N. J., underwent an unparalleled expansion. To meet the demands imposed by national defense needs, a new \$250,000 plant was erected in Bendix which more than doubled facilities formerly available at Garden City, N. Y. With increased demands for Air Associates' products even these expanded facilities were found inadequate and plans for additions to the new building were developed before the end of the year.

Construction also was started on a new plant at the Los Angeles Municipal Airport and in 1941 west coast operations were moved from Glendale, Calif., to the new plant with production facilities more than doubled.



FOUR-WAY SELECTOR VALVE

Produced by Aircraft Accessories Corp., it operates under 1,000 lbs. to the square inch of hydraulic pressure with only 6 lbs. of pressure on a  $2\frac{1}{2}$  in. handle.

Aircraft Accessories Corporation, Glendale, Calif., manufacturers of hydraulic actuating equipment for aircraft, in 1940 moved into a new plant in nearby Burbank which made possible tripling of production on unfilled orders totaling over \$1,600,000. The new plant building, containing 46,000 sq. ft., was erected in double-quick time to expedite supply of equipment to plane manufacturers engaged in filling national defense and British orders. Research and experimentation were intensified in the new plant, to permit development of new hydraulic equipment and further improvement of present products, including Airaco Directional control valves, hand pumps, check valves, relief valves, brake valves, and pressure regulators.

Aircraft Accessories Corporation No. 40000 Automatic Pressure Regulator was compact, and had a total weight of five lbs., without

plumbing. It was designed to handle pressure loads up to 1,500 p.s.i. The corporation built hydraulic actuating cylinders for a leading aircraft builder. One cylinder was for retraction and lowering of landing gear, while the other was designed to actuate the flaps of the airplane. The Model 62008 four-way hydraulic selector valve, manufactured by the corporation, incorporated a flow governor regulating extension and retraction time of flaps and landing gear, and a pressure governor controlling action of the flaps within fixed ranges of load. The pressure governor automatically actuated the flaps when speeds in excess of a plane's design limits were attained.

Aircraft Accessories Corporation also manufactured the No. 65009 hydraulic hand pump for use as a stand-by source of power; a complete line of single and double ball check valves to provide a means of positive non-reversal of the directional flow of fluid in the hydraulic system, and the No. 62002 four-way selector valve, which required only slight pressure for operation.

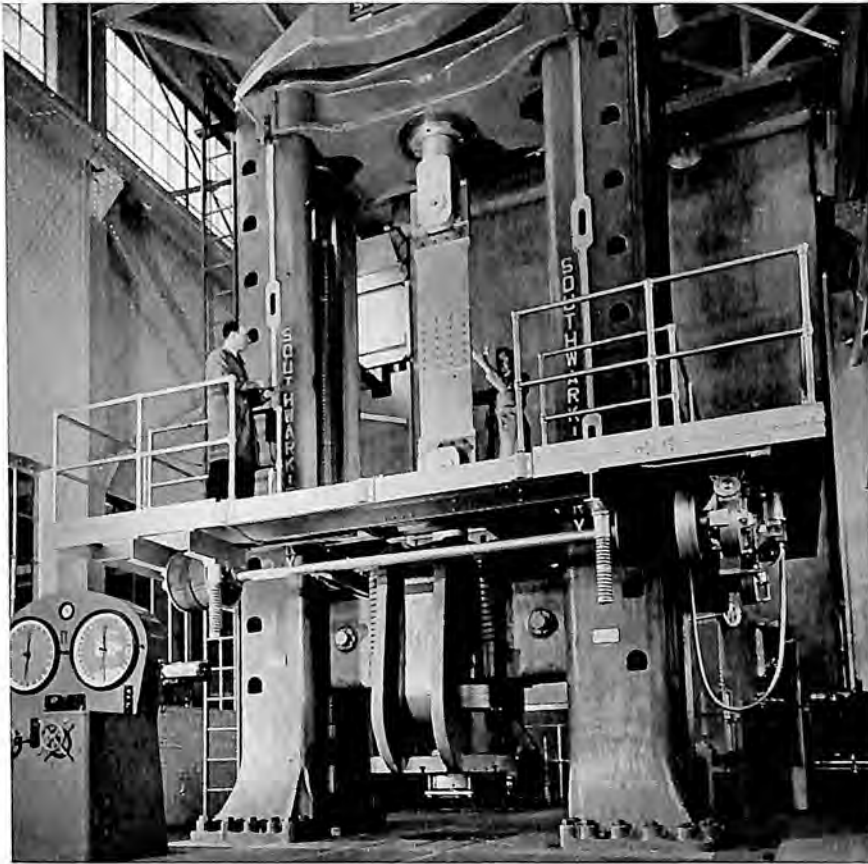
Aircraft Tools, Inc., Los Angeles, Calif., added the production of high speed drills, micrometer stop counter sinks, a new line of 45 and 90 degree heavy duty angle drills, a complete line of hole saws, and Allen screw type drill adaptors, all high speed precision small tools for aircraft builders. In addition to inaugurating production of precision small tools, the company continued production of its standard line of aircraft production tools.

Aircraft Hardware Manufacturing Co., Inc., Bronx, N. Y., manufactured many types of constructional hardware for aircraft, and continued manufacture of its standard line of bolts, nuts and turnbuckles. The company's stainless steel department expanded to four times its original size, with special screw machine parts and swedging terminals leading all items in sales. Intricate precision screw machine products were carefully checked in this department for dimension, exact tensile and hardness range, perfect plating, passivating or anodic finish.

The Ajax Metal Company, Philadelphia, Pa., furnished brass, bronze, nickel and aluminum alloys—metals used in making castings for various airplane parts—in ingot form to the aircraft manufacturers, in accordance with their latest specifications.

Aircraft Radio Corporation, Boonton, N. J., produced its line of radio receivers and transmitters.

Aluminum Company of America, Pittsburgh, Pa., expanded its facilities for producing aluminum and aluminum alloy materials for aircraft construction to meet the increased demand created by the Government's airplane building program. This increase in the company's facilities was the beginning of a \$150,000,000 expansion pro-



ALUMINUM COMPANY'S GIANT MACHINE

Templin universal metal working machine installed in Aluminum Research Laboratories, is capable of exerting a force of 3,000,000 lbs. in compression and 1,000,000 lbs. in tension. This precision instrument is used for study of characteristics of aluminum materials and structures.

gram, undertaken in the interest of national defense, by which productive capacity was to be increased by the middle of 1942 to more than twice the 1939 capacity. In addition to increasing its output of aluminum and aluminum alloy castings, sheet, Alclad sheet, tubes, screw machine products, rivets, extruded and rolled shapes, rods, bars and forgings, the company continued its research program. One of the most important developments in the Aluminum Research Laboratories was the placing in operation of the Templin universal metal working and testing machine. Most powerful device of its

kind in the world, this giant precision machine permitted study of materials and structures in their full size, rather than in the scale models to which the laboratories were formerly limited. Valuable information about aluminum was expected from the use of that machine.

American Bosch Corporation, Springfield, Mass., in 1940 went into production on 7-cylinder aviation magnetos and greatly expanded its facilities for producing 9- and 14-cylinder magnetos, the latter models having been introduced in 1939. Plans called for the production of 4-cylinder and 18-cylinder magnetos during 1941. Under the impetus of national defense contracts the company commenced the establishment of a branch factory at Providence, R. I., to provide separate and parallel manufacturing facilities for its products.

American Screw Company, Providence, R. I., supplied the aircraft industry with wood, machine and sheet metal screws and miscellaneous hardware.

American Tube Bending Company, Inc., New Haven, Conn., specialized in the production of parts for aircraft and aircraft engines manufactured to the customer's designs and specifications. These parts included intake pipes, small exhaust collectors and manifolds, oil lines, landing gear struts, engine mount rings and control sticks.

Apex Machine & Tool Company, Dayton, O., continued production of its line of power bits, hand drivers and standard and specialized types of universal joints used in the manufacture of aircraft and engines.

Arch Roof Construction Company, New York, designed and constructed hangars and manufacturing plants featuring arched roofs with clear spans to 800 feet with or without an overhead hoist system.

The Aro Equipment Corporation, Bryan, O., further developed its Automatic Fuel Selector Valve, which automatically shuts off fuel line from empty tank and cuts in on fuel line from tank containing fuel. Fuel pumps, hydraulic pumps, vacuum pumps, propeller de-icing equipment, and oxygen supply regulators for high altitude flying, were among other Aro developments. The company built two additions to its factory and added much new precision machinery. Scheduled deliveries were made on large orders for propeller hubs and Aro Fuel Segregators.

The B. G. Corporation, New York, manufacturers of spark plugs, in 1940 developed new spark plug models to keep pace with requirements of high specific power output engines. Additional mod-

els of spark plugs also were developed for use in foreign types of engines. A light weight, compact, portable, spark plug gap-setting tool, was made available especially for field service kits. An ignition harness test set was developed for checking ignition harness to determine whether the wires and terminal sleeves were in satisfactory condition. A large percentage of cases of irregular engine operation due to ignition, in the past believed due to spark plugs, was found by the use of the ignition harness test set to be due to ruptured wire insulation, moisture or damaged terminal sleeves.

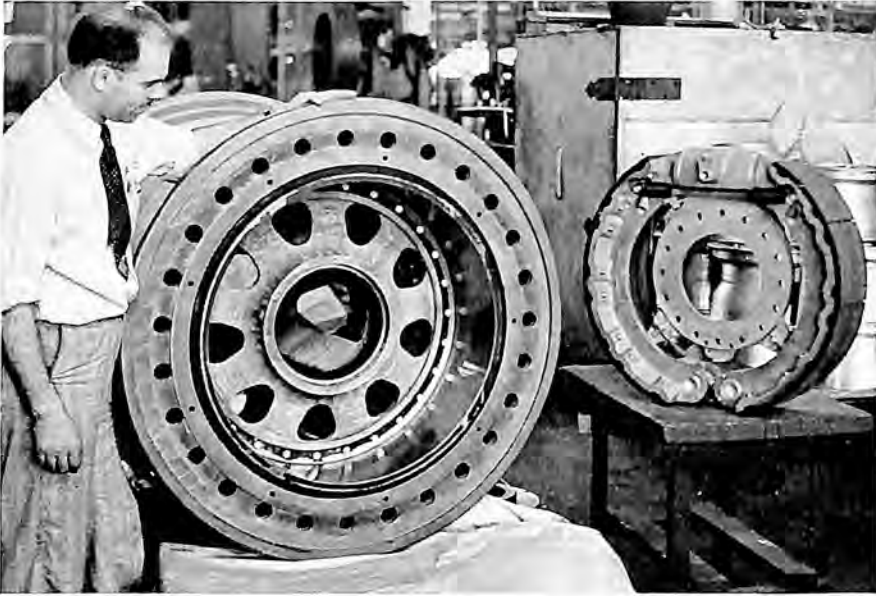
B. H. Aircraft Company, Long Island City, N. Y., continued to supply the Government and aircraft industry with fabricated sheet metal parts of various kinds.

Bendix Aviation Corporation, South Bend, Ind., makers of scores of accessories for aircraft, launched a very large expansion program in 1940 to meet growing national defense demands. From a total of 2,192,129 sq. ft. of floor space and 9,381 employees at the beginning of the year, the company had 2,254,542 sq. ft. of floor space and 12,979 employees by mid-year, and was operating plants and equipment with a replacement value of \$20,000,000. Upon completion of the continuing expansion, the company was to have added another 2,000,000 sq. ft. of floor space, and new machinery and equipment costing more than \$24,000,000. By the end of 1941, 26,000 employees were to be employed in the company's aviation division alone.

The entire expansion program, which called for quadrupling of early 1940 capacity, also involved an extensive program of training of employees.

Research, which in prior years resulted in development of many important aircraft accessories, was continued and the company capitalized on its 1937-1938-1939 research, which cost \$8,256,000, to make available the accessories which the national defense program called for in great volume.

Bendix completed during 1940 one of the major achievements in aircraft landing gear by designing and building one set of 96-in. wheels, complete with brakes, for the world's largest airplane. These wheels were of the smooth contour, dual brake type weighing 1,255 lbs. each when complete with brake drums. These were the largest magnesium wheel castings ever poured, each requiring approximately 2,000 lbs. of metal to produce a finished machined casting weighing only 675 lbs. The brakes for these wheels were of the popular Bendix duo servo type, each designed and tested to dissipate 5,660,000 ft. lbs. of kinetic energy. There were four brakes built having a total capacity of 22,640,000 ft. lbs. of kinetic energy



#### BENDIX BRAKE FOR BIG WHEEL

Developed by Bendix Products Division of Bendix Aviation Corp., this 96-inch wheel has a 30- x 8-inch brake. The wheel is a magnesium alloy casting with demountable flange and dual brakes.

while operating at only 1,000 lbs. per sq. in. line pressure hydraulically controlled.

Other developments were the compensating master cylinder and the power control valve for hydraulic brakes. These units greatly increased smoothness of operation and provided for full brake application while the airplane was parked. In order to study more closely problems involved in airplane brakes, Bendix installed a large brake dynamometer. The dynamometer was a 68,200 lb. machine with an inertia wheel 84 in. in diameter, and weighing 37,000 lbs. It was capable of simulating brake requirements for airplane wheels having a static loading of 25,000 lbs. and a landing speed up to 120 m. p. h.

Many new designs in the oleo shock strut for both military and civilian planes were completed. These shock absorbing units were of the combined hydraulic and pneumatic type. Air under pressure and fluid were utilized in the strut to produce controlled resistance during the operation of the unit. Bendix was in production on shock struts for the largest bombers now being produced in quantities for both the United States and British Air Force and a great number



of smaller struts were being manufactured for all types of aircraft, such as transports, dive bombers, primary, secondary and advanced trainers.

Plants and subsidiaries operated by the corporation, and their products were:

Consolidated Divisions—Bendix Products Division, South Bend, Ind., produced automotive brakes (mechanical and hydraulic), airplane wheels, brakes and pneumatic shock struts, chassis testing and corrective shop equipment, Stromberg automotive, aircraft, and marine carburetors. B-K vacuum power braking, remote-control gear shifting, remote-control systems for vehicle and industrial applications, Bendix-Weiss constant-velocity universal joints, ordnance equipment; Wayne Division, Wayne, Mich., produced aircraft engine components and undercarriage equipment; Eclipse Machine Division, Elmira, N. Y. produced Bendix starter drive, red cap and industrial hose couplings, mowerake, Morrow bicycle coaster brake, Bendix Startix, ordnance equipment; Marshall-Eclipse Division, Troy, N. Y., produced automotive brake linings; Zenith Carburetor Division, Detroit, Mich., manufactured Zenith carburetors, flame arresters and fuel filters; Export Division, New York, managed the sale of Bendix Products in foreign markets; Eclipse Aviation Division, Bendix, N. J., produced engine starters, starter accessories, generators, dynamotors, landing gear motors, de-icer operating mechanisms, vacuum pumps, engine driven hydraulic pumps, and miscellaneous accessory equipment; Pioneer Instrument Division, Bendix, N. J., manufactured aircraft instruments and equipment and navigation instruments; Philadelphia Division, Philadelphia, Pa., produced electrical and mechanical components; Julien P. Friez Division, Baltimore, Md., weather and meteorological instruments, flight recording equipment, air conditioning control equipment; Scintilla Magneto Division, Sidney, N. Y., produced magnetos, spark plugs and radio shielding, also Diesel fuel injection systems; Marine Division, Brooklyn, N. Y., Bendix-Cory marine signalling, communicating and lighting equipment, Bendix-Holmes automatic steerer, hydraulic and vacuum remote controls for power-driven water craft.

Consolidated Subsidiaries—Bendix Aviation, Ltd., Burbank, Calif., manufacturers and distributors of Bendix Products on Pacific Coast; Bendix Radio Corporation, Baltimore, Md., aircraft radio devices and radio measuring instruments; Hydraulic Brake Company, Detroit, Mich., hydraulic brakes for motor vehicles; Peco Manufacturing Corporation, Philadelphia, Pa., automotive service equipment and ordnance products.

Non-Consolidated Domestic Affiliated Companies—Bendix-Westinghouse Automotive Air Brake Company, Pittsburgh, Pa., makers of air brakes and air control devices for motor vehicles (51 per cent owned by Bendix Aviation Corporation; 49 per cent by Westinghouse Air Brake Co.); The Lubrication Corporation, Chicago, Ill., automotive and industrial lubricating equipment (jointly owned by Bendix Aviation Corporation and Standard Oil Company of Indiana); Jaeger Watch Company, Inc., New York, eight-day and magnetic automotive clocks and chronometric tachometers.

Bendix Aviation, Ltd., Burbank, Calif., expanded its floor space 160 per cent, personnel 400 per cent and its equipment 150 per cent and brought to the aviation industry many new and improved developments in radio, hydraulic units and landing gear equipment. Custom built radios to meet the exacting demands of air lines, military, export and private owners were developed and manufactured. To meet the demand for export military equipment, a continuous tunable master oscillator transmitter was designed. This transmitter, known as Type TA-15A, had a very wide frequency coverage, exceptional oscillator stability, and met a definite need in the export military field. A special high gain interphone amplifier was developed to work with headphones and microphones of British design. Numerous interphone station boxes were necessary to provide operational characteristics suitable to meet military requirements, and many miscellaneous radio accessories were constructed to be used in connection with main radio units manufactured by Bendix Radio Corporation.

A complete line of hydraulic equipment was developed to meet the requirements of all types of aircraft, i.e., hand pumps, selector valves, actuating cylinders, check valves, relief valves, restrictor valves, power brake valves, quick disconnect couplings, pressure regulators, sequence valves, pressure warning switches and completely engineered hydraulic systems. A unique development was the multiple bank selector valve. This unit incorporated three separate valves in a common housing with a common pressure and exhaust manifold. The valve was operated by handles attached to concentric shafts protruding from one end. Any valve could be operated independently of the others.

Landing gear equipment was designed and manufactured to meet requirements for airplanes up to 20,000 lbs. gross weight. Complete engineering service was made available, as well as facilities for testing all types of landing gear equipment.

Boots Aircraft Nut Corporation, New York, developed the light

weight Boots Aircraft nut, a stamping from sheet metal produced by the Scovill Manufacturing Company and United-Carr Fastener Corporation. The Boots Stamped nut, known as the wing style, was from 20 to 60 per cent lighter than other approved self-locking nuts and was generally less expensive, the corporation stated. This stamped nut was said to allow a saving in weight of more than 50 lbs., in certain types of airplanes. It was used by many major airplane manufacturers. The Boots Aircraft nut consisted of two portions—a load-carrying portion and a locking portion. The two were connected by a spring member, which was forced to expand well within its elastic limit, as the nut was screwed upon the bolt. Thus a resilient force was established and maintained between the load carrying threads of the nut and bolt, which force acted in the same direction as the tightening force. These features eliminated all axial play between the threads, acting with rather than against the tightening force. Boots nuts were authorized for use in airplane construction by the Army, Navy and Civil Aeronautics Board.

Breeze Corporations, Inc., Newark, N. J., serving most types of transportation in peaceful or wartime pursuits, in 1940 devoted 90 per cent of its manufacturing facilities to national defense contracts. A backlog of \$11,863,000 was on the corporations' books as of December, 1940. Shipments in 1940 totaled nearly \$5,000,000 as compared with \$2,598,982 in 1939. Four plants operated by Breeze in Newark and one in Elizabeth, N. J., increased combined floor space to more than 300,000 sq. ft. A total of \$250,000 was spent for new equipment, materials, plant structures and personnel.

A new method of manufacturing armor plate faster for American warplanes and other fighting units was developed. Improvements in and increased production of cartridge starters and radio ignition shielding was matched by gains in manufacture of Breeze conduits and fittings, conduit junction boxes, swaging machines and hand swaging tools, electrical connectors, exhaust gas analyzers, resistance type thermometers, tab controls, ammunition rounds counters, internal tie rods, tachometer, fuel pump and remote control drives, doors and hatches for vessels, and other equipment, including stainless steel structures and fabricated products. The Breeze radio ignition shielding was refined and supplied with improved flexible conduits, gaskets and connectors. The improved components were effective in making shielding assemblies watertight to meet current Army-Navy specifications. Disconnect plugs were used on spark plug leads on some engines so that portion of the ignition cable having the shortest life was replaceable without complete removal and rewiring of a shield. A new line of multiple-circuit electrical connectors was

introduced for use at firewall, generator, radio and instruments with improved contacts. The line conformed with latest Army-Navy specification, and included single units for accommodating as many as 42 circuits. The Breeze fuel-air ratio indicator gave a fast, accurate reading of the fuel-air mixture based on analysis of the exhaust gas. The engine Cartridge Starter developed by Breeze secured its energy from a shell using slow-burning fuel to generate the required power at a controlled rate which provided ample torque without danger of shock to engine parts. The starter could be used without drain on the airplane battery, as the shell was fired by the current from a flashlight cell.

Briggs Manufacturing Company, Detroit, Mich., as a sub-contractor to the aircraft industry, manufactured an increasing number of wing panels for Boeing Flying Fortresses.

Cambridge Instrument Company, Inc., New York, developed precision instruments for use in the increasingly important practice of aviation medicine. The company also developed instruments for use in industry and research laboratories. Cambridge Electrocardiographs for the use of heart specialists were produced in growing number, with many earmarked for physicians connected with the air services. This work was carried on in the company's plant at Ossining, N. Y., where a 75 per cent plant expansion was completed during the year. Instruments manufactured included completely automatic gas analyzers for determining oxygen, hydrogen, carbon dioxide and carbon monoxide.

Champion Aviation Co., Los Angeles, Calif., introduced light-weight, wind-driven generators. These generators were especially designed and built for aircraft use, particularly in light planes. They were of streamline design, built of Dural wherever possible, with electrical parts of cadmium plated brass. They were equipped with voltage control and release to prevent over-charging. On the four larger models the propeller position was made adjustable to produce maximum power on all variations of cruising speed. Six powered models of 6, 12, and 20 ampere capacity weighed only 6, 9, and 13 lbs. respectively. Twelve-volt models of the same weight were available in 4, 8, and 15 ampere sizes.

Champion Spark Plug Company, Toledo, O., in 1940 continued to expand production of a mica insulated spark plug and also developed a successful ceramic insulated spark plug for use in high output engines. A 30,000 sq. ft. plant expansion was scheduled for quantity production of the new ceramic insulated plug. Champion continued its policy of devoting its resources to research, engineering and manufacture of spark plugs only.

Chandler-Evans Corporation, South Meriden, Conn., makers of Ceco fuel pumps and non-icing carburetors introduced a device called Protex-Plug, designed to protect aircraft engines against corrosion during shipment and storage. It operated on the principle of chemically dehydrating the atmosphere surrounding the surface to be preserved. It was in the form of a dummy spark plug containing the dehydrating chemical and was installed in the spark plug holes in aircraft engine cylinders. The development was started by United Aircraft Corporation and taken over under license by Ceco. The corporation also completed design, development and flight test of an entirely new type of carburetor, in which substantial saving in weight and space over previous models was indicated. The corporation continued production and delivery of its line of fuel pumps and non-icing carburetors. Equipment was added to build up fuel pump production to the point where Ceco pumps represented a substantial element in the national defense program.

The Cleveland Pneumatic Tool Company, Cleveland, O., manufacturers of Aerol Shock Absorbing Struts and Cleco Pneumatic Tools, in 1940 greatly increased engineering, testing, and manufacturing facilities. A large and fully equipped drop test laboratory was built, and much larger floor areas were provided for manufacture of struts and pneumatic tools. A large building for the heat treating department, more than three times the former size, was erected, and completely equipped with modern furnaces and related quenching and recording devices. The company continued to increase its line of riveters and squeezers for aircraft manufacture, and methods of flush riveting received special attention. Production of sheet holders during the year ran into millions. Cleco sheet holders were used to hold sheets together and were applied to structural members during the riveting process. They were reported to save about three fourths of the preliminary fastening time.

Climax-Molybdenum Company, New York, manufactured Chromium-Molybdenum steel for aircraft. It was an established material because of its satisfactory welding characteristics and high strength-weight ratio. The company reported that it could be fabricated into seamless tubing as well as into sheet and bar stock; that it would withstand severe cold, and also respond uniformly to heat treatment.

Curtiss Propeller Division, Curtiss-Wright Corporation, Caldwell, N. J., supplied standard equipment for Army pursuit airplanes, including the Curtiss P-40 and P-36A, Lockheed P-38, Bell Airacobra and the Republic Lancer series. Curtiss propellers also were adopted by the Navy, as standard equipment for such planes as the Grumman F4F3 and Brewster F2A2 fighters. The Curtiss Tomahawks and

Mohawks, Lockheed, Brewster, and Grumman fighter planes used by Great Britain also used Curtiss Propellers. As a result of the demand for this type of constant speed, full-feathering aircraft propeller, the Curtiss Propeller Division expanded its facilities. At the end of 1939 the company had three plants, with an area of 490,000 sq. ft. It increased to four plants, with 1,000,000 sq. ft. by the end of 1940, and the complete expansion program called for five plants with total floor area of approximately 1,415,000 sq. ft. Full implications of the growth of this new Curtiss-Wright Division were seen in the fact that, on July 31, 1938, Curtiss Propeller Division numbered only 111 employees, with 17,000 sq. ft. of floor space. In 1940, the Division moved its headquarters to Caldwell, N. J., with plans to bring employment to a total of nearly 15,000. Operations started in the new, modern plant within 96 days of ground-breaking. The factory, originally built to cover 270,000 sq. ft., was extended even before completion, so that its total area became 380,000 sq. ft. On January 1, 1941, faced with increasing national defense requirements, the Division acquired part of the old Marmon Motor Company plant at Indianapolis, Ind. This factory enclosed more than 400,000 sq. ft. and plans called for employment of 4,000 persons. In February, the Division announced it would build a 415,000 sq. ft. propeller plant at Beaver Borough, about 20 miles northwest of Pittsburgh.

During this period of expansion, the Division continued its engineering and technical progress. It developed, especially for use on the Bell Airacobra a so-called "hollow shaft" propeller permitting an aircraft cannon to fire through the hub. Four-bladed propellers, which permitted the most efficient use of the 1,850 to 2,200 h.p. available in newer engines, were tested and placed in production on such planes as the Martin B-26 and the Republic P-47B. Reversible pitch propellers, which facilitated maneuvering on the water, and automatic synchronizer control, which resulted in quieter propeller operation and reduced strain on the pilot, were adopted as standard equipment for large flying boats, such as the Consolidated PB2Y-2. Development of hollow steel blades continued on an increased scale, due largely to the lighter weight of propellers with this type of blade, and to the superior abrasion characteristics of the steel blade as compared to other materials. Also, steel blades remained the only type for which blade shank "cuffs" were available. These so-called "cuffs," which increased width of the inner portion of the blade, resulted in improved cooling of aircooled engines, thus permitting use of smaller engine cowl openings, with resultant increased airplane performance.

Diebold Safe and Lock Company, Canton, O., in 1940 attracted

much attention as a vital defense plant, due to its production of airplane armor. Eighty-five per cent of the company's activity was for the defense program. Plans were made to increase armor production facilities substantially in 1941. Other defense products manufactured by the company were trench mortar stands, armored pilot seats, and complete armored bodies with fittings for scout cars, both 4-wheel and half-track types. To meet its national defense obligations, approximately \$1,000,000 was spent by the company for additional heat-treating, fabricating and assembling of equipment.

Among new business tools developed by Diebold was the Cardineer, a wheel filing system, which made possible the handling of active card records in about half the space and at half the total cost of ordinary record systems equipment. The Cardineer made it easy to post or refer to records, by presenting every record at one common position and holding it there without effort on the operator's part until work was finished. The unit was compact and portable. Another business tool was the Diebold Sectional Drawer Visible Filing System which enabled users to build each stack of Visible Files to suit their requirements.

The Detroit Macoid Corporation, Detroit, Mich., during 1940 devoted extensive attention to turning out plastic extrusions as developing shortages in certain metals made this work important to the national defense program. The company's early experience in manufacture of cellulose coatings and molding of plastics for the automobile industry led to its receiving specifications of widely varied types during the year. Many new plastic applications resulted. As an example, the company produced plastic tubing, plastic rod, and moldings extruded in continuous lengths. These products had many advantages, such as light weight and corrosion resistance. Extruded parts were furnished in Thermo-Plastic materials such as Tenite, Lucite, Crystalite, Plastacele, Lumarith, Ethocel, or Vynilite. The Macoid product chiefly used in airplanes was transparent tube. This tube was used for radio lead wires. Organized in 1934, the company by 1937 was furnishing major automobile manufacturers plastic strips in continuous lengths to replace metal moldings, particularly for interior finish. The company in 1941 continued intensive research on new plastic applications designed to benefit the aircraft industry.

The Dow Chemical Company, Midland, Mich., anticipating the increase in demand for Dowmetal and magnesium by the aircraft industry, doubled production at its Midland plant and started construction of a plant at Freeport, Tex., for extraction of magnesium from sea water. This new plant was producing metal early in 1941. In addition to large quantities of cast Dowmetal called for in engine

and accessory parts, increasing quantities of cast Dowmetal were specified for both stressed and non-stressed castings in the airplane itself. In addition to the use of castings, wrought alloys in the form of sheet and extrusions were used in appreciable quantities for such parts as seats, panel stiffeners, turret and canopy framing, oil tanks, cabin linings, wheel fairings, dust covers and hub caps. To meet this greater demand for fabricated parts, Dow rolling, extrusion and foundry facilities in Midland and Bay City, Mich. were increased substantially.

Dowty Equipment Corporation, New York, was formed early in 1940 to manufacture under license from Dowty Equipment Ltd. of Cheltenham, England, landing gear struts, hydraulic pumps, valves, and allied equipment on which the English company held patents. Contracts were closed with foreign and domestic clients. Tests of different units were conducted at Wright Field and in conjunction with airplane manufacturers supplying aircraft to the Government. A complete Dowty Levered Suspension type landing gear and conventional nose wheel strut was developed for use on a new Grumman twin-engine pursuit airplane. Also developed was the Dowty Liveline hydraulic pump, which permitted a simplified type of hydraulic plumbing in aircraft due to the automatic feature of the pump. Quantities of these pumps were installed on the Jacobs L-6MB engine, which was supplied in large numbers to the Canadian Government for installation on Avro Anson twin-engine planes. Considerable research was done and plans were formulated for new applications of the Dowty patents in both the landing gear and hydraulic field.

Dzus Fastener Company, Babylon, N. Y., supplied the aviation industry with a self-locking vibration-proof fastener in a variety of sizes and head styles. This fastener was especially designed for quick assembly or removal of detachable parts.

Eastman Kodak Company, Rochester, N. Y., in 1940 manufactured a number of items of photographic equipment for the aircraft industry.

Eaton Manufacturing Company, Cleveland, O., in 1940 appropriated more than \$2,500,000 for building expansions and purchase of equipment necessitated by the company's increasing participation in the national defense program. Additions at five of the company's plants, totalling 170,000 sq. ft. of floor space were completed and two other additions, totalling 90,000 sq. ft., were well under way at the year's end. These expansions enabled Eaton to get into production on many new aircraft engine parts, as well as step up its output of the Sodium-Cooled Valve, developed years ago by Eaton's Wilcox-

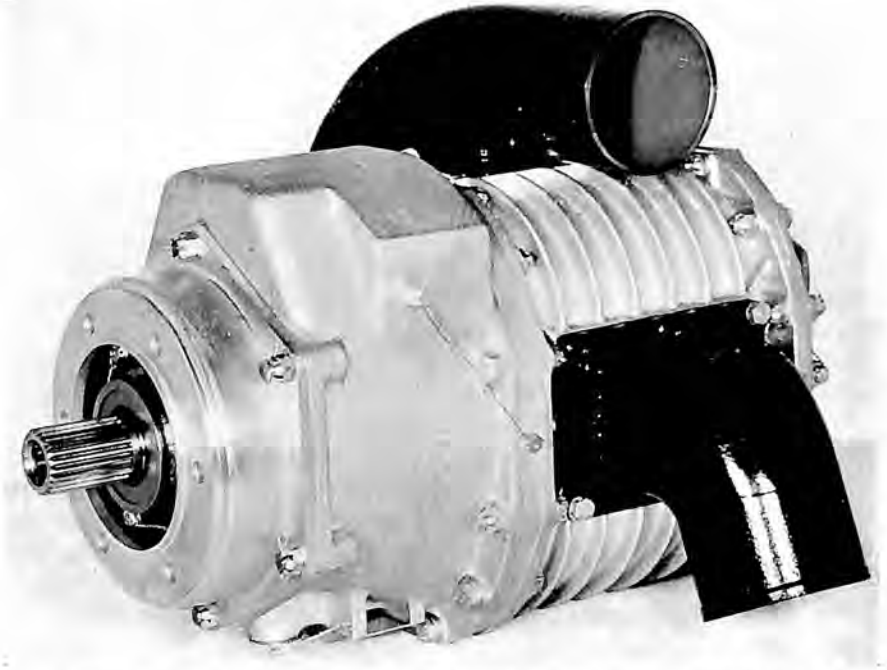


Rich Division, and used in aircraft engines of 300 h. p. or more. The Zero-Lash Hydraulic Valve Lifter, another Wilcox-Rich contribution to engine efficiency and performance, was incorporated in three makes of aircraft engines. Tests were under way on other engines incorporating the Zero-Lash Lifter.

Eclipse Aviation Division of Bendix Aviation Corporation, Bendix, N. J., in 1940 developed many new aircraft accessory units which with increased demand brought about by the defense program, resulted in further plant expansion and creation of subcontracting facilities. It was estimated that from September, 1939, to September, 1941, manufacturing facilities would be expanded tenfold. Decentralization of facilities was worked out to make it possible for Eclipse to manufacture any one product at two or more locations in the event of an emergency.

Eclipse in 1940 developed the Series 42 and Series 43 combination direct cranking electric and inertia starters, smaller and lighter versions of the Series 41 and capable of handling the same size engines. In conjunction with demand for engines of higher output, Eclipse developed the A-160 and A-120 Series of direct cranking electric starters, Series 44 electric inertia starters and the Type III combustion starter, capable of cranking engines rated from 2,000 to 3,000 h. p. A further development in starting equipment was a new direct cranking electric starter for use in the Rolls Royce Merlin engine. This starter presented a new idea in construction, in that part of the starter was built into the engine. A direct cranking electric semi-portable starter also was developed during 1940, consisting of a gear box mounted on the engine and a portable heavy duty electric motor. In an effort to effect weight reduction in starting equipment, Eclipse developed a combination hydraulic starter-pump unit. To provide generating equipment of reduced weight Eclipse redesigned its 750 watt and 1,500 watt generators with a resultant decrease in weight of 30 per cent. Progress also was made in development of main engine driven DC generators with capacities ranging up to 6 k. w. at 30 volts, and 12 k. w. at 110 volts. For use in conjunction with these generators, several new and improved types of voltage regulators were developed. Supplementing its standard line of battery operated dynamotors, Eclipse developed a series of dynamotors of new design.

Among miscellaneous electrical devices developed by Eclipse were motor-generator sets capable of providing 800 cycle, 110 volt power from a DC or AC source of supply. In addition, development work was completed in connection with several 12, 24 and 110 volt explosion proof motors for various applications. Other electrical



ECLIPSE "ROOTS BLOWER" TYPE CABIN SUPERCHARGER

devices were improved. These included Solenoid operating switches, battery booster coils of greater effectiveness, improved relays and other devices to supplement power supply systems for aircraft. In line with increased demand for electrical power, Eclipse developed several types of 2 and 4 cycle aircooled engines for long-range aircraft in capacities up to 10 k.w. In particular Eclipse designed a 2-cylinder aircooled super-charged engine for driving both the generator and cabin supercharger. A light weight, sea level, 2-cylinder aircooled engine was in the process of design. To provide sufficient power take-offs for additional accessories without redesigning the main aircraft engine, Eclipse developed a 50 h. p. output gear box of 5 drives and a 30 h. p. output gear box of 7 drives. Increased demand for auxiliary power supply systems for battery charging and radio operation was responsible for increased development in this field.

One of the major Eclipse developments was an entirely new series of air pumps, which successfully passed all endurance tests. Of entirely new construction throughout, these pumps required very little lubrication and gave long service. A series of 3 snap action de-icer

distributor valves also were produced. Inflation time was reduced to approximately 5 seconds. These new valves required no remote cable or push rod for control. The distributor was controlled by an electric switch in the pilot's compartment which stopped the distributor in a fixed position, and thereby permitted passage of air from the distributor overboard through a venturi, which in turn produced the vacuum necessary to hold the de-icers flat against the wing surface in the "off" position. Eclipse also developed a vane type anti-icer pump to meet the need for supplying alcohol to the carburetor to prevent ice formation. All of the operating parts of the pump were made from stainless steel and the motor was completely enclosed and explosion proof. Several types and sizes of cabin superchargers, such as the Roots Blower type for small planes, and a centrifugal type for commercial transports and bombers, were developed. Other additions to the Eclipse line were a complete new series of engine driven and motor driven spur gear type hydraulic pumps, available in a complete range of capacities and standard drives. Improvement in design increased performance and service life of the Eclipse standard series of "Gerotor" type hydraulic pumps. Further development of standard production hydraulic remote control units for other applications was under consideration. Among projects undergoing development were constant and variable volume piston type hydraulic pumps, high speed lightweight motor driven pumps, and hydraulically operated wind shield wipers. An electric propeller governor control was designed and manufactured for use in conjunction with a Curtiss electric constant speed propeller. In addition, certain improvements incorporated in the standard propeller control resulted in improved operation and longer service life.

Edo Aircraft Corporation, College Point, N. Y., manufacturers of all-metal seaplane floats for airplanes ranging in gross weight from approximately 1,000 to 20,000 lbs., in 1940 expanded its manufacturing facilities from approximately 16,000 sq. ft. of floor space to approximately 84,000 sq. ft. with 47,000 more sq. ft. under construction. The expansion was necessary to take care of large defense orders for the U. S. Navy and foreign governments as well as private and commercial users. The company worked on Navy orders of special floats for Vought-Sikorsky Dive Bombing and Scout Observation types, for Curtiss-Wright Observation Scout planes, Ryan Military Trainers, and Northrop Patrol Bombers. The latter ship was stated to have the fast speed of 230 m. p. h. as a seaplane. The company's experimental and development program also was expanded to study float gear for special defense needs. The outstanding trend in the commercial and private fields was the tremendously increased demand

for light plane floats, caused partly by the Civilian Pilot Training Program, partly by lack of sufficient airports, and partly by greatly increased seaplane facilities. The latter development was due largely to the National Youth Administration-Civil Aeronautics Administration seaplane landing float program, under which hundreds of seaplane landing floats were built throughout the country.

The Eisemann Magneto Corporation, New York, developed the Model LA Aircraft Magneto, completely shielded and adaptable for use on 2, 4, 5 and 6-cylinder engines. It continued all the features of the AM Aircraft Magneto, such as unit cast housing with integral mounting flange, a single piece cast magnet rotor, self-lubricated bearings, complete sealing against entry of oil or fumes and thorough ventilation. Many models of magnetos for the aircraft industry were produced in the Eisemann plant at Brooklyn, which added personnel and floor space and operated on two shifts to meet increased demands. The Eisemann Model AM-4 Aircraft Magneto was used extensively in the Civilian Pilot Training Program. This unit was of simple and compact design, sturdy in construction, had few moving parts and an electrical circuit affording a wide margin of safety, and still was small and light. The company continued its policy of having field agents pay periodical educational calls upon managers of airports, flying schools, and operators of aircraft.

The Electronic Specialty Company, Glendale, Calif., manufacturers of lightweight aircraft radio receivers and transmitters, developed a new type ultra-high frequency Radio Flight Instructor for use at schools and by traffic control towers. Make-up and operation of the Radio Flight Instructor was described by the company as follows: "The transmitter is crystal controlled on one of the four ultra high frequencies assigned for this service, and the matched receivers in the planes are pre-tuned to the transmitter frequency. The only control on the receiver is for volume, and the sets are automatically turned 'on' and 'off' when the headphones are plugged in." A number of flight schools used the Radio Flight Instructors to correct student errors from the ground, and for traffic control. Electronic entered large scale production of lightweight aircraft radio receivers and transmitters, manufactured under American Telephone and Telegraph license, in 1940. Developed primarily for private owners and fixed base operators, Ranger radio equipment built by Electronic Speciality was extremely simple to operate. The Ranger Beacon receiver weighed less than 8 lbs. complete with battery pack and headphones, and covered a frequency range of 200-400 kc. Another product was a portable, two-way radio telephone unit that weighed approximately 13 lbs., including batteries. The

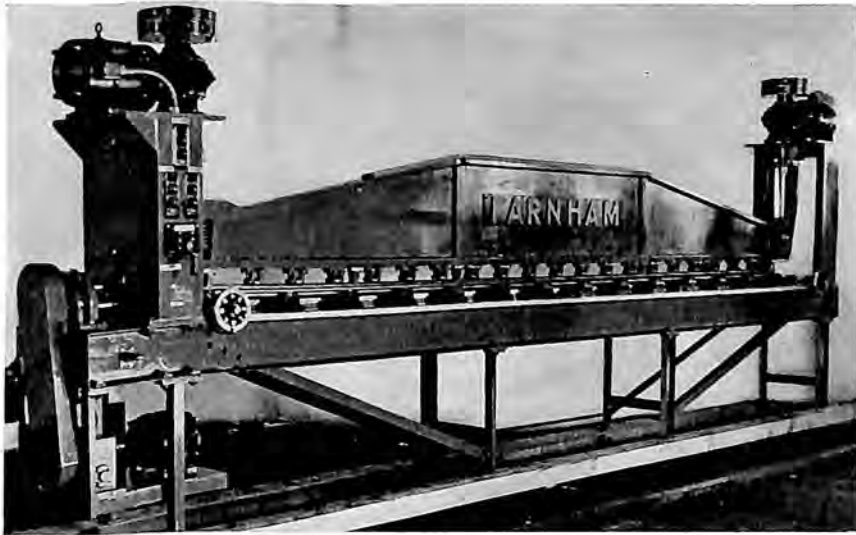
receiver covered the 200-400 kc band, and the transmitter was crystal controlled on 3105 kc., the established channel for plane-to-ground communication. Circuits were so designed that while transmitting, the receiver tube filaments were automatically cut out. Life of the built-in battery pack was thus extended to approximately 150 hours of operation. Instantaneous heating tubes made this possible. A unique feature of this radio unit was that a built-in loud speaker could be used when the receiver was placed away from the plane, such as in hangar offices, homes or at hotels.

Fairchild Aviation Corporation, Jamaica, N. Y., in 1940 developed, among items not held confidential for defense purposes, the Fairchild median octant, the Fairchild T-5 aerial camera, and the Fairchild K-15 aerial camera. Under the stimulus of the national defense program Fairchild stepped up production to the highest point in its history. A 4-story addition to its plant at Jamaica was completed and construction was started on another 4-story structure, expected to be ready for occupancy in April, 1941. The completed program of expansion contemplated an increase of more than 100 per cent in manufacturing floor space. Personnel was increased by more than 50 per cent and a further increase was scheduled when additional manufacturing facilities became available. Company dollar volume was 80 per cent higher than 1939 and unfilled orders as of December 31, 1940, amounted to approximately \$21,000,000, compared with \$1,923,200 on December 31, 1939.

The Fairchild median octant was developed to meet the need for a rugged, dependable instrument for measuring the mean value of a number of observations taken for the purpose of determining the altitude of a heavenly body. A series of observations could be made in rapid sequence and instantly recorded, after which the mean was determined quickly by rotating a convenient altitude setting knob which gave the desired value on a drum type counter graduated to permit readings to one minute of arc. The instrument measured the altitude of the heavenly body from zero to 90 degrees. A horizontal star field of about 11 degrees and a vertical star field of about 8 degrees was covered by this octant, which was of extremely compact design and weighed only about 2 1/2 lbs. The Fairchild T-5 aerial camera was designed especially for precise topographic mapping photography. Among the unusual features incorporated in this camera were a built-in view finder, intervalometer, light meter, and the mechanism which recorded on each exposure, the time of the exposure, serial number of exposure, serial number of camera, flight altitude, level bubble indication of camera verticality and data card for recording date and other information pertinent to the flight. A

special shock proof vertical suspension mount was provided to hold the camera in a vertical position in the airplane. The Fairchild K-15 aerial camera was provided to help meet demand for various special military type aerial cameras. The K-15 was designed especially for high altitude oblique and vertical reconnaissance photography from both standard military type aircraft and pressure cabin aircraft. A trip lever adjacent to the right hand grip permitted tripping of the shutter with the forefinger of the right hand. Therefore, when used for oblique photography, the photographer never needed to release his hold from the camera, either for winding or tripping. The camera was equipped with focal plane shutter adjustable for speeds of  $1/75$ ,  $1/150$  and  $1/300$  of a second. Provisions were included for attachment of suitable filters. An electrical heater was provided to prevent filter from fogging when taking photographs immediately after a descent from high altitude. Fairchild Aerial Surveys worked extensively on three continents in 1940, completing work on maps outside the United States covering more than 40,000 sq. mi. Operations were carried on by a fleet of ten mapping airplanes.

Farnham Manufacturing Company, Buffalo, N. Y., in 1940 brought to fruition several years of experimentation with machinery designed to reduce man-hours per plane in the aircraft manufacturing industry. The year, with its tremendous expansion of the aircraft industry, created unprecedented demand for Farnham machines. After so many years of experimentation, the company was ready to deliver several types of machinery new to the industrial world. Concentrating exclusively on aircraft production requirements, Farnham increased its production tenfold during the year. By April, 1941, this production was scheduled to be doubled by addition of new facilities. Many new machines were reported by the company to be on the drawing boards at the end of 1940, but officials were not ready to disclose their nature. The following machines, fully developed, were produced in 1940. Farnham leading edge forming rolls, about 50 of which were put in use by 21 leading aircraft manufacturers. Capacities varied from 6 ft. rolls to roll down to a  $3/8$  in. radius, to 20 ft. rolls to roll  $3/6$  in. material to  $1\ 1/2$  in. radius. The rolls were fully motorized for faster production. Farnham spar cap milling machine, a high speed miller producing machined-all-over spar caps in a very small portion of the time necessary with conventional methods. Most machines had a bed 30 ft. long. They have from one to seven high-speed heads according to the design of the cap. Actual machining time being only a part of the total time spent on a spar cap, the Farnham organization paid much attention to elimination of time consuming auxiliary operations. Farnham precision counter-sinker,



FARNHAM LEADING EDGE SKIN FORMING ROLL

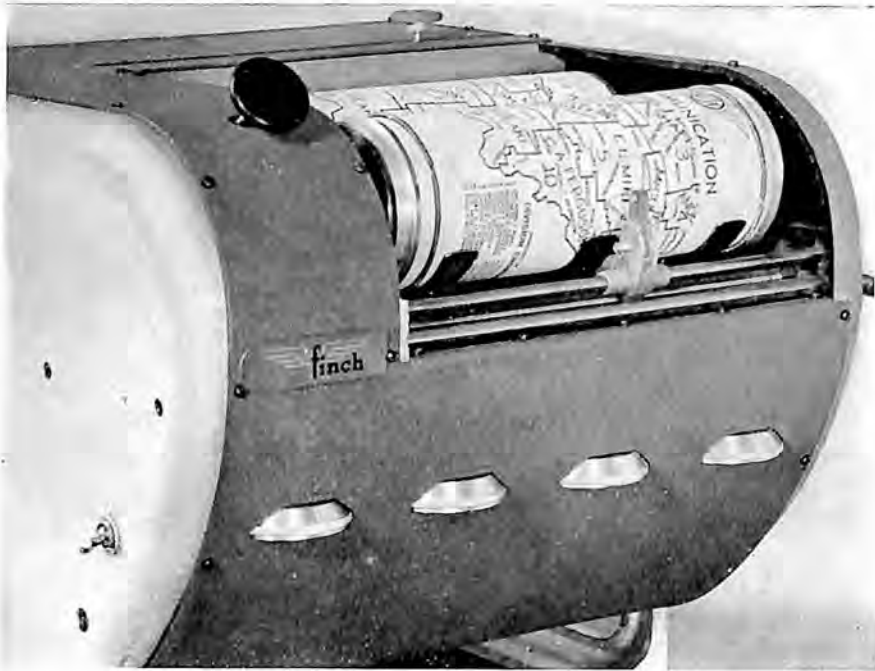
which countersunk holes accurately at high speed and minimized time-consuming and money-wasting rejections.

Farnham arm router and stack drill, two pieces of equipment improved considerably during 1940, the most conspicuous improvement being the use of cast aluminum arms of generous proportions, with less mass and greater rigidity. The Farnham organization conducted continued research on the arm router and stack drill. Officials stated there was still room for improvement.

The Farnham Company, in collaboration with the Bell Aircraft Corporation, in 1940 built an experimental pantograph router. Results were most encouraging, but company officials said much work remained to be done before a fool-proof machine was completed. The company developed several other items, including power driven rolls for cold working rows of spot welds, power driven transfer tables for hydraulic presses, and carriage drills for spar drilling. Improvements also were introduced in Farnham draw benches and stretching benches; also Farnham direct acting rivet squeezers.

Federal Metal Hose Corporation, Buffalo, N. Y., in 1940 furnished to the larger part of the aircraft manufacturing industry flexible metallic tubing in a large range of sizes from 3/8 in. I. D. to 14 in. O. D. This flexible aluminum tubing was supplied to the industry in both the United States and Canada.

Federal Products Corporation, Providence, R. I., manufactured



FINCH FACSIMILE AIRCRAFT "DUPLEX" UNIT

dial indicators and gages which were used in the automotive and aircraft industries for maintaining precision and controlling sizes of finished parts. Gages designed for many different checking purposes were produced, including those for checking engine parts for correct size, checking range and gun bores from .30 caliber and up, checking wall thickness of shells, fuse parts, threads and other defense materials. The company stated that the greatest value of the dial indicator gages was in the accuracy of the comparison and the speed and certainty with which the work could be checked. The plant was working on a three-shift basis and maintaining deliveries.

Finch Telecommunications, Inc., New York, in 1940 produced facsimile transmitting and receiving equipment which made possible the sending or receiving of written or printed matter by radio to or from aircraft. The equipment was considered important due to its possible military and commercial uses. Such items as sketches of artillery positions, weather maps and storm warnings, written orders and reports, and even photographs, could be sent from air to ground, or ground to air, with this equipment. The speed of its operation was high; received copy was printed at a rate of 8 sq. in. to the



minute. If a message was transmitted from typewritten copy, about 75 words per minute could be sent, or 150 per minute if transmitted from fine printed matter. Even 75 words per minute compared favorably with voice communication and the Finch equipment afforded the important additional advantage of a written record. Further, the recorder required no attention or skill in operating. The equipment operated with a battery box and oscillator weighing only about 15 lbs. and worked from any of the standard types of power, or from batteries. Its use replaced the microphone of any voice transmitter operated at zero db or 6 milliwatts at the microphone jack, and replaced the loud speaker of any voice receiver having an audio output of 5 watts. The audio frequency range employed was in the range from 400 to 2,400 cps, coinciding with the limits of ordinary telephone circuits.

Disclosure of the workings of the equipment was made late in the year at Bendix, N. J., airport. News that the Finch Telecommunications company was supplying the units to the British, led to the assumption that the British actually were supplying radio facsimile transmissions in aerial maneuvers and was followed by the demand for the demonstration. The demonstration was made in a plane fitted with a standard duplex facsimile outfit identical with those shipped abroad. Two receiving points were used; one mobile, the other fixed. The demonstration was completely successful. The Finch company also manufactured mobile communication equipment and miscellaneous apparatus.

The Firestone Tire and Rubber Company, Akron, O., through its aeronautic division, in 1940 greatly extended its field of activities and more than doubled its 1939 volume of business. From the laboratories came linings for self-sealing fuel tanks being delivered to aircraft manufacturers. The tanks were covered with steer hide, which did not rip when pierced by bullets. Next to this was a layer of LA-100, special sealing material being turned out by Firestone. This permanently sealed bullet holes, but was slow to act. Therefore, a layer of sponge rubber, which acted quickly but was not permanent, and another layer of IA-100, were used to supplement each other. Cooperation with defense authorities led to development of radio-controlled seadrome contact light buoys. These rubber donuts proved satisfactory to the navy and were used to mark off clear spaces of water at seadromes.

The Formica Insulation Company, Cincinnati, O., producers of mechanical and electrical parts for the aviation industry, in 1940 developed a new fluorescent type of instrument panel legible in the dark when illuminated by ultra-violet or "black light." These marked

instrument panels incorporated the fluorescent chemicals in the body of a plastic Formica sheet to protect them from efficiency-destroying grease.

During the year the company, which produced laminated phenolic control pulleys, fairlead bushing, machined propeller parts and electric insulating parts, more than doubled its molding capacity for control pulleys by installation of additional presses and provision of additional molds. Additional presses were installed late in 1940 which added 80 per cent to capacity for laminated phenolic sheets, from which machined parts for propellers and airplanes were made. Also, a factory addition was built which added 35,000 sq. ft. to floor space. Shortly after Jan. 1, 1941, an additional building was leased which added 55,000 more feet, making a total of 400,000 sq. ft. Productive personnel was increased about 40 per cent.

Fuel Development Corporation, New York, in 1940 made Anilol and Anilol equipment. Anilol was a patent anti-knock and carburetor de-icing fluid. When mixed with fuel each percentage of Anilol by volume increased the fuel's octane value. When used in conjunction with Anilol injection equipment, Anilol not only increased octane rating of the fuel, but also served as a very efficient carburetor de-icer. Originally, Anilol gasoline mixtures of a predetermined value were prepared to meet minimum octane rating requirements of given aircraft engines. Later this was found unnecessary because under ordinary flight conditions, the engines operated only a relatively short time at full throttle. This led to the development of the octane control valve which automatically operated Anilol control fluid in correct proportion at the carburetor air intake when higher octane values were needed.

Anilol and Anilol injection equipment were developed to fulfill the need for a safety device in internal combustion engines operating under emergencies requiring maximum power output.

The Gaertner Scientific Corporation, Chicago, Ill., in 1940 manufactured the O-5-A Aircraft Oxygen Regulators and accessories and the Estoppey Bomb Sight. A considerable amount of development work in automatic oxygen equipment was undertaken. The O-5-A Aircraft Oxygen Regulator supplied oxygen to one person at a controlled rate varying automatically with altitude. This was the type of regulator used by the U. S. Navy. The complete assembly comprised the regulator, an oxygen tank containing compressed gaseous oxygen, a flowmeter and breathing mask. Some installations were supplied with a pipe stem for administering oxygen instead of the face mask.

The regulator was supplied with an emergency valve which bypassed the automatic valve inside the regulator and admitted an ad-



LIGHT BUOYS FOR NIGHT LANDINGS

Night test landings made in San Francisco Bay with the aid of new seadrome contact light buoys developed by The Firestone Tire & Rubber Company and The Westinghouse Electric and Manufacturing Company. Each light unit consists of a pneumatic rubber buoy three feet in diameter, together with the light which it supports and protects from collision. The light is a new type fluorescent, battery-powered unit which rides 24 inches above the waterline. Due to the diamond-shaped section of the rubber float, the lights will not roll more than 20 degrees from vertical, even in six-foot waves. Red, green and amber lights are used in different positions to indicate wind direction and clear water.

ditional supply of oxygen to the mask or mouthpiece. A manually adjustable valve was used to vary the basic automatic rate of flow as needed by the individual user and the degree of his physical exertion. The flowmeter indicated the rate of flow of oxygen and showed whether this quantity was sufficient for the particular flight altitude. A visual red warning signal was provided to show when there was no flow of oxygen. A small bail-out cylinder was developed to allow a flier to breathe oxygen for about 15 minutes, while descending by parachute to a safe altitude.

General Aircraft Equipment, Inc., New York, manufactured a number of items for the aircraft industry and the air services in its plant at South Norwalk, Conn. Oxygen equipment, controls, air cleaners, flame traps, propulsive and flame damping exhausts, cowlings and starters were among the items produced.

The General Electric Company, Inc., Schenectady, N. Y., in 1940 continued development on superchargers and greatly increased its manufacturing facilities for both turbo superchargers and gear driven impellers. Cabin superchargers were supplied for airplanes, with further development work being accomplished. General Electric was also active in electrical control equipment development. Manufacturing facilities were increased to handle production of electrical aircraft

instruments, including d-c selsyns, remote indicating instruments for all engine functions, engine synchronizing indicators, and miscellaneous position indicators. Generators, motors and controls were manufactured for special aircraft applications.

The B. F. Goodrich Company, Akron, O., makers of various aeronautical products, in 1940 carried on vigorously its campaign against formation of ice on airplanes, cause of many tragic accidents. The continuing program of research and development to lessen formation of ice on planes resulted in improvements in de-icers, the pulsating rubber devices that removed ice from the leading edges of aircraft in flight. In the new designs a trend toward larger and fewer pulsating tubes, cleaner aerodynamic shape and simplification of operating systems, was followed. The researches had as their goal exact determination of where ice forms on various types of air foils in various flight attitudes and meteorological conditions, and the types and forms of de-icers best suited to provide adequate protection. The new, wider de-icer will permit more efficient airplanes of higher wing-loadings and greater speeds to operate safely through more severe icing conditions, according to the company's aeronautical engineers.

The possibility of ice building up at the point where the de-icer attaches to the wing is minimized with the use of a fairing flap that is cemented over the fairing strip, providing cleaner aerodynamic shape to the entire installation. This extension was adopted universally by transport operators in replacements ordered late in 1940. The researches also provided valuable data on the pressure distribution around commonly-used air foils, with and without trailing-edge flaps, in all flight attitudes, and the effect of externally-fitted and inflated de-icers. This data permitted stress analyses of the de-icer which promised to be of value in insuring the safe operation of the wider designs. The snap-action distributor valve, first introduced experimentally in 1939, was further improved and installed in new de-icer systems. The valve greatly improved efficiency of the operating system, and made possible control by electrical means. Other developments relating to de-icers included introduction of a greatly improved surfacing material that increased dissipation of static electricity, and perfecting of protective devices for fixed wing slots.

As a result of successful experiments with propeller "feed-shoes" this device, used to cause a more efficient flow of anti-freeze on the propeller blades, was improved. The new design was twice as wide as the experimental feed shoe, half as thick, and 50 per cent longer. An improvement in the aerodynamic efficiency of the device was effected by redesigning the grooves. The weight reduction increased the dependability of the cement bond holding the feed shoe on the



#### GOODRICH TEST FOR FUEL TANK

A ponderous device that simulates by a rocking action some of the stresses and strains imposed on an airplane's fuel tank in flight, was developed by the B. F. Goodrich Company to test its self-sealing fuel tank. Called a "slosh tester," the device rocks the fuel tank in 16 to 18 cycles a minute to measure the effect on the tank of the force of the sloshing fuel.

blade, tests showed. Properly installed and operated, the feed shoe assured complete freedom from ice on the propeller blades, permitting use of full power, according to the company's engineers. In addition, the new design conserved anti-freeze fluid, and because it lessened more effectively the adhesion of ice, it minimized the hazard of damage to the fuselage caused by dislodging of large ice particles.

Comparable improvements were made in other aeronautical products. Military agencies adopted specifications for heat-resisting aviation tire tubes and the company's entire tube line was strengthened with heat-resisting compounds. The problem of proper balance of airplane tires and tubes received considerable attention. Tires and tubes were balanced to closer limits, and marked for proper assembly to counteract unbalance. Substantial improvements in tire performance were noted with refinements in construction methods which also, in several instances, resulted in savings in weight. Experiments in the use of rayon cord in airplane tires were continued. Here the ob-

ject was the obtaining of less weight and higher load rating for a given size tire.

In the field of mechanical rubber goods for aviation use, the company made developments. Bullet-sealing hose and fuel tanks were introduced and installed on many military aircraft. Considerable progress was made in adapting synthetic rubber to various uses in aviation, particularly where oil and heat resisting properties were desired. Among articles of synthetic rubber used in aviation were packings, grommets and gaskets, oil-resisting hose, hydraulic hose assemblies and gas pump diaphragms.

The company's refrigerated wind tunnel continued to be available to the aircraft industry for special test purposes. Numerous wind-tunnel tests of various products were made, including tests of a new hydraulically-powered wind-shield wiper, resulting in its adoption for commercial transports.

The Goodyear Tire and Rubber Company, Akron, O., in 1940 completed development of its multiple-disc brake, designed to bring the fastest and most powerful airplanes to a safe, easy stop. Goodyear engineers tackled this problem with manual hydraulic air brakes when it became evident that, with planes growing larger and faster, the matter of braking to avoid over-shooting landing fields was of vital importance. As a result of the multiple-disc brake development, Goodyear was given a \$2,800,000 order by the Government.

Goodyear research in light metals in the building of metal frames for airplanes led during 1940 to a request that it make plane parts for the aircraft manufacturing industry. By the end of the year the Goodyear Aircraft Corporation, the company's aeronautical subsidiary, was hard pressed to handle the business offered, which included construction of barrage balloons, bullet-proof fuel tanks, and collapsible pneumatic boats and flotation gear for use by planes making forced landings on water. The company's lighter-than-air division, virtually inactive for several years, renewed operations after receiving a contract for six blimps. Goodyear continued manufacture of airplane tires, a field in which the company pioneered.

Grimes Manufacturing Company, Urbana, O., makers of all types of lighting equipment for aircraft service, in 1940 conducted experiments in ultra-violet instrument lighting and introduced new fixtures, including many for combat airplanes such as flush formation, cockpit spot, indicator, recognition, and signal unit lights. Many of these were developed in cooperation with Army and Navy engineers and with aircraft manufacturers, all of whom required new types of lighting units meeting definite performance standards and conforming satisfactorily to particular structural designs. The

Grimes Company, with many years of experience acquired "growing up" with the industry, has been able to solve problems where coordination between aircraft design and lighting results was most necessary. This company was engaged 100 per cent in designing and manufacturing lighting equipment for aircraft.

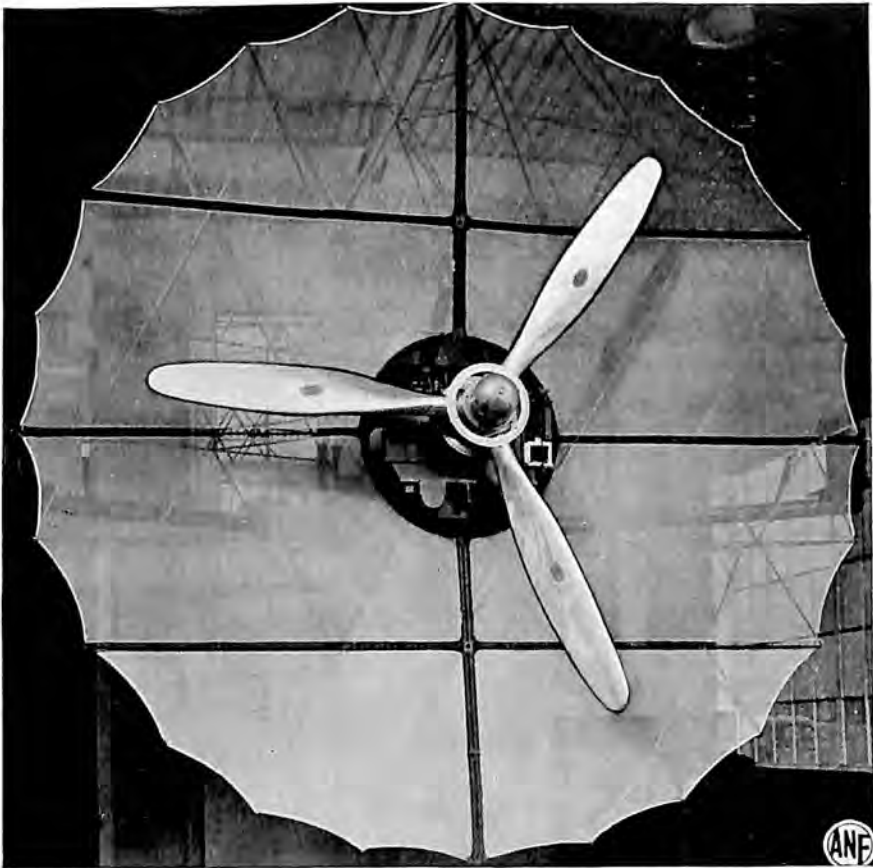
Grimes grew 500 per cent over a period of six months in 1940, adding many new departments and working out new processes to speed production. All parts for every light were made in the company's plant, where processing was carefully controlled, checked, and inspected.

The Gulf Oil Corporation, Pittsburgh, Pa., through its Aviation Department, in 1940 continued to supply aviation lubricants and fuel.

The Hamilton Standard Propellers Division of United Aircraft Corporation, East Hartford, Conn., in 1940 further increased its productive capacity. Additions to the East Hartford plant were completed and a new 200,000 sq. ft. factory put in operation at Pawcatuck, Conn. Floor space devoted to manufacturing at the East Hartford plant was expanded by 50 per cent, bringing the total floor area to nearly 315,000 sq. ft., while employment increased to include 3,000 persons by December. At the end of the year, Hamilton Standard Propellers had on order more than 27,000 propellers for the U. S. Government. Output of Hamilton Standard constant speed and Hydromatic quick-feathering propellers also was augmented by the introduction of straight-through production lines for all major propeller parts. In addition, all manufacturing processes were reviewed to eliminate unessential operations. This led to adoption of new standards for the surface finish of propeller parts, in which the finish was made appropriate to the utilization of the part involved. As a result, propeller blades, domes, etc., which formerly were buffed to a bright polish, were made with a satin finish, while for certain other parts machined surfaces superseded ground finishes. These alterations were limited to insure that the serviceability, safety, and interchangeability of parts were not affected.

Numerous Hydromatic propellers that had accumulated from 5,000 to more than 7,500 hours of service time were returned to Hamilton Standard Propellers for detailed inspection. These propellers all were found to be in excellent condition and were returned to the operators for further service.

Engineering facilities also were increased by the construction of a new test office and laboratory. Among the equipment installed in this laboratory was a new and larger cold room for investigating propeller operation at the extremely low temperatures encountered



**"SPIDER WEB" IN HAMILTON STANDARD PLANT**

It looks like the web of a gigantic spider, but this wire-mesh disc is used to measure any possible lack of aerodynamic balance in the propeller you see mounted in front of it, the most minute variation causing the "web" to flutter. This is one of the typical research activities through which the American aircraft industry is increasing the quality of its national defense products.

in high altitude flying; a high-speed whirl rig on which propeller hubs, molded blade shank fairings, and accessories were tested under centrifugal loads several times those encountered in service; and special apparatus recently developed by Hamilton Standard Propellers for measuring the effects of dynamic and aerodynamic unbalance in full-scale propellers. This apparatus, for the first time, enabled the effects of these two types of unbalance to be separated. The dynamic unbalance was measured by rotating the propeller on a flexibly supported arbor. Motion of the arbor was measured elec-



trically by instruments which revealed the magnitude and location of the unbalance. The determination of aerodynamic unbalance was accomplished by means of a large wire-mesh disc placed in the air stream behind the rotating propeller. This disc remained at rest only when the propeller was in perfect aerodynamic balance. When it was not, the disc oscillated around a fixed axis. These oscillations were indicated by instruments, permitting the amount and angular position of the aerodynamic unbalance to be determined.

The advantages attending the use of molded rubber fairings, developed by Hamilton Standard Propellers to improve the aerodynamic form of the blade shanks and to furnish additional cooling on radial engines, were further extended by the enclosure of de-icing fluid distributor tubes within the fairings themselves. These tubes enabled de-icing fluid to be applied simultaneously at a number of points along the leading edge of the blade thereby improving the distribution of the fluid and increasing the area of the blade which was covered effectively.

In addition to the electrical synchronizing equipment which was introduced several years ago for use on multi-engine aircraft, a new type of synchronizer utilizing a combination of electrical and mechanical control features was designed. This equipment provided accurate automatic synchronization and also provided a substantial saving in installation weight.

In order to minimize the cockpit or cabin vibration of passenger-carrying aircraft, apparatus was developed which permitted determination of the net static, dynamic, and aerodynamic unbalance of the rotating system with the propeller installed on the engine in the airplane. The equipment was portable, and was electrically operated. From the measurements obtained with this apparatus, it was possible to determine the size and position of corrective weights which, when added to the propeller, reduced the vibration at propeller speed to a value below the range of perceptibility. New blade designs were introduced giving increased propeller efficiencies at high airplane speeds. These blades found wide application in the field of high performance airplanes.

The Hartzell Propeller Company, Piqua, O., increased production of airplane propellers, both wood and metal, and of propeller-type air moving equipment. Increases in both personnel and plant facilities were made to meet requirements of the national defense program. Facilities for production of metal propellers, particularly, were increased. To accommodate this increase manufacture of fans was removed from the airplane propeller plant and a new 60 x 460-ft. factory building was erected to house fan production. This increased

space available for production of propellers by 50 per cent. Hartzell manufacturing activities bore both directly and indirectly on national defense. Production of airplane propellers was a direct contribution. Greatly increased demands for Hartzell propeller-type fans and blowers were traceable to industries engaged in defense work. Fans and blowers were used for general plant ventilation, cooling and drying materials and products, man cooling, dispersal of concentrations of fumes, dust and heat, and for other air moving jobs. They helped increase production in many plants which worked on defense orders.

The Harvey Machine Co., Los Angeles, Calif., in 1940 completed development and tests and began production on the new Harvey Radio Automatic Direction Control. This instrument combined the automatic pilot and direction finder in one automatic, electrically controlled instrument. The automatic pilot was controlled by electrical impulses from two radio stations, rather than one. These two signals were mixed and the plane held on a straight line by control of the automatic pilot.

Harvill Aircraft Die-Casting Corp., Los Angeles, Calif., accumulated a backlog of approximately \$640,000, substantial proportions of which were orders from airplane manufacturers building military craft for the United States. The firm, which started 11 years ago with one employee had grown in 1940 into a plant with 65,000 sq. ft. of floor space and 500 employees. This new plant, completed in October, 1940, incorporated advances in employee comfort, safety and convenience. Between 1930 and 1935 Harvill developed new alloys and die casting processes that increased production speed of vital parts required in building aircraft. The Harvill organization was a cog in the 1940 speed-up program of the aircraft industry. Great demand for die-cast parts, in preference to conventional sand cast or fabricated parts, was brought about because of the high tensile strength and light weight of aluminum, brass and magnesium alloys, and the speed with which they were cast. Under Harvill methods it was possible to die-cast specialized parts economically because the need of machining was substantially eliminated. Harvill built its own dies, perfected the Harvill High-Pressure Die Casting machine, and equipped its new plant to maintain a high rate of production. In addition to die-casting parts for the aircraft industry, the Harvill Company produced all types of castings for industrial use, such as dish washers, engine cover plates and model air liners as ornaments. Beside the improved manufacturing facilities provided by the new plant, there was established a special laboratory for chemical and physical determinations of various metals, and also a system



#### DIE CASTINGS FOR DEFENSE

Corner of the Harvill Aircraft Die Casting Corp. plant where thousands of castings are turned out daily, mainly for use in aircraft construction.

of metallurgical control of all products from ingot to customer. Also provided was an alloying department, in which all alloys were compounded direct to Harvill specifications under supervision of the plant metallurgist. Provision was made for research and practical work on customer's problems.

Hayes Industries, Inc., Jackson, Mich., makers of aircraft wheels and brakes, in 1940 continued production of its standard line and at the same time doubled its plant capacity. The reversible hydraulic brake developed a year ago was produced, as was the expander tube brake. The reversible brake was primarily developed for naval aircraft operating from the deck of aircraft carriers, and was so designed that it would hold equally going in either forward or reverse position. The brake also was so designed that the amount of Servo could be changed readily to accommodate the brake for various weights and types of aircraft. The expander tube brake was made under Goodrich-Palmer patents and was constructed of special alloy steel stampings. The brake was operated either by brake fluid, Servo oil, or air, and had no tendency to grab. Torque developed was proportioned directly to pressure applied.

The International Flare-Signal Division of the Kilgore Manufacturing Company, Tipp City, O., continued supplying its parachute flares and signals to commercial aviation, the U. S. Government and foreign governments. This equipment, which included both electrically and pistol-operated types, afforded outstanding advantages in flexibility of installation and operation, safety and dependability.

Flares for emergency illumination from aircraft have been a major development of International during the past decade. The earlier flares were merely large "candles", wired for electrical ignition and affixed to brackets mounted under the lower wings toward the tips, from which their name, "wing tip flares", was derived. Such installations obviously involved abnormal fire hazards, and the illuminative properties unavoidably were so limited that a plane had to descend to a low altitude for effective observation of the ground, thereby greatly reducing the area of illumination and seriously impairing the scope of maneuverability and consequently the chances for a successful forced landing.

With increasing night flying operations, it quickly became apparent that the "wing tip flares" were not only dangerous but extremely inadequate, and also that a suspended source of light effective from relatively high altitudes and independent of the plane, beneath which the pilot, if flight conditions permitted, could maneuver at will over a relatively large illuminated area, was an essential requirement. Parachute flares were known, but they had been designed primarily for military purposes, and the requirements of commercial aviation presented entirely different problems of installation, maintenance and operation.

The smallest approved parachute flare was required to burn not less than one minute and developed more than 70,000 candlepower. Next came a 1½ minute parachute flare with a minimum requirement of 110,000 candlepower. The largest approved parachute flare commercially available was the 3-minute, which developed more than 200,000 candlepower. All these parachute flares were required to have an average rate of descent of not more than 550 feet per minute.

All International Flares were approved by the Civil Aeronautics Administration for commercial use within prescribed limits for the respective types, and were used largely as equipment in the C. A. A.'s own fleet of planes.

Walter Kidde & Company, Inc., New York, manufacturers of fire extinguishing systems for airplanes, and other safety equipment, in 1940 developed a new trailer-type auxiliary fire truck for use at small airports and industrial plants. This unit proved extremely effective, carrying 300 lbs. of carbon dioxide gas in a 6-cylinder installation. It was equipped with hosereel and a special nozzle for use against crash fires. Among other items made by the Kidde Company were Lux Built-In fire extinguishing systems for airplanes, portable extinguishers, flotation gear, life rafts and safety vests. Versatile carbon dioxide gas formed the basis of the many products developed by Walter Kidde & Company. Carbon dioxide, fastest extinguishing

agent known to aviation, was carried by the Built-In extinguishing system. Lightweight piping carried it to a perforated tubular ring attached to the engine mounting. A pilot's control released carbon dioxide gas through perforations in the ring, snuffing out fires breaking out in the accessory or engine compartment. Flame detectors also were developed by Kidde engineers to give a visual or audible warning the instant fire developed. An additional development was the pistol-grip carbon dioxide portable extinguishers for cabin protection. Special machining made these extinguishers extremely light in weight. There were two sizes—one with 4 lbs., the other with 2 lbs., of carbon dioxide capacity. These newest extinguishers augmented the regular line of heavier and more powerful Lux extinguishers for airport, hangar and machine shop protection.

Knu-Vise, Inc., Detroit, Mich., in 1940 manufactured toggle-action clamping devices. The company's products were used in the aircraft manufacturing industry. The line of equipment numbered several types of toggle clamps for varying uses from light through heavy duty. Some of the clamps were portable and were used, for example, to hold sheet metal panels in position when holes were being transferred from one to another, a frequent operation in manufacturing aircraft. The portable clamp was placed in position simply by closing and squeezing the handles, and remained in position until completion of the operation, when opening the handles released the parts. The compound action of toggle levers developed a pressure in excess of 800 lbs. at the jaws of the pliers, with exercise of only 10-lb. pressure of the fingers.

Kollsman Instrument Division of Square D Company, Elmhurst, N. Y., in 1940 developed the Telegon remote direction indicator. The indicator worked on the same principle as the recently developed Kollsman direction indicator, but utilized the Telegon remote indicating mechanism, enabling the aircraft builder to place the compass directional element away from interference by armor plate. Development of the Telegon remote direction indicator was considered a valuable contribution to possible increases in armor protection for fighting pilots. Kollsman continued its rapid growth from the one-man laboratory of 1928 by raising total employees to over 800, almost doubling the working force in one year. With completion, early in 1941, of a new plant addition, and resultant 60 per cent increase in available floor space, employee total was expected to rise to 1,200. Additional plant space also was being used in Long Island City for the Optical Division.

One section of the new building was slated for construction almost entirely of non-ferrous metals to provide a non-magnetic building for

compass assembly and calibration. With growth of the national defense program, almost all production was devoted to supplying increased quantities of standard Kollsman sensitive instruments, such as sensitive altimeters, tachometers, pitot-static tubes, air speed indicators, etc., to the Army, Navy and Great Britain.

Lawrance Engineering and Research Corporation, Linden, N. J., during 1940 produced a line of auxiliary power plants for aircraft use. These motors were used to operate main engine starters, light and heating systems, radio and control mechanism and armament and cabin supercharging equipment.

Lear Avia, Inc., Dayton, O., makers of radio apparatus for aircraft, in 1940 introduced the Learmatic Navigator, which won for its inventor, William P. Lear, the 1940 Frank M. Hawks Memorial Award, for "outstanding contribution to aircraft radio".

Essentially, the Learmatic Navigator was an instrument combining and integrating the indications of an automatic radio direction finder and a directional gyro. This unique instrument permitted straight-line navigation along any desired track, toward or away from a radio transmitting station; straight-line navigation under unknown and varying drift conditions, without visual references outside the airplane; rapid position fix and straight-line navigation to destinations not provided with radio transmitting stations; rapid instrument approach and landing, on land or sea, using a single non-directional marker located on the prolongation of the desired runway or landing lane; all indications of an automatic radio direction finder and all indications of a directional gyro. A circular azimuth scale was divided into 360 degrees linearly, and was provided with an adjustable "desired track" index. The index could be set for any desired degree bearing. The "desired track" index remained stationary with respect to the ground throughout any maneuver, and afforded the pilot a continuous reference of his heading with respect to his desired line-of-flight. In operation, an arrow constantly pointed toward the radio transmitting station to which the instrument was tuned. Since the azimuth scale was linear, both the true and the reciprocal bearings could be read direct from the instrument scale.

Surmounting the instrument was a fixed transparent glass cover on which was etched a miniature reference airplane to aid the pilot in visualizing his position and heading with respect to a radio transmitting station and his desired track. The instrument was mounted in the airplane so that the miniature reference airplane coincided with the actual airplane in which the instrument was installed. Several reference lubber lines, spaced 5 degrees apart, were etched at the forward end of the cover, aiding the pilot in quick visualization of



LEARADIO MACHINE SHOP

minute angles off his line of flight. In operation, the pilot set his desired track index to the course he wished to follow with respect to a radio transmitting station, and tuned his automatic radio direction finder to the frequency of that station. The operation of the instrument was automatic and continuous.

Lear Avia was organized in 1939. It manufactured radio apparatus, instruments and accessories for military, commercial and private aircraft, and maintained direct factory branches at New York, Washington, Wichita, and Los Angeles. The main factory was located at Dayton, O.; a factory at Hollywood was devoted almost entirely to manufacture of non-radio accessories; another factory at Piqua, O., was scheduled to begin producing in March, 1941. The company's 1941 backlog was estimated at \$5,000,000. Best known of Lear Avia products was its extensive line of radio transmitters, receivers, and direction finders for private aircraft. In addition, the company manufactured advanced equipment for commercial and military aviation and for export. Most popular single item of the Lear line was a small portable receiver operating from AC or DC power source or from self-contained dry cells. The 1941 model had three bands (200-400, 500-1,550, 2,200-6,500 kcs.), interphone system, built-in speaker as well as headphones, and provision for connection to an airplane's antenna in addition to the built-in loop. Lear Avia radio accessories included antenna systems, primary line and simultaneous radio range filters, manual and automatic antenna reels, antenna loading coils, crystals, microphones, and headphones. Non-radio accessories for

aircraft included low-power lightweight electric motors, a variety of operational control equipment for the actuation of landing gear, landing flaps, adjustable cowls, rudder elevator and aileron tabs, and other devices.

All equipment, except the Learadio portable, conformed to Government requirements.

The Leece-Neville Company, Cleveland, O., in 1940 supplied the industry with 12-volt voltage regulated engine driven electric generators made in four capacities, 15, 25, 50 and 100 amperes, and 24-volt in two capacities, 25 and 50 amperes. The Leece-Neville voltage regulator provided a desirable method for charging an electric storage battery because, by this method, the battery received a comparatively high beginning charging current, which gradually decreased as the battery charged, until at the end of charging, the current decreased to a harmless value. This was considered desirable because, although an empty battery could receive a comparatively high charging current without harm, it would become overheated and suffer damage if a high current was applied when it was full. Leece-Neville voltage regulation not only protected the battery and other electrical units, but prolonged their lives.

Lenz Electric Manufacturing Company, Chicago, Ill., in 1940 manufactured a variety of wires and cables for use in wiring radio and telephone instruments. Several wires were designed especially for airplane radio and instrument wiring. Outstanding among these wires was Aeroglas, a radio hook-up wire made especially to meet specifications laid down by aeronautical radio engineers. Aeroglas was insulated by cellulose butyrate tape and glass braid, and was impregnated by a flame resisting compound. It offered an extremely high voltage breakdown and excellent flame resistant qualities—both desirable characteristics in airplane radio and instrument wiring. The company, which began business in 1904 making telephone wires and cables, diverted most of its manufacturing activities to radio wiring after the advent of that medium of communication. Other wires made by Lenz were Aerolac, Lenglas, Spibrac and Lencel. In addition, standard hook-up wires were produced. Low tension power and light curves for aircraft, harness assemblies and cable assemblies were built to special requirements.

Liberty Aircraft Products Corporation, Farmingdale, N. Y., in 1940 manufactured aircraft accessories, precision machine parts, tools, production machine parts to order, screw machine products, milling and gear cutting work, engine cylinders, pistons and crankcases, heat treating and carburizing in electric furnaces with atmospheric control, cadmium plating and anodizing aluminum alloy parts, aircraft sheet



metal work, wing assemblies, tail surfaces, pontoons, bomb racks, and complete aircraft doping and finishing work.

Link Aviation Devices, Inc., Binghampton, N. Y., manufacturers of the Link Trainer, used extensively by U. S. air services for ground pilot training, in 1940 completed an expansion program which made possible a production increase of Trainers from about five a week to more than 30 a week. Orders received from the Army Air Corps and the Navy Bureau of Aeronautics for more than 600 Trainers, along with other orders from abroad, occasioned the expansion. First, the company enlarged its plants, but found this enlargement inadequate, so it took over a modern fireproof factory on the outskirts of Binghampton, quintupling its previous floor space. All divisions of the company were moved into the new plant. Production in the company's Canadian factory at Gananoque was continued.

From the technical standpoint, several marked improvements were made in the Trainer. Most notable was development of an automatic recorder, which operated in conjunction with the air speed and varied in speed of travel with the air speed. Also incorporated in the recorder was a device for introducing wind velocity and direction. Another improvement was development of a quickly interchangeable stick and wheel control, a desirable feature particularly during the primary training stage. Provision was made for removing the operating mechanism from the base of the Trainer, reducing noise and decreasing heat inside the Trainer. Many other refinements were incorporated, including improved radio, better arrangement of instrument board, and additional space inside the pilot's cockpit. The Trainer was widely used in 1940 for visual instruction to check aptitude of potential pilots prior to flight. Trainers were placed in rooms, walls of which were painted with scenery depicting various types of horizons, and it was found that, by means of a series of checks and balances, capability of students could be determined accurately. It also was found that this training was effective in reducing actual flight time required by students during primary flight training stage. The company continued to operate its school for training Link Trainer instructors, and cooperated with the Army and Navy in setting up similar instructional schools for these services.

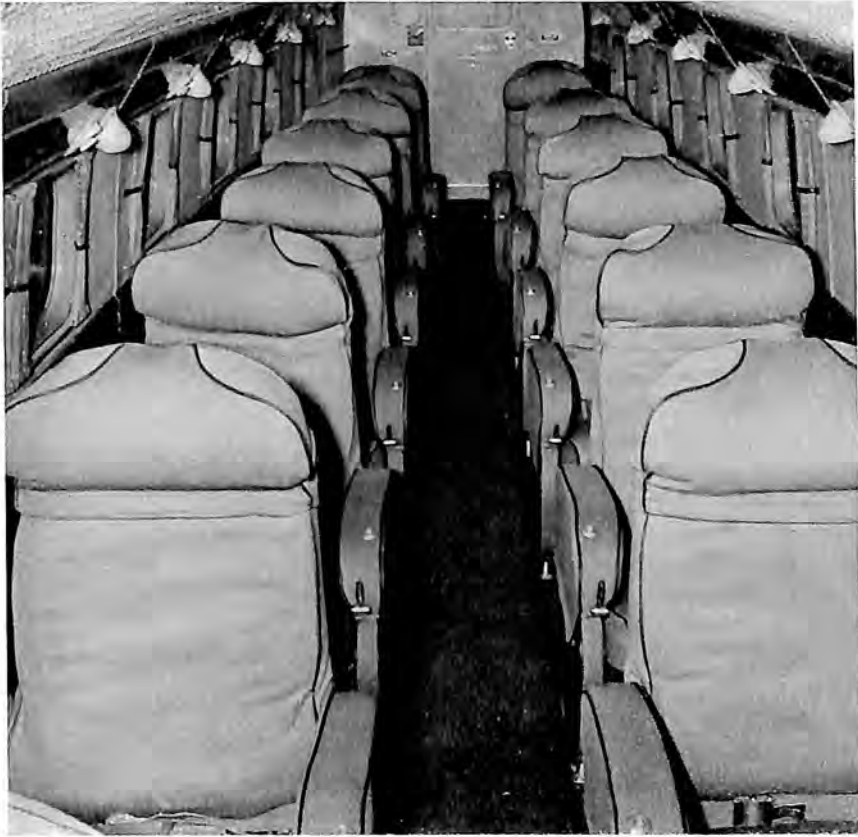
The Liquidometer Corporation, Long Island City, N. Y., in 1940 supplied tank quantity gauges for use on Air Corps, Navy, commercial, and export aircraft. The Liquidometer Dial Change and Selector Switch Combination Unit, providing in one unit separate dials for a number of tanks, so that readings on separately calibrated dials were obtained by turning the knob of a built-in selector switch, was redesigned to provide a smaller, more compact, and lighter unit. Units

of this type were installed on a large number of aircraft. In addition, the company started manufacture of a line of dual and multiple meter indicators, designed so that readings for several tanks were recorded on one indicator without requiring the use of a selector switch. Plant capacity was increased approximately 100 per cent and the number of employees was doubled.

Littelfuse, Inc., Chicago, Ill., in 1940 added many new items of aircraft fuse products to its line, to meet both military and commercial requirements. These new products included Air Corps Littelfuse (1-300 amps.), aircraft fuse panels, panel pull mountings for 4 ag fuses, fuse retainers, "Jerkit" Fuse Pullers, etc. Other items were Aircraft Littelfuses, anti-vibration type (0-60 amps), Hi-amp types (20-300 amps), Renewable Fuse Links up to 300 amps, fuse mountings, fuse extractor posts, beryllium copper fuse clips, high voltage radio fuses and mountings, safety panel pull fuse mountings and non-renewable Bakelite enclosed fuses.

The Warren McArthur Corporation, New York, in 1940 designed, engineered, and manufactured seats for pilots, gunners, navigators, radio operators, passengers and cameras. In this activity, the corporation surmounted a number of problems unique to construction and placement of aircraft seats. Load problems were worked out carefully, including the problem of great loads which military plane seats must withstand. These loads went up as high as 2,400 lbs. on the seat, 1,600 lbs. on the safety belt, and 1,200 lbs. on the back. Problems of corrosion, wear and vibration also were solved. Chairs constructed of high strength aluminum alloys without welding proved satisfactory in this connection. They were protected from corrosion by an anodic treatment. The company devoted much research to developing a favorable strength-weight ratio, most important because of the necessity for keeping down weight in aircraft. McArthur chairs were constructed almost entirely of aluminum; cadmium plated steel alloys were used only where wear was a consideration. An advantage of the McArthur system of joining tubing was the ease with which special assemblies were produced, and the fact that it thus was made possible to use standardized parts for a number of assemblies. McArthur chairs were tested with 50-lb. bags of lead shot, dropped from various angles to prove the chair's ability to withstand loads.

Realizing that proper seat design was growing more important with increasing speeds and longer flights, and consequent greater fatigue, the McArthur company devoted extensive research to mechanical measurements and adjustments providing maximum comfort, along with adequate performance of required functions. Space was usually at a premium; some chairs, to save valuable space, were



WARREN McARTHUR TRANSPORT CHAIRS

Installed in a Lockheed Lodestar.

designed to slide back on tracks to permit the pilot to get to his seat.

Reporting on the company's activities an official said: "Difficulties were chiefly structural, for most seats are cantilevers, that is, a pedestal supported at the base and subjected to various loads at the free end. These are essentially inertia loads of the human body caused by movements of the plane. The seat structure was the linkage connecting these two and not only had to control their relationship through adjustable devices, but also had to carry these loads through these same devices."

Macwhyte Company, Kenosha, Wisc., in 1940 produced special hoisting slings, to be built into aircraft by the manufacturers and used for lifting by a crane. Some of the special slings were made with swaged cable terminals and special fittings. Grommet construction

and braided wire rope slings also were made, all slings and fittings of corrosion resisting alloys. Swaged cable terminals were made in stainless steel eye end, fork end, stud end and turnbuckle end types. "Spike" antennae of tapered corrosion resisting steels were developed for mounting on underside of the fuselage to reduce static and improve radio communications. Macwhyte tie rods for internal and external bracing were produced from corrosion resisting alloys. Macwhyte "Hi-Fatigue" aircraft cables were made from galvanized, tinned and stainless steel, fabricated to reduce constructional stretch and increase fatigue resisting properties.

Moore-Eastwood & Company, Dayton, O., in 1940 continued to produce aircraft tools, dies, and special machinery, and at the same time produce for national defense bomb racks, bomb shackles, gun sights, gun mounting posts, gun mount adapters, filler valves, gun synchronizer generators, pistol mountings, tab controls, cable meters for tow-targets, etc. The company was organized in 1916 to build aircraft tools, dies, etc., exclusively. In 1923 the company began making special airplane parts and fittings; for the past eight years it has devoted most of its facilities to manufacturing airplane parts.

Norma-Hoffmann Bearings Corporation, Stamford, Conn., continued production of its lines of precision ball, roller and thrust bearings, adapted for practically every load, speed and duty. In the aviation division, new types and sizes of sealed aircraft control ball bearings, designed to meet special requirements for control applications, were produced. They included single- and double-row, shielded and unshielded, as well as enclosed felt seal bearings with removable seals. For conditions involving possible misalignment, a series of self-aligning felt seal bearings with removable seals was developed.

Northwest Air Service, Inc., Seattle, Wash., developed a propeller pitch setter, a machine to align blades by mechanical methods rather than by manual labor, requiring only 20 minutes to do the same work that formerly took three men an hour.

Pacific Aviation, Inc., Los Angeles, Calif., makers of aircraft hydraulic units, started operation in May, 1940, in Hawthorne, Calif., in a 3,000-sq. ft. plant, employing four machinists. In September, 1940, the plant was moved to Los Angeles, and at the end of the year, personnel included 150 skilled mechanics and a staff of aeronautical engineers and other personnel. It was anticipated that total personnel would reach 350 during 1941. In addition to manufacturing hydraulics, the company prepared to begin fabrication of wing fittings for an aircraft manufacturer. Pacific Aviation supplied most of the leading aircraft manufacturing concerns on the Pacific Coast. Among its products were tail wheel operating hydraulic struts, wing flap

operating hydraulic struts, water rudder retracting hydraulic struts and bomb door operating hydraulic struts.

Parker Appliance Company, Cleveland, O., produced seamless tubular plumbing for aircraft with Parker tube couplings. Parker also developed a number of thread compounds, thread seals and valve lubricants to overcome the tendency of threaded aluminum alloy parts to seize when assembled. The company also produced a line of fabricating tools.

Pioneer Instrument Division of Bendix Aviation Corporation, Bendix, N. J., in 1940 expanded its aircraft instrument production and developed many new instruments. A new plant, with 63,000 sq. ft. of air-conditioned space, and well over half a million sq. ft. of production floor space was obtained in Philadelphia, Pa. Assembly and production of Pioneer aircraft instruments for the Army, Navy and commercial aviation will be carried on there, as well as in Bendix, to handle present demands of aviation expansion.

With the advent of Integral Torque Meter in high horsepower aircraft engine installations, Pioneer developed an adaptation of the remote indicating system to give brake mean effective pressure indication on the instrument panel using the Torque Meter on the engine as the prime mover. This Torque Meter operated on a hydraulic principle, with the hydraulic pressure varying with the Torque (brake m.e.p.) output. This hydraulic pressure was measured with a Pioneer Remote Indicating Autosyn Transmitter and Indicator unit, which was calibrated in brake m.e.p. With the necessity of measuring fuel rates of the higher horsepower output aircraft engines, Pioneer developed a new high-range Miniature Autosyn Flowmeter installation. This instrument measured fuel consumption rates for take-off conditions and provided an accurate indication of the number of gallons per hour or the number of lbs. per hour of gasoline consumed under all operating conditions. With this knowledge of the true fuel rate and the brake horsepower output from the Torque Meter, it was possible to calculate the over-all brake thermal efficiency and to keep the throttle setting so the engine was always operating at maximum efficiency. The Pioneer Remote Indicating Autosyn principle, which gained recognition in its application to multi-engine aircraft instrument installations, was applied to perform the same functions with a substantial saving in weight and bulk, as well as in power required for operation. This Miniature Autosyn equipment was supplied for all engine functions, as well as serving as an indicator for many of the moving controls of the aircraft, including numerous new functions for supercharged-cabin pressure control position for airplanes engaged in substratosphere flying. Pioneer also developed and dis-

tributed a compact and dependable direct-current landing gear, tail wheel (or nose wheel) and landing flap position indicator. This instrument incorporated an extremely practical dial that showed the wheels and flaps in their relative positions. A new electric tachometer, featuring engine outlet pad generator mounting, was developed to overcome impracticability of direct-reading tachometers on multi-engine installations. This instrument was designed for accuracy under all encounterable operating conditions, and added the feature of remote indication.

An electrically-heated pitot tube was developed that was not affected by ice or rain, since it was designed not only to prevent ice formation when energized, but also to dissipate any ice accumulated on the tube body when the heater was not energized. This tube was called the Weather-Proof Pitot Static Tube. To overcome difficulties encountered with magnetic compass installations in modern aircraft, Pioneer developed the remote indicating compass. With this installation it was possible to install the compass element or transmitter in a part of the aircraft remote from electrical disturbances created by the numerous electrical appliances located around pilot's compartment. The remote indicating compass was particularly adapted to military aircraft equipped with armor plate, and multi-engine aircraft with their numerous electrical appliances. An improved Rate of Climb Indicator mechanism was developed which substantially reduced the overall length of the instrument. The Pioneer Rate of Climb also incorporated a temperature compensated diffuser assembly that had no moving parts and which inherently compensated for changes in air density at different altitudes, a case volume temperature compensator, and a more rugged mechanism construction which gave greatly improved operation and simplified instrument service.

Pioneer also developed a Turn and Bank Indicator that operated on  $\frac{1}{2}$  in. of mercury suction. This installation was particularly adapted for light aircraft using a venturi tube to supply suction. A variation of this instrument was developed to enable turn and bank indicator operation on 4 in. of mercury, and particularly suited for operation on the same suction system used for the Automatic Pilot. Thus necessity for a suction reducing orifice in the supply line was removed. Inasmuch as the manifold pressure (blower housing pressure) had a direct effect upon the brake horsepower output of an internal combustion engine, the need for an accurate measure of this pressure stimulated development of the Pioneer Sensitive Manifold Pressure Indicator. Amplified pointer movement with extreme accuracy, coupled with the standard vapor-proof feature, made the Sensitive Manifold Pressure Gauge a contribution to optimum engine

operation. A new type of Airspeed Warning Sector was developed to facilitate quick checks of instruments on the instrument panel. Use of bright red, yellow, green and white colors made readings on the dial face easy. In aircraft optical instruments Pioneer brought out the Aircraft Bubble Octant, with an averaging recording device which greatly decreased the time required for establishing a "fix" with celestial navigation. The Pioneer gyro-stabilized Drift Meter also was developed to eliminate errors involved in drift angle measurements when the aircraft was flying in rough air.

The Pioneer Parachute Company, Manchester, Conn., in 1940, among other advancements it attained in making and testing parachutes, developed the new foul-proof pilot chute. This was a chute with no breakable parts and no exposed springs to pierce or bind the silk. Having no ribs, as most of the older types of pilot chutes had, there was no danger of ribs poking through or hooking under the main canopy skirt. The chute folded wafer thin when packed, and in action sprang into full size instantly. Another development was an improved pack, which was incorporated in the P1-B-24 parachute, embodying new safety features and providing added comfort and convenience. Added safety was achieved by improved packing technique made possible by the new development. Friction burns and canopy splitting, due to shroud lines getting over the canopy, were eliminated. The P3-B-24, another model, retained all the safety and comfort features of the P1-B-24, and in addition eliminated the roll on the shoulder to meet special requirements of some airplanes.

Another development made by Pioneer was its testing tower, the only one of its kind in the world. This tower gave Pioneer engineers a new method of testing parachutes by the use of slow-motion movies which recorded the way the chutes open. New ways of packing chutes and certain structural improvements were developed as a result of the testing system. Motion pictures were made from the rigging of the tower. From this tower, 50 feet high, a dummy equipped with a parachute pack was whirled around at speeds of from 70 to 300 m.p.h. Power was supplied by a 320 h.p. Diesel engine. When the whirling dummy attained the proper speed the parachute was released automatically and chute and dummy floated to earth. To record this action a specially built 16 mm. motion picture camera that took 128 frames of film a second instead of the usual 16 frames, operated with the boom as it spun around. This slow-motion movie record brought out many enlightening facts. In many cases on old type chutes, the pilot chute, supposed to open first and serve as an anchor to facilitate the opening of the big canopy, was the last thing to operate. This revealed a serious hazard, in that the main canopy and the lines suspend-



#### TESTING PIONEER PARACHUTES

The Pioneer Parachute Co.'s revolving testing tower at Manchester, Conn., for studying the behavior of chutes under different conditions.

ing the user were fouled. An improved pilot chute, and a way of packing it so that the hazard was eliminated, was developed. Packing of the main canopy of the chute also was changed because of the movie studies. By means of the new packing, it was made virtually impossible for the skirt of the canopy to tilt up in opening, an occurrence which has accounted for many parachute failures.

Pioneer Parachute Company was affiliated with Cheney Brothers, manufacturers of silks, and largest producers of parachute fabrics.



It was the only parachute company in this country where the entire product from raw silk to finished parachute was under one control. The company in 1940 increased its capacity by 500 per cent, expanding its production from 50 to 300 weekly.

RCA Manufacturing Company, Inc., a Radio Corporation of America Subsidiary, Camden, N. J., in 1940, while carrying on its usual production of radio equipment for aircraft, developed a new transmitter for the Piper Aircraft Corporation, to be used in light planes.

This transmitter was an advanced type of dry-battery-operated aircraft transmitter now commercially used by many light plane pilots. While its many new features were of interest, the company believed that of greater interest was the trend which its installation indicated. Until now, the company said, aircraft radio equipment usually was sold to the light plane owner through merchandising programs, and also was installed at the factory upon a special order. Now, however, the company stated, light plane manufacturers have begun to treat radio as a necessary part of their airplane and ceased to treat it as a luxury in the light plane field; henceforth radio will be considered as standard equipment. The RCA aviation radio section also announced in 1940 a new loop antenna and adapter kit especially designed as an aural-null direction finding attachment.

R E F Aircraft Corporation, Syosset, N. Y., during 1940 produced various sheetmetal and machined parts, jigs and unit assemblies for use in aircraft manufacture. They also specialized in welding and tool and die fabrication.

Reynolds Metals Company, Richmond, Va., manufacturers of aluminum sheet and other strong aluminum alloys, in 1940 continued its normal activity and at the same time was able to devote its resources and energies to the all important task of producing materials for the national defense program, particularly the aviation industry. Months ago, without encouragement or firm orders, the plant space then available was placed upon a war basis and certain plants were equipped for the production of supplies for our armed forces. A tremendous plant expansion program, partially financed by a cash outlay of over \$3,000,000 and by a fully secured mortgage loan from the Reconstruction Finance Corporation was slated ultimately to total over \$40,000,000.

The Reynolds production set-up was: (1) Aluminum Ingot Production Bauxite Reduction Plant at Lister, Ala., scheduled for operation in April, 1941, with annual capacity of 40,000,000 lbs. Second and still larger ingot moulding unit, located in the Bonneville-Grand Coulee area of the Pacific Northwest, scheduled for operation August

1st, 1941, providing an additional annual ingot capacity of 60,000,000 lbs.; (2) Aluminum Alloy Sheet Plant at Louisville, Ky., in completely expanding commercial operation since 1937, capacity, 2,500,000 to 3,000,000 lbs. a month; (3) Aluminum Alloy Rod Plant at Louisville, Ky., capacity, 1,500,000 lbs. monthly; (4) Extrusion Plant, an ultra-modern structure at Louisville, housing large and efficient aluminum alloy extrusion and heat treating equipment. Estimated capacity, 4,000,000 lbs. of extruded rod, tubing and shapes monthly; (5) Rolling Mill and Rod Plant, a new \$17,500,000 aluminum alloy rolling mill for sheet and rod now under construction at Lister, to roll sheet aluminum up to 112 in. wide and in any length, and rod up to 6 in. in diameter. Monthly capacity, 3,000,000 lbs.; (6) Richmond Strong Alloy Sheet Plant, current conversion of a part of the company's extensive Richmond plant facilities. Plus additional construction there, still more production capacity for Reynolds strong alloy sheet was to be made available.

Beginning in the spring of 1941, from these modern and efficient plants there was slated to flow for both defense and civil purposes 100,000,000 lbs. of virgin aluminum and over 200,000,000 lbs. of strong and common alloys in sheet, strip, rod, wire, tubing and extruded shapes.

The company's Thermostat Division, consisting of Robertshaw Thermostat Company, Youngwood, Pa.; Grayson Heat Control, Ltd., Lynwood, Calif.; Fulton Sylphon Company, Knoxville, Tenn., and Bridgeport Thermostat Company, Bridgeport, Conn., manufactured a line of thermostats and control devices for gas and electric heating and cooking appliances, electric control clocks, automatic temperature and pressure controls, bellows, drawn brass products, steel stampings, and brass assemblies of various types. Two other manufacturing concerns affiliated with Reynolds Metals—Richmond Radiator Company, Uniontown, Pa., and American Thermometer Company, St. Louis, Mo.—manufactured bath tubs, lavatories, sinks and other enameled ware products, steam, hot water heating, gas boilers and radiation, winter air-conditioning units, thermostats, heat control devices, and a line of thermometers designed for various industrial and domestic uses.

Rochester Ropes, Inc., Jamaica, N. Y., during 1940 manufactured a line of wire rope and strand, aircraft cable and fittings in its factories at Jamaica and Culpeper, Va.

John A. Roebling's Sons Company, Trenton, N. J., makers of wire and wire rope, insulated wire and cables, wire cloth and netting, in 1940 concentrated on improving its standard line of aircraft equipment.

Ruckstell Burkhardt Engineering Company, Phoenix, Ariz., in



#### FOR MORE DEFENSE ALUMINUM

No. 1 plant of the Reynolds Metals Co. at Louisville, Ky., where rapid expansion has been underway to provide additional facilities for production of strong aluminum alloy, sheet and other products.

1940 continued its production of auxiliary power engines for the aircraft industry.

S K F Industries, Inc., Philadelphia, Pa., manufacturers of ball and roller bearings, experienced in 1940 a spurt in orders as the result of the defense program and the steady growth of commercial aviation. Greatest demand was for the cylindrical roller bearing used extensively on airplane engine crankshafts. Unusual care was taken in the manufacture of this bearing to assure high standards of performance. Additional capacity was secured by eliminating retainer rivets, thus permitting addition of several rollers to the one-piece retainer design. A separable type of guide flange also simplified complete disassembly of the bearing and inspection of all the individual parts at times of major engine overhauls. Also in accelerated demand were S K F control bearings—AN standard bearings of three general types: deep-groove ball bearings, self-aligning ball bearings, and cylindrical roller bearings. Having a maximum number of balls or rollers, these bearings took high radial loads with a minimum of weight. An uptrend also was noted in orders for double-row cylindrical roller bearing for machine tools, as well as for double-felt seal ball bearings for accessory locations. S K F underwent an expansion in 1940, due to defense orders. Plants were enlarged, and air-conditioned to prevent damage from rust and dust to bearings.

A. Schrader's Son, Division of Scovill Manufacturing Company, Inc., Brooklyn, N. Y., in 1940 manufactured tire valves for the air-

craft industry. The firm effected a standardization of its production which largely eliminated service expense and delays. The standardization was achieved by developing a replaceable core and an air-tight cap for valves.

Scintilla Magneto Division of Bendix Aviation Corporation, Sidney, N. Y., supplied Bendix-Scintilla magnetos for all classes of aircraft engines. Of special note was a radio shielded magneto for light plane engines which was widely used on sport planes. Bendix-Scintilla radio shielded ignition harness was placed on the market, but it was supplied initially only to engine manufacturers as original equipment. Bendix-Aviation Spark Plugs, shielded and unshielded, were manufactured in large quantities for numerous engine requirements.

Sensenich Brothers, Lititz, Pa., in 1940 manufactured over 10,000 propellers and enlarged the plant to double production. The entire plant was air-conditioned to maintain proper atmospheric conditions necessary in the manufacture of wooden propellers. Sensenich Brothers had 95 models approved by the Civil Aeronautics Administration, including propellers for engines up to 450 h.p.

Sheffield Gage Corporation, Dayton, O., developed two new gage instruments expected to be of substantial value in the defense program. One of these was the Sheffield Multichek Electriganage, a precision instrument for rapid inspection of mass production parts having several critical dimensions, as, for instance, the several diameters and shoulder lengths of an armature shaft. This gage was widely used for inspection of timing fuse elements, shell bodies, cartridge cases and miscellaneous army ordnance work. Measurements of length, diameter and depth were flashed simultaneously on a control board by means of colored signal lights, as the part being inspected was placed at gage position. When one of these signal lights showed amber, the diameter was within tolerance. If the light showed red, it indicated that the diameter was undersize; if green, oversize. In addition to the individual signal lights, one for each measurement, the gage was equipped with a master signal light integrating all measurements. When this master signal showed white, all dimensions were within tolerance.

The other new gage was the Sheffield Precisionaire, an instrument to check precisely gun bore diameters. The Precisionaire eliminated substantially the very high degree of skill heretofore required in checking gun bores with conventional gages. It also provided a more rapid method of checking as contrasted with the conventional gage operation which required individual readings at intervals from breech to muzzle. The Precisionaire checked diameters of bores of any length and any caliber, also the diameter of the rifling grooves in the gun barrel.

Work was pushed on development of a gage to check and weigh

automatically components of small arms ammunition, and also finished cartridges at the rate of 3,600 an hour. Sheffield carried out a capacity-doubling plant expansion, increased research facilities, and organized an employee training program.

Shell Oil Co., Inc., New York, handled a considerably increased amount of aviation business. Noteworthy trends were greater use of higher octane gasolines, 80, 87, 90, and 100. As in previous years, a great deal of time was devoted to research work, both in the laboratories and in service tests. Active assistance was rendered to the work of the Aviation Fuels Division of the CFR Committee; notably in the study and development of new laboratory detonation test methods and in the correlation of test results with other engine and fuel manufacturers; in the study of fuel tank corrosion; of the piston ring-sticking tendencies of aircraft oils; of vapor lock problems in aviation engines; and of the extension of octane ratings beyond 100. A range of straight mineral aircraft oils, Aero Shell 62, 80, 100, 120, and 140, were produced.

Thomas L. Siebenthaler Manufacturing Company, Kansas City, Mo., which in 1940 became a part of Aircraft Accessories Corporation, Burbank, Calif., manufactured radio transmitters and receiving equipment, and aircraft maintenance and repair equipment. Specially developed during the year was the propeller governor testing unit to test all types of propeller governors. In addition to its complete line of aircraft radio equipment, including antennae, bearing indicators, amplifiers, maintenance and repair equipment, the company manufactured air field operations equipment such as auxiliary starters, propeller dollies, battery carts, variable inductances, neutralizing condensers, and variable condensers. The company's machine shop accepted orders and subcontracts for aluminum alloy sand castings for aircraft use both raw and machined; hand screw machine and turret lathe parts, in aluminum, brass, and steel, and radio and electrical wiring assemblies for aircraft use. Siebenthaler, whose chief business for several years was with the major commercial airlines, participated extensively in production for the defense program. As a result, a large personnel and plant expansion was begun. Erection of a modern building with air-conditioned offices and water-cooled plant, which was slated to occupy 50,000 sq. ft., was started. The new plant was scheduled to be ready for occupancy May 15, 1941. The Siebenthaler Company during the year underwent a complete reorganization, with extensive changes and expansion both in executive and engineering departments.

Simmonds Aerocessories, Inc., New York, in 1940 recorded developments on many new products, and also expanded its organization.

The L. F. Benton Company, Vergennes, Vt., was acquired. Benton was the oldest maker of mica spark plugs in America and the first to make aircraft spark plugs in three interchangeable and replaceable parts. Extensive research and development work was undertaken and an improved Benton type plug, known as the Simmonds-Benton Aircraft Power Plug, was introduced. The Simmonds Corsey flexible push-pull control was adopted by leading manufacturers of both civil and military aircraft. Perhaps the company's most notable technical development was a flexible conduit casing for use on the throttle and mixture and propeller controls on "soft mounted" aircraft engines. Military types were equipped with this control. The type "T" Simmonds fastener was adapted to a variety of new uses. New and smaller sizes were developed. This fastener was of the spring actuated plunger type. Quickly attachable and detachable, this type of fastener proved most successful in carrying structural and operating stresses.

Simmonds Non-Slip Flooring was adopted by a number of producers of military aircraft, both of trainer and combat type, for use on wing walks. In some military types, Non-Slip Flooring was used on cockpit floors and at bombers' and gunners' stations. The Olaer High Pressure Hydraulic System was brought over from France for further development in America. This system was successful in Europe, over 3,000 military aircraft having been equipped before the fall of France. Substantial progress was made in development of the Simmonds Vacuum System and the prospect was that advanced development work on this system would be completed in the first half of 1941. In the autumn of 1940, the Simmonds Lange Latent Heat Stabilized Chromometric Radiosonde emerged from developmental stage and went into quantity production.

Sinclair Refining Company, New York, in 1940 developed as a national defense contribution, Sinclair Pennsylvania 120-GQ oil. This was a straight mineral product meeting important specifications, and was especially suitable for the requirements of engine and plane manufacturers working on both Government and commercial contracts. This oil successfully passed the Wright Aeronautical full scale test and also gained approval of other prominent engine builders. Marketing of Sinclair products also included Sinclair Pennsylvania AAC oils, which were popular with aviation training schools using U. S. Army air equipment, and other specialized aircraft lubricants to air lines, engine builders, plane manufacturers and the air services.

Sinclair's work in development and testing of aircraft lubricating oils was further enhanced through its modern, well-equipped engine laboratories at East Chicago, Ind. Particular progress was achieved in utilizing the C.U.F. engine in correlating performance of aircraft



#### SOLAR EXHAUSTS FOR DEFENSE

A variety of Solar exhaust systems are manufactured at the plant in San Diego, Calif. They are set up in jigs, during which they are carefully gauge-checked in a final inspection.

oils in this engine with their performance under actual flight conditions. Sinclair's scientific research had continued over a long period of years, during which Sinclair scientists had the advantage of checking results developed in research activities with results concurrently developed in actual air line operation.

Socony-Vacuum Oil Company, Inc., New York, in 1940 supplied its aviation products to air lines, Government aviation services, aircraft engine and plane builders, and private operators. The products included Aero Mobilgas, Aero Mobiloils, and aviation specialty products, Gargoyle aircraft hydraulic fluid, aircraft compass fluid, aircraft instrument oil and Mobilgrease. Gargoyle aircraft hydraulic fluid was developed to meet the specialized needs of the industry for the operation of such hydraulically controlled devices as automatic pilots, brakes, shock struts, and retracting mechanisms. To meet the particular requirements of the Curtiss electrically-controlled feathering propeller, Gargoyle Speed Reducer Oil No. 2 was developed. Extensive research work was carried on continually by this organization.

Solar Aircraft Company, San Diego, Calif., designers and manufacturers of exhaust manifolds and related power plant accessories, continued its expansion program; and the plant had 111,000 sq. ft. of floor area, equipped with special machinery and tools, at the beginning of 1941. Production during 1940 actually doubled the production of 1939, yet was looked upon by the company as one of preparation for

the heavy production required under the defense program. The personnel was to be increased from its January 1 level of 700 employees to approximately 1,500 by the middle of 1941. Research, engineering and experimental work was directed toward development of satisfactory manifolds for the new high-powered twin-row radial engines for both military and commercial installations, and for the V-type engines for installation in the new pursuits and interceptors. Design development work also was continued on the Airmax line of exhaust and central heaters. The company's position as a fabricator of stainless steel aircraft parts and accessories was furthered by the acquisition of license under the "Shotweld" process of resistance welding. Solar continued to carry on considerable research and development work.

Sperry Gyroscope Company, Inc., Brooklyn, N. Y., in 1940, to meet the requirements of the defense program and provide for the increased use of its products among commercial customers, carried out a marked expansion of its facilities. Personnel in all departments and companies rose to a total of 16,000, working in 14 different plants and utilizing 2,500,000 sq. ft. of floor space.

The Automatic Direction Finder was the newest of the Sperry line of aeronautical instruments. It was the first Sperry instrument designed to help solve the aircraft navigation problem by utilizing radio waves. In keeping with the Sperry policy of developing automatic instruments, the new Radio Direction Finder gave a pilot his bearings continuously and automatically. The Sperry Automatic Radio "D.F." represented an important advance in airplane navigation. Although it was still a relatively new instrument, it was installed in the planes of several major air lines.

Another new Sperry development was the Flightray. This device was designed to simplify the work of the pilot of large aircraft by combining the indications of a number of instruments on the face of a single dial. Using the cathode ray principle, the Flightray assembled the most important flight information in a single pattern, where it was readily available to the pilot. Flightray was especially applicable to blind flying.

The Sperry corporation was engaged in five fields. The first of these was anti-aircraft defense. This was relatively new, and with development of the military airplane as a weapon of warfare, it followed inevitably that more emphasis was destined to be placed on anti-aircraft protection. The Sperry company pioneered development of an entire system against air attack. This consisted of the Anti-Aircraft Searchlight, the Sound Locator and the Director. The sound locator detected the position of an approaching plane. Once position





#### SPERRY TEST OF INSTRUMENTS

Typical of Sperry expansion is the mass test of aeronautical instruments above. Simulating the roll and pitch of an airplane in rough air, the Scorssby device used in this test is said to be easily capable of handling the 60,000 instruments which Sperry estimated that it would build in 1941. Here a total of 80 instruments are being tested at one time. They are Sperry Directional Gyros and Horizons.

was determined, the Sperry Searchlight was used to illuminate the plane. Simultaneously, the anti-aircraft director, functioning as a computing mechanism, determined direction, elevation, and fuze setting required to aim the anti-aircraft gun at the approaching airplane, and to keep the gun trained automatically on the plane as it moved across the sky.

A second field of Sperry activity embraced those instruments manufactured for military and naval services and classified by the Government as confidential.

The third field consisted of aeronautical instruments. Every large commercial airplane, and every military and naval plane, with the exception of a few primary trainers, carried Sperry instruments. Basic navigational equipment on virtually every aircraft panel was the Directional Gyro and the Gyro-Horizon. The Sperry Directional

Gyro enabled the pilot to keep his plane "on course" in rough or smooth air. The Sperry Gyro-Horizon provided an Artificial Horizon for the pilot when he was flying in overcast or "on top" of the clouds, out of sight of the ground. The Automatic pilot was capable of actually taking over the controls of a large airplane in flight. Designed to relieve the human pilot from the manual operation of a plane, thus permitting him to perform other duties, the Automatic Pilot could be set for straight and level flight, or be adjusted to make the plane climb or descend, without human hands touching the controls.

A fourth field of Sperry activity was Hydraulics. Hydraulic units complemented many Sperry products. Vickers Incorporated, Detroit, Mich., manufacturer of oil hydraulic devices, was a unit of The Sperry Corporation. An example of the use of hydraulics was found in the Automatic Pilot for airplanes. Here a Vickers Hydraulic unit and a Directional Gyro, and a Gyro-Horizon manufactured by the Sperry Gyroscope Company were joined to form the complete Automatic Pilot. Hydraulic units likewise were used throughout the aeronautical industry. Wherever there was a need to transmit power, and where that power must be varied from time to time in amount and speed, and where control of the power was important, there was a field for an oil-operated hydraulic system. For when power was transmitted under these conditions, hydraulics usually was better fitted to handle the job than any other medium.

The fifth field of Sperry activity was marine. The marine Gyro-Compass was the foundation stone on which the company had been started. It was still one of the principal products. In addition to the compass, the company developed a supplementary line of devices to aid the mariner.

Sperry Products, Inc., Hoboken, N. J., in 1940 continued its production of exactor controls for the aircraft industry.

Spriesch Tool & Manufacturing Company, Inc., Buffalo, N. Y., manufactured bomb racks and shackles and during 1940 doubled personnel, planning to triple it in 1941.

Standard Oil Company of California, San Francisco, Calif., in 1940 continued research and development of high quality fuels and lubricants to meet the exacting requirements of aviation service. A complete line of fuels and lubricants under the familiar brand "Stan-avo" was available in the company's marketing area, which included Washington, Oregon, California, Idaho, Nevada, Utah and Arizona, and the territories of Alaska and the Hawaiian Islands. These products were available through any of the company's distributing plants, or through the representation of airport dealers. Through an arrange-



U. S. Army Signal Corps photo

#### NEW SPERRY SEARCHLIGHT AND SOUND LOCATOR

The Sound Locator determines the position of an approaching plane. Once this is determined, the 60-inch Sperry Searchlight, developing 800,000,000 candlepower, is used to illuminate the target.

ment with several selected petroleum marketers throughout the country, credit cards issued by any of these companies were honored at practically every airport in the United States. The advantages offered through this arrangement met with considerable public acceptance, from the standpoint both of convenience and assurance of receiving a high quality of aviation products.

Standard Oil Company of New Jersey, New York, through its Esso Laboratories, which won the 1939 National Award for Chemical Engineering Achievement continued to pioneer in development of super fuels for aircraft engines. In addition to supplying Pratt & Whitney and Wright Aeronautical Corporation, as well as other leading manufacturers, with their requirements of fuels and lubricants, Esso Marketers cooperated with engine builders through manufacture of numerous batches of higher octane experimental blends, some of which were developing fuels of the future. Millions of gallons of 100 octane aviation gasoline were supplied to the U. S. Army and Navy. Another Esso contribution was continued development and widespread distribution of an aircraft hydraulic oil, "Univis 40". Esso Marketers continued to supply several air lines with gasoline, lubricants and specialties,

Steel Products Engineering Company, Inc., Springfield, O., manufactured a line of segregators and other accessories for the industry.

Summerill Tubing Company, Bridgeport, Pa., in 1940 carried through a plant expansion and at the same time developed tapered tubes for aircraft for a wide range of uses, including push rods for engines, landing gear struts and torque tubes. Plant facilities in building and equipment were nearly doubled, and plans were made for a further 35 per cent expansion. A large percentage of Summerill production was devoted directly to tubing for use in connection with the defense program. Other items produced for applications to ordnance included magazines for fire control apparatus and anti-aircraft guns.

Summerill continued to produce cold-drawn seamless tubing for aircraft. It included tubing for fuselages, engine mounts, landing gears, control surfaces, push rod tubes for engines, and stainless and special low carbon tubing for service and hydraulic lines. Besides being an important manufacturer of vital defense materials, Summerill had a continuous record of having carried on a policy of research and development since the founding of the company in 1899.

Suncook Mills, New York, in 1940 produced specialized fabrics and tapes for the aeronautical and mechanical trade. These fabrics, called Flightex, were made of finest long staple Arizona Pima cotton by specialists on rigid standards for workmanship and quality. The resulting product was a lightweight, durable and smooth-finished fabric, which met Army and Navy specifications. Flightex fabrics were used in the covering of many airplanes. A special reinforcing tape was developed for the highspeed commercial airplane, lighter, thinner, and stronger than Government Specification reinforcing tape. This also assured maximum protection with the smallest possible ridge under the surface tape. Suncook Mills maintained a Government-approved laboratory in its mill at Suncook, N. H.

Superior Tube Company, Norristown, Pa., in 1940 trademarked two of its products, Brawn Monel and Weldrawn Stainless Steel. A number of its tubing products were adopted in the construction of instruments for aviation, as well as other uses. The company was a supplier to the distributors of The International Nickel Company in their alloys and, according to this arrangement, all sizes under  $\frac{1}{2}$  in. OD were manufactured in the Norristown plant of this company. Also, where tubes were between  $\frac{1}{2}$  in. and  $\frac{5}{8}$  in. OD, inclusive, when gauges .035 in. and lighter were required, these, too, were supplied by the Superior Tube Company.

Taylor-Winfield Corporation, Warren, O., makers of Hi-Wave welders for fabrication by spot welding of aircraft assemblies, in 1940

introduced its equipment, after two years of research and development. Units were shipped to, or ordered by, most aircraft manufacturers. The company also began work on further improvements in this equipment, including a new Roller Anti-Friction Welding Head, patented air lock, improved control cabinets, and other refinements. The company maintained a complete resistance welding Research Laboratory. All improvements were fully worked out in this laboratory before being scheduled for manufacture.

To accommodate the demand for equipment, a factory addition of 6,000 sq. ft. of floor space was added and further additions were under consideration. The company also engaged in design and manufacture of resistance welding machines for various other types of defense work. A large fabricating division was operated in Detroit. This plant was engaged principally in fabrication of Diesel engine bases and other types of fabrications used for defense production.

The Texas Company, New York, in 1940 was a supplier of high octane aviation fuels and lubricants to all branches of aviation. It was active in developing new processes for making high octane aviation gasoline. The most important of these was the alkylation process, which was pioneered in this country by The Texas Company. Two alkylation plants were placed in operation by the company and produced large quantities of stocks to make fuels of 100 octane rating and higher.

Texaco participated in cooperative research work with engine companies and air lines studying the effects of volatility and vapor locking at high altitudes. High octane safety fuels were supplied to the Government, engine companies and one air line for research work. Texaco carried out research work with aircraft engine oils, and developed a new lubricant, Texaco aircraft engine oil 120-G, for certain engines, which proved successful in air line service. This product subsequently was adopted by all air lines using Texaco aircraft engine oils in these particular engines. Further improvements in aircraft engine oils for other engines were studied in Texaco research laboratories. In addition, special low-temperature greases were developed for lubricating propellers, control pulley bearings and aerial cameras.

Thompson Products, Inc., Cleveland, O., in 1940 added to production of about 1,000 different aircraft engine and plane parts a non-pulsating aircraft engine fuel pump. Three blades or vanes extending through the rotor formed the pumping chambers in the bore of a specially shaped liner. The bore consisted of arcs and spiral arcs so positioned that there was a positive cam action on the blade elements. The spirals gave the blades a shuttling motion that was without shock at either end of travel. High suction lift and rapid build-up of pres-

sure at low crank speeds were provided by the deal between liner and rotor. The relief valve was a balanced diaphragm of molded synthetic rubber. It provided a bypass for the fuel to give a constant discharge pressure. Shaft seal used a hardened ring that was separate from the splined drive shaft and guided by rotor journals. This pump was approved and adopted by the U. S. Air forces. Among other parts manufactured by Thompson Products were sodium-cooled engine valves, valve seat inserts, valve keys, tappets, booster pumps, propeller parts, retractable strut assemblies and landing gear assemblies.

The Timken Roller Bearing Company, Canton, O., in 1940 increased production of Timken bearings for aircraft engine carburetors, Link Type Dynamic aircraft engine suspension mounts, and aircraft engine rocker arms. Production also was increased for Timken bearings for landing wheels, tail wheels, tail wheel swivels, retractable landing gear mechanisms, and some control mechanisms. A large part of the new electric furnace alloy steel capacity added during 1940 was used in filling increased demands for aircraft tubing and miscellaneous aircraft alloy forging steels.

Tinnerman Products, Inc., Cleveland, O., manufactured Speed Nuts and Speed Clips for use in assembly of aircraft, and expanded activities for the defense program. The company's products also were used in such Army vehicles as trucks and scout cars. More than 800 standard types and sizes of Speed Nuts and Speed Clips were produced by Tinnerman.

Titanine, Inc., Union, N. J., during 1940 continued production of its line of dopes, primers, surfacers, lacquers and thinners for the aircraft industry.

Titeflex Metal Hose Company, Newark, N.J., in 1940 manufactured a complete line of shielding equipment and accessories for the aircraft industry. In addition to its principal product in this field, radio shielded ignition harnesses, Titeflex produced radio shielded spark plug elbows, shielding conduit and fittings, filter units, wiring manifolds, and terminal and junction boxes. Titeflex also supplied its well known flexible pressure tubing for fuel and oil lines, instrument lines, and hydraulically controlled devices.

Titeflex developed a detachable type spark plug lead which was adaptable to conventional radio shielded ignition harnesses. The use of a spark plug lead of this type permitted removal of any individual unserviceable assembly without disturbing the ignition cable contained in the wiring manifold. A detachable spark plug lead was especially desirable where the ignition cable was conducted adjacent to exhaust manifolds, the excessive heat of which normally caused rapid breakdown of the wire insulation. It was also feasible with this new de-

velopment to use 7 m/m wire in the shielded manifold and 5 m/m wire in the spark plug leads, thereby creating saving of weight.

Uniloy Accessories Corporation, Lancaster, N.Y., manufacturer of tail wheel assemblies for light aircraft, developed a new device for the hangar storage of such aircraft. The device, consisting of two wheel cradles and one "nose" cradle, permitted the stacking of airplanes with subsequent tripling of storage capacity. A company test showed that planes could be stacked easily in three minutes by two men. During the year the company carried out an expansion of plant facilities, greatly increasing machine shop and foundry capacity. The company, in view of the increased demands of the aircraft industry stimulated by the national defense program, prepared for a substantial increase in production of aluminum alloy castings of various aircraft parts and fittings.

United Aircraft Products, Inc., Dayton, O., in 1940 designed and manufactured for the aircraft industry oil temperature regulators, fuel pumps, fuel units, oil dilution solenoids, "Y" drain valves, gun solenoids, fuel strainers, finger strainers, viscosity, spring loaded and thermostatic valves, fuel cocks and tab controls.

At the company's Los Angeles Division, complete hydraulic equipment, such as tail shocks, bomb rack operating mechanisms, accumulators, hydraulic valves and landing gear struts, were manufactured. During the year the company acquired the firm of Aircraft Precision Products, Inc., in Vernon, Los Angeles, Calif.

U. S. Gauge Company, New York, in 1940 made a complete line of pressure and vacuum gauges and dial-thermometers in all sizes, and numerous aircraft instruments and pump specialties.

Vickers, Inc., Detroit, Mich., manufactured a line of hydraulic equipment for the aircraft industry. These precision products included pressure relief valve, gear type pump or fluid motor, piston type pump or fluid motor, pressure unloading valve, dual directional valve and a 5-in. accumulator.

The Weatherhead Company, Cleveland, O., leading manufacturer of flexible hose assemblies in 1940 put into operation a new accelerated production program on aircraft fittings. This program was highlighted by the addition of the AC811 tube fitting and the AN conduit fitting lines to the company's previous production of N.A.F. and AC Tube Pipe and Hose fittings. In 1941 the new AN tube, pipe and hose fittings were placed in production. In the field of flexible hose assemblies, The Weatherhead Company developed a new rigid production control that made possible the manufacture of aircraft hose assemblies in quantities never before considered possible. The standard applications for low, medium, and high pressure assemblies were

supplemented by new demands for fire resistant and bullet sealing materials. Due to the developments in military aviation requiring extensive use of oxygen apparatus, The Weatherhead Company prepared a program on standard hose assemblies that were tasteless and odorless. Preceded by more than a year of developmental work, The Weatherhead Company entered into the production of hydraulic actuating cylinders, vacuum selector valves, vacuum check valves, and needle check valves, designed in accordance with Air Corps and Navy specifications, and incorporating new factors of design that provided advanced features of light weight, durability and simplicity.

Wellington Sears Company, New York, in 1940 continued to produce for the expanding defense program its well-known line of aeronautical fabrics, including style BA30, grade A airplane cloth; style BA24X, lightweight airplane cloth and style 5510, long staple lightweight airplane cloth.

Western Electric Company, New York, in 1940 through Bell Telephone Laboratories conducted a program of scientific research and added to its line of transmitting and receiving apparatus new units designed to promote a progressively higher standard of aircraft communications service. One new development was a radio receiver that also served as an interphone. This new equipment gave the pilot advantages of direct finger-tip control—greater operating precision, simplicity of use, and reduced maintenance. Another 1940 addition was the new 29A multi-frequency radio receiver, providing for the remote selection of 10 different frequencies and reception of telephone, telegraph and modulated telegraph. It covered a band of 2 to 15 megacycles inclusive and was operated from a source of either 12 or 24 volts. It utilized a self contained dynamotor as the high voltage power supply.

A companion piece for the 29A receiver was the new 27A transmitter, a multi-channel radio telephone for aircraft providing electrical dial-switch selection of any one of 10 pre-tuned frequencies in the range of two to 15 megacycles with an output power of 125 watts. The 27AA transmitter unit provided in addition, a range of frequencies from 300—500 kc for long wave transmission. The combination of 29A receiver and 27A transmitter was extremely simple to operate. Both were remotely controlled simultaneously from a small switching panel located on the instrument board. Western Electric also announced a 27B "marker receiver." This was a crystal controlled receiver permanently tuned to 75 megacycles. In addition to indicating the presence of a marker station signal, the new receiver also identified the type of station over which the ship was flying. All



marker stations fell in one of three service classifications; fan or airways position markers, outer markers, and inner markers. Each class radiated a distinctive audio-frequency tone. When picked up by the 27B receiver, these tones were made known to the pilot in two ways—audibly and visually. Conventional earphones were employed for the audible indication and an ingenious system of colored signal lamps provided the visual indication. The unit required no operating attention during flight and contained no moving parts. Complete with vacuum tubes and power supply, including the apparatus for automatic visual indication, it weighed but 19 lbs. 3 oz.

Finally, during the year, Western Electric originated development work at Bell Telephone Laboratories on three new units of aircraft radio equipment which utilized the ultra high frequencies. These units met specifications prepared by the major transport companies. The first of these—a radio receiver to operate in 119—132 megacycle band—featured a quick-shift mechanism which enabled pilots within a period of approximately two seconds to select any one of 30 frequencies. A unique mechanical assembly, in this unit, assured the equivalent of crystal stability. This receiver formed a mobile counterpart of the new system of ultra high frequency beam-stations planned for the nation's airways.

The second unit—a combined transmitter and receiver—covered the band extending from 140 to 144 megacycles. This unit served as a medium for two-way communication between the pilot and airport personnel when the airplane was approaching a terminal. The third unit—a glide path receiver for the airplane—finally linked the vital chain of apparatus needed for a compact, efficient, and reliable system of instrument landing.

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., in 1940 began building the largest wound-rotor motor ever constructed, to make possible wind tunnel testing of full size planes under conditions actually encountered in flying at 400 m.p.h. The motor, of 40,000 h.p., was being built to drive two 40-foot fans in the full-scale wind tunnel at Wright Field.

Other aircraft products manufactured by Westinghouse included main and auxiliary generators and control instruments, lighting equipment, radio receivers and transmitters.

Electric power loads increased in airplanes in 1940, and auxiliary engine-driven generators by Westinghouse offered dependable power sources independent of main engines. The a-c 110 volt, 400 cycle, 3 phase system was developed for large airplanes with heavy motor loads. Alternators rating 12.5 kva at 75 per cent power factor, and two pole motors running at 22,500 r.p.m. full load speed were made available.

Control apparatus established accurate voltage regulation and provided direct current for excitation and battery charging. The 24-volt system was used on airplanes with light power loads. Five kw generators were designed for speeds ranging from 3,200 to 6,000 r.p.m. to conform to prime mover requirements.

There was a definite change in airplane auxiliary power plant requirements during the past year due to progress in engine-driven generators. Westinghouse equipment made it possible to utilize the main engine type generator on an auxiliary engine. Thus, a four-motor bomber could have five generators of the same type. These generators could be operated in parallel with any four handling the airplane load. Westinghouse aided in developments in airport lighting that reached the point where all daytime operations could be carried on at night. Radio controlled seadrome lights made possible night landing of seaplanes. These fluorescent contact lights were mounted on buoys strung out in lines simulating, in effect, runway lighting at land airports. Production of airplane engine parts was increased by using a new type of furnace with an "Endogas" atmosphere. This insured the delivery of heat-treated parts with bright, clean surfaces that needed little or no finishing. All S. A. E. steels were treated with processing time, in many cases, cut from one week to eight hours. The use of Micarta in airplanes increased due to its light weight, long wearing, and decorative properties. Rudder bars and other vital parts were controlled through molded Micarta pulleys, standard safety equipment on aircraft.

The S. S. White Dental Manufacturing Company, New York, manufacturers of flexible shafts for aircraft, in 1940 developed a tachometer drive combination made entirely of non-magnetic materials, and advanced development of flexible shaft controls for gun fire equipment, bomb sights and other confidential items in connection with the defense program. Other S. S. White 1940 developments included tachometer adapters for firewall mounting and fuel pump engine connections. A new swaging tool making possible cutting of flexible shafting to length in the field or any shop, right-angle tachometer drives for engine tachometer mounting, and right-angle and T-angle adapters for radio and other remote controls were in process of development. Chief among the developments in flexible shafting was a type especially constructed for remote control. This type was characterized by minimum torsional deflection under load and equal deflection in either direction of rotation—properties essential to smooth, sensitive remote control. For use with this shafting in aircraft applications, a metallic casing of smaller size and proportionate reduction in weight was produced. Applications of S. S. White

flexible shafts included power drives of tachometers, electric tachometer generators, fuel pumps, controllable pitch propeller governors, ammunition rounds counters, windshield wipers and cowl flaps; and remote control of radio receivers and transmitters, antenna and compass loops, antenna reels, controllable pitch propellers, tabs, turn bank indicators and radiator shutters.

The Wilcox-Rich Division of Eaton Manufacturing Company, Detroit, Mich., in 1940 made two contributions to aircraft progress: development of the Rich valve in sodium-cooled form, and development of the Zero-Lash Hydraulic Valve Lifter. The valve was made of Silchrome X steels. It had a hollow chamber in the head and stem which contained a liquid coolant. When splashed up and down with the valve movement, it transferred the heat from the intensely hot head to the cooled stem. The Zero-Lash Hydraulic Valve Lifter was used by three aircraft engine manufacturers and tests were under way with others. This device employed hydraulics to give zero clearance, bringing many distinct benefits which included accurate valve timing, increased engine output with little or no increase in weight, prolonged life of valve and seat, simplified engine design, improved engine performance, and elimination of need for adjusting tappets.

There were three large Wilcox-Rich plants, in Battle Creek, Marshall, and Saginaw, Mich., in addition to the headquarters plant and laboratory at Detroit. These plants made other parts of the valve gear mechanism: tappets, valve springs, push rods, and valve seat inserts. In connection with the latter, company engineers made important experiments in determining the best valve seat insert design and material to use when matched with a specific valve and to fit a certain type of engine requirement.

Wittek Manufacturing Company, Chicago, Ill., manufactured stainless steel hose clamps for aircraft. The clamp, made of a solid band of stainless steel, combining light weight with greater strength, was standard equipment with manufacturers of commercial and military aircraft, the company stated.

Woodward Governor Company, Rockford, Ill., continued to manufacture a governor for pitch propellers.

During 1940 there were many companies active in the aeronautical field other than those actually manufacturing aeronautical equipment. Companies engaged in the distribution and export of aircraft, aircraft engines and aeronautical equipment included Edwin D. Allmendinger, New York; American Eastern Corporation, New York; Aviation Equipment & Export, Inc., New York; Charles H. Babb Company, Glendale, Calif.; Bendix Export Division of Bendix Aviation Corporation, New York; China Airmotive Company,

New York; Curtiss Exports Division of Curtiss-Wright Corporation, New York; General Aircraft Corporation, South Lowell, Mass.; Gillies Aviation Corporation, Bethpage, N. Y.; Intercontinent Corporation, New York; J. V. W. Corporation, Newark, N. J.; Miranda Brothers, Inc., New York; Northwest Air Service, Inc., Seattle, Wash.; Tri-American Aircraft Corporation, New York; United Aircraft Export Division of United Aircraft Corporation, East Hartford, Conn.; and O. J. Whitney, Inc., New York. Insurers or classifiers of aeronautical risks included Aero Insurance Underwriters, New York; Associated Aviation Underwriters, New York; National Aviation Insurance Agency, Chicago, Ill.; Newhouse & Sayre, Inc., New York; Parker & Company, Philadelphia, Pa., and U. S. Aviation Underwriters, Inc., New York. Among other companies whose activities were concerned with some phase of aviation business were Aviation Capital, Inc., Barr Shipping Corporation, Hirsch, Lilienthal & Company, Loomis, Suffern & Fernald, National Credit Office, Inc., Smith, Barney & Company, Standard Statistics Company, Inc., all of New York City; Cox & Stevens Aircraft Corporation, Mineola, N. Y., and Don A. Luscombe Company, Hallowell, Pa.

## AIRCRAFT SPECIFICATIONS

From all official company reports received at time of going to press.

Name of Manufacturer	Model	No. of Places	ATC No. or Mil.	Make of Engine	No. of Engines	Total Rated H.P.	Wing Area Sq. Ft.	Gross Weight Lbs.	High Speed M.P.H.	Cruising Speed M.P.H.	Range Miles
Aeronca Aircraft Co.....	65-CA	2	675	Continental A-65	1	65	169	1250	109	105	500
Aeronca Aircraft Co.....	65-LB	2	702	Lycoming O-145-B	1	65	169	1250	109	105	500
Aeronca Aircraft Co.....	S-65-CA	2	675	Continental A-65	1	65	169	1320	95	85	450
Aeronca Aircraft Co.....	65-TL	2	728	Lycoming O-145-B	1	65	169	1150	90	81	250
Aeronca Aircraft Co.....	65-TF	2	728	Franklin 4AC-176-B2	1	65	169	1150	90	81	250
Aeronca Aircraft Co.....	65-TC	2	728	Continental A-65	1	65	169	1150	90	81	250
Aeronca Aircraft Co.....	50-TL	2	728	Lycoming O-145-A	1	50	169	1150	83	75	250
Aeronca Aircraft Co.....	50-TC	2	728	Continental A-50	1	50	169	1150	83	75	250
Babcock Aircraft Corp. . .	LC-13-A	2	ATC pending	Glenn L. Martin 333 or Franklin 6-AC-298-F3	1	120	135.44	1600	150	135	450
					1	130	135.44	1600	150	135	450
Beech Aircraft Corp.....	E17B	5	641	Jacobs L-5	1	285	296.5	3390	....	177	750
Beech Aircraft Corp.....	F17D	5	689	Jacobs L-6	1	330	296.5	3590	....	182	700
Beech Aircraft Corp.....	D17A	5	713	Wright R-760-E2	1	350	296.5	4250	....	170	755
Beech Aircraft Corp.....	D17R	5	638	Wright R-975-E3	1	450	296.5	4250	....	202	820
Beech Aircraft Corp.....	D17S	5	649	Pratt & Whitney Wasp Jr.	1	450	296.5	4250	....	202	840
Beech Aircraft Corp.....	18A	8-10	630	Wright R-760-E2	2	700	347.5	7500	....	200	1200
Beech Aircraft Corp.....	18R	8-10	Exp.	Wright R-975-E3	2	900	347.5	7500	....	220	1100
Beech Aircraft Corp.....	18S	6-8	710	Pratt & Whitney Wasp Jr.	2	900	347.5	7500	....	220	1100
Beech Aircraft Corp.....	M18	3-8	Mil.	Wright R-975-E3 or Pratt & Whitney Wasp Jr.	2	900	347.5	7500	....	220	1100
Bell Aircraft Corp.....	Airacobra	1	Mil.	Allison	1	1150	213	7200	.....Restricted	.....	.....
Bellanca Aircraft Corp....	31-42	6-8	578	Wright R-975-E3	1	420	311	5600	165	145	.....
Bellanca Aircraft Corp....	31-55	6	565	Pratt & Whitney Wasp H	1	550	311	5600	190	172	.....
Bellanca Aircraft Corp....	66-76	2-16	563	Wright Cyclone or Pratt & Whitney Hornet	1	760	665	11,400	172	155	.....
Bellanca Aircraft Corp....	14-9	3	716	LeBlond	1	90	140	1700	135	120	.....
Boeing Aircraft Company	299T	9	Mil.	Wright Cyclone	4	4800	.....	47,500	325	.....	3500
Boeing Aircraft Company	307B	38	726	Wright Cyclone	4	4400	1486	45,000	250	222	2340
Boeing Aircraft Company	A-314	89	704	Wright Cyclone 14	4	6400	2867	84,000	190	175	4000
Brewster Aeronautical Corp.....	339	1	Mil.	Wright Cyclone 9	1	1100	208.9	6272	340	.....	1500
	340	2	Mil.	Wright Cyclone 14	1	1650	341	12,169.9	304	.....	1500
Cessna Aircraft Corp.....	C-145	4	701	Warner Super Scarab	1	145	181	2450	162	151	525
Cessna Aircraft Corp.....	C-165	4	701	Warner Super Scarab	1	165	181	2450	169	157	485
Cessna Aircraft Corp.....	T-50	5	722	Jacobs L-4MB	2	225	295	5100	195	191	750

AIRCRAFT SPECIFICATIONS



Name of Manufacturer	Model	No. of Places	ATC No. or Mil.	Make of Engine	No. of Engines	Total Rated H.P.	Wing Area Sq. Ft.	Gross Weight Lbs.	High Speed M.P.H.	Cruising Speed M.P.H.	Range Miles
Engineering & Research Corp.	Ercoupe 415C	2	718	Continental	1	65	142.6	1175	117	105	350
Fairchild Aircraft	24 W41	4	707	Warner	1	145	174	2550	130	120	720
Fairchild Aircraft	24 W-41A	4	Pend.	Warner	1	165	174	2550	135	125	720
Fairchild Aircraft	M-62 A (PT-19)	2	724	Ranger 6-440	1	175	200	2450	135	120	480
Fairchild Aircraft	M-62 B	2	Pend.	Warner	1	165	200	2450	130	115	480
Fleetwings	XBT-12	2	Mil.	Pratt & Whitney R 985-25	1	450	240.42	4410	.....	.....	556
Fleetwings	33	2	Exp.	Franklin 6 AC-298	1	130	116.7	1650	.....	.....	520
General Aircraft	G1-80	2	.....	Lycoming	1	75	123	1350	110	98	400
Grumman Aircraft	F4F-3	1	Mil.	Pratt & Whitney Twin Wasp	1	1200	.....	.....	Restrict	d	.....
Grumman Aircraft	G-36	1	Mil.	Wright Cyclone or Pratt & Whitney Twin Wasp	1	1200	.....	.....	Restrict	d	.....
Grumman Aircraft	G-21A	8	654	Pratt & Whitney Wasp Jr.	2	800	375	8000	201	190	1050
Grumman Aircraft	JRF-2	8	Mil.	Pratt & Whitney Wasp Jr.	2	800	375	8000	200	.....	950
Grumman Aircraft	Widgeon	4-5	Pend.	Ranger 6-440C-5	2	400	245	4500	163	150	775
Harlow Aircraft Co.	PJC-2	4	659	Warner Super Scarab	1	145	185	2600	.....	135	500
Harlow Aircraft Co.	PC-5A	2	Pend.	Warner	1	165	185	2600	163	145	425
Howard Aircraft Corp.	DGA-15P	5	717	Pratt & Whitney Wasp Jr.	1	450	210	4350	270	200	785
Howard Aircraft Corp.	DGA-15J	5	717	Jacobs	1	330	210	4350	261	190	1280
Howard Aircraft Corp.	DGA-15W	5	717	Wright	1	350	210	4350	261	190	1280
Howard Aircraft Corp.	DGA-18	2	739	Warner	1	125	179.5	2000	118	108	365
Interstate Aircraft	S1-A	2	Exp.	Continental A65-8	1	65	173.8	1200	107	100	375
Lockheed Aircraft Corp.	Lodestar	17	723	Wright or Pratt & Whitney	2	1800	551	17,500	250	229	1800
Lockheed Aircraft Corp.	414-56	5	Mil.	Wright or Pratt & Whitney	2	2000	551	18,500	284	255	2160
Lockheed Aircraft Corp.	P38	1	Mil.	Allison	2	2300	.....	13,500	.....	.....	1100
Lockheed Aircraft Corp.	12A	8	618	Pratt & Whitney	2	800	352	8650	225	212	824
Lockheed Aircraft Corp.	Electra	10	595	Pratt & Whitney or Wright	2	840	458.3	10,500	212	202	713
Lockheed Aircraft Corp.	212	3-8	Mil.	Pratt & Whitney or Wright	2	840	352	9200	216	200	980
Luscombe Airplane Corp.	8A	2	694	Continental	1	65	140	1200	110	104	350
Luscombe Airplane Corp.	Seaplane	2	694	Continental	1	65	140	1260	105	95	350
Luscombe Airplane Corp.	8C	2	694	Continental	1	75	140	1200	115	110	325
Luscombe Airplane Corp.	8B1	2	694	Lycoming	1	65	140	1200	110	102	375
The Glenn L. Martin Co.	167-W	3	Mil.	Pratt & Whitney	2	2100	538.5	15,297	304	248	2470
The Glenn L. Martin Co.	PBM-1	7	Mil.	Wright	2	2700	.....	40,000	.....	Restrict	d
The Glenn L. Martin Co.	B-26	5	Mil.	Pratt & Whitney	2	3700	.....	26,625	.....	Restrict	d
North American Aviation	NA-16-3	2	Mil.	Pratt & Whitney	1	550	253.73	5260	206	180	730
North American Aviation	NA-40A	5	Mil.	Wright Cyclone	2	2700	610.1	24,000	308	243.5	2650
North American Aviation	NA-73	1	Mil.	Allison V-1710	1	.....	235.75	7708	.....	Restrict	d
Northrop Aircraft	N-3PB	3	Mil.	Wright Cyclone	1	1200	376.8	9190	257	215	1400

<i>Name of Manufacturer</i>	<i>Model</i>	<i>No. of Places</i>	<i>ATC No. or Mil.</i>	<i>Make of Engine</i>	<i>No. of Engines</i>	<i>Total Rated H.P.</i>	<i>Wing Area Sq. Ft.</i>	<i>Gross Weight Lbs.</i>	<i>High Speed M.P.H.</i>	<i>Cruising Speed M.P.H.</i>	<i>Range Miles</i>
Piper Aircraft Corp.....	J3	2	660	Continental, Lycoming or Franklin	1	65	178.5	1100	93	85	200
Piper Aircraft Corp.....	J4	2	721	Continental	1	75	183	1400	100	93	455
Piper Aircraft Corp.....	J5	3	725	Continental or Lycoming	1	75	179	1450	95	87	320
Pitcairn-Larsen Autogiro Co.....	PA-36	2	.....	Warner Super Scarab	1	175	1452*	2050	121.7	102	350
Pitcairn-Larsen Autogiro Co.....	PA-39	2	Mil.	Warner Super Scarab	1	175	1400*	1946.7	111	93	280
Porterfield Aircraft Corp..	CP-55	2	720	Continental	1	55	168.8	1160	102	91	300
Porterfield Aircraft Corp..	CP-65	2	720	Continental	1	65	168.8	1160	108	98	300
Porterfield Aircraft Corp..	LP-65	2	720	Lycoming	1	65	168.8	1160	106	96	325
Porterfield Aircraft Corp..	PP-65	2	720	Franklin	1	65	168.8	1200	107	97	300
Porterfield Aircraft Corp..	75-C	2	611	Continental	1	75	136	1326	118	108	350
Porterfield Aircraft Corp..	90	2	611	Warner	1	90	136	1326	130	115	325
Rearwin Aircraft & Eng..	Sportster 7000	2	574	Ken-Royce	1	70	166	1460	115	103	500
	9000KR	2	591	Ken-Royce	1	90	166	1460	125	112	500
	9000	2	624	Warner	1	90	166	1460	123	110	450
Rearwin Aircraft & Eng..	Speedster 6000M	2	661	Menasco	1	125	143.2	1700	150	130	575
Rearwin Aircraft & Eng..	Cloudster 8090	2	711	Ken-Royce	1	90	161.8	1635	125	110	650
	8125	2	711	Ken-Royce	1	120	161.8	1800	135	120	600
	8135	3	711	Ken-Royce	1	129	161.8	1900	135	120	600
Rearwin Aircraft & Eng..	Skyranger 165L	2	.....	Lycoming	1	65	164.6	1350	105	95	500
	165F	2	.....	Franklin	1	65	164.6	1350	105	95	500
	175	2	729	Continental	1	75	164.6	1350	110	100	500
	180F	2	.....	Franklin	1	80	164.6	1350	115	105	525
Republic Aviation Corp..	EP-1	1	.....	Pratt & Whitney Twin Wasp R-1830	1	1050	225	605.3	320	260	600
Republic Aviation Corp..	2-PA Guardsman	2	.....	Pratt & Whitney Twin Wasp R-1830	1	1050	250	7480	310	250	580
Republic Aviation Corp..	YP-43 Lancer	1	.....	Pratt & Whitney Twin Wasp R-1830-B1	1	1200	223.7	7155	375	310	960
Ryan Aeronautical Co....	ST-3	2	Mil.	Kinner	1	125	134.3	1825	123	112	312
Ryan Aeronautical Co....	ST-3	2	Mil.	Kinner	1	160	134.3	1825	132	123	266
Ryan Aeronautical Co....	ST-3	2	Mil.	Menasco	1	125	134.3	1825	126	115	345
Ryan Aeronautical Co....	ST-3	2	Mil.	Menasco	1	150	134.3	1825	136	122	309

\* Rotor disc area.



Name of Manufacturer	Model	No. of Places	ATC No. or Mil.	Make of Engine	No. of Engines	Total Rated H.P.	Wing Area Sq. Ft.	Gross Weight Lbs.	High Speed M.P.H.	Cruising Speed M.P.H.	Range Miles
Ryan Aeronautical Co....	STM-S2	2	Mil.	Menasco	1	150	124	1828	122	108	246
Ryan Aeronautical Co....	STA	2	571	Menasco	1	125	124	1600	126	115	366
Ryan Aeronautical Co....	STA Special	2	681	Menasco	1	150	124	1600	142	128	326
Ryan Aeronautical Co....	YO-51	2	Res.	Pratt & Whitney Wasp	1	.....	.....	.....	Restricted	.....	.....
Ryan Aeronautical Co....	S-C	3	658	Warner	1	145	202	2150	150	135	525
N. B. Rich Airplane Co....	Rich-Twin	2	NX2300	Lycoming	2	150	140	1600	135	115	375
St. Louis Aircraft.....	PT-1	2	Mil.	Wright Whirlwind	1	225	298	2766	126	108	368
St. Louis Aircraft.....	PT-LM-4	2	Mil.	Ranger	1	180	157	2012	137	125	345
Southern Aircraft Corp...	BM-10	2	Mil.	Lycoming, Continental, Jacobs or Wright	1	225	304.5	2790	123	105	355
Spartan Aircraft Co.....	NS-1	2	Mil.	Lycoming R-680-7	1	220	301.32	2800	115	100	350
Spartan Aircraft Co.....	7W	5	628	Pratt & Whitney Wasp Jr. SB	1	450	250	4400	212	190	900
Stearman Aircraft.....	A75	2	PT-13B	Lycoming R-680-11	1	220	297.6	2701	125	103	425
Stearman Aircraft.....	A75N1	2	PT-17	Continental R-670-5	1	220	297.6	2664	124	100	400
Stearman Aircraft.....	A75J1	2	PT-18	Jacobs R-755-7	1	225	297.6	2726	125	105	420
Stearman Aircraft.....	A75N1	2	N2S-1	Continental R-670-4	1	220	297.6	2717	124	100	400
Stearman Aircraft.....	B75	2	N2S-2	Lycoming R-680-8	1	220	297.6	2756	124	103	425
Stearman Aircraft.....	B75N1	2	N2S-3	Continental R-670-4	1	220	297.6	2727	124	100	400
Stearman Aircraft.....	A75L3	2	.....	Lycoming R-680-B4D	1	225	297.6	2674	125	103	386
Stearman Aircraft.....	90	2	.....	Lycoming R-680-B4D	1	225	201	2810	140	115	430
Stearman Aircraft.....	91	2	.....	Pratt & Whitney	1	450	201	4150	190	160	800
Stearman Aircraft.....	91C3	.....	.....	Wright R-975-E3	1	420	201	4145	190	160	800
Stearman Aircraft.....	76D1	2	.....	Pratt & Whitney Wasp Jr. T1B	1	320	297.4	3336	151	131	560
Stearman Aircraft.....	76D3	2	.....	Pratt & Whitney Wasp Jr. SB	1	400	297.4	3250	157	135	635
Stearman Aircraft.....	100	4	.....	Pratt & Whitney R-2180	2	1400	609.44	18,230	275	250	1200
Stinson Aircraft Div. of Vultee Aircraft.....	Voyager	3	738	Franklin	1	90	155	1627	115	.....	350
Swallow Airplane Co....	LT65	2	Pend.	Continental	1	65	126.6	1200	115	100	350
Taylorcraft Aviation Corp.	B12	2	700	Lycoming, Continental or Franklin	1	65	183.5	1200	105	95	375
Taylorcraft Aviation Corp.	BT	2	700	Lycoming	1	50-65	183.5	1150	97	88	250
Taylorcraft Aviation Corp.	D	2	.....	Lycoming, Continental or Franklin	1	65	180	1200	102	92	300
Vega Airplane Co.....	35-70	2	.....	Menasco D4	1	125	147.2	1823	124	112	325
Vega Airplane Co.....	35-67	2	.....	Menasco D4B	1	160	147.2	1799	138	122	293
Vega Airplane Co.....	35-72	2	.....	Kinner R-5	1	150	147.2	1858	134	122	260
Vega Airplane Co.....	35-75	2	.....	Warner Super Scorpion	1	165	147.2	1843	137	120	287

Name of Manufacturer	Model	No. of Places	ATC No. or Mil.	Make of Engine	No. of Engines	Total Rated H.P.	Wing Area Sq. Ft.	Gross Weight Lbs.	High Speed M.P.H.	Cruising Speed M.P.H.	Range Miles
Vega Airplane Co.....	35-76	2	.....	Ranger 6-440C-3	1	180	147.2	1883	139	125	270
Vought-Sikorsky Div. of United Aircraft Corp...	V-156	2	Mil.	Pratt & Whitney Wasp	1	750	305	6500	259	225	1055
Vought-Sikorsky Div. of United Aircraft Corp...	S-43	19	593	Pratt & Whitney Hornet	2	1500	780	20,000	190	173	1590
Vought-Sikorsky Div. of United Aircraft Corp...	VS-44A	28-40	Pend.	Pratt & Whitney 1830	4	4200	.....	57,500	225	175	3800
Vultee Aircraft.....	Vanguard 48-C	1	Mil.	Pratt & Whitney R-1830-S3C4-G	1	1200	197	6182	350	299	700
Vultee Aircraft.....	Valiant 54	2	Mil.	Pratt & Whitney R-985-T1B2	1	450	239	3991	182	170	730
Vultee Aircraft.....	Valiant 54	2	Mil.	Wright R-975-E3	1	450	239	3981	180	168	740
Vultee Aircraft.....	Attack-bomber V-12C	3	Mil.	Wright GR1820-105B	1	1050	384	(At tack M ission) 10,111	254	226	2500
Vultee Aircraft.....	Attack-bomber V-12C	3	Mil.	Wright GR1820-105B	1	1050	384	(Bo mbing M ission) 12,078	231	194	2380
Vultee Aircraft.....	Attack-bomber V-12D	3	Mil.	Wright GR2600-A5B	1	1600	384	(At tack M ission) 10,886	281	248	1780
Vultee Aircraft.....	Attack-bomber V-12D	3	Mil.	Wright GR2600-A5B	1	1600	384	(Bo mbing M ission) 12,853	270	230	1700
Vultee Aircraft.....	Valiant 51	2	Mil.	Pratt & Whitney R-1340-S1H1-G	1	550	238	5628	236	213	900
Waco Aircraft Co.....	ARE	4-5	714	Jacobs L-6	1	330	246	4001	185	177	1080
Waco Aircraft Co.....	SRE	4-5	714	Pratt & Whitney SB	1	450	246	4200	200	195	880
Waco Aircraft Co.....	HRE	4-5	Pend.	Lycoming R-680	1	300	246	4001	168	160	944
Waco Aircraft Co.....	AVN	4	677	Jacobs L-6	1	300	246	3800	161	151	460
Waco Aircraft Co.....	YKS	4-5	626	Jacobs L-4	1	225	244	3250	144	135	518
Waco Aircraft Co.....	ZKS	4-5	626	Jacobs L-5	1	285	244	3250	152	144	504
Waco Aircraft Co.....	VKS	4-5	648	Continental W670M	1	240	244	3250	145	136	492
Waco Aircraft Co.....	VKS	4-5	648	Continental W670M-1	1	250	244	3250	148	140	500
Waco Aircraft Co.....	UPF-7	2	642	Continental R670-3	1	220	244	2650	138.6	123	365
Waco Aircraft Co.....	YPT-14	2	Mil.	Continental	1	220	244	2650	138.6	123	365

## AIRCRAFT ENGINE SPECIFICATIONS

From all official company reports received at time of going to press.

Name of Engine	<i>Air cooled Franklin</i>	<i>Air cooled Franklin</i>	<i>Air cooled Franklin</i>	<i>Air cooled Franklin</i>	<i>Air cooled Franklin</i>
Type	Opposed	Opposed	Opposed	Opposed	Opposed
Model Number	4AC-176-B2	4AC-176-F3	4AC-199-E3	6AC-264-F3	6AC-298-F3
No. of Cylinders	4	4	4	6	6
Blower	None	None	None	None	None
Norm. H.P. Take-Off					
R.P.M.					
Norm. H.P. Rtg.	65	80	90	120	130
R.P.M. Alt.	2200	2500	2500	2600	2550
Fuel Octane No.	73	80	80	80	80
Cubic Inch Displ'mt	176	176	199	264	298
Bore & Stroke	4 3 1/2	4 3 1/2	4 1/4 3 1/2	4 3 1/2	4 1/4 3 1/2
Size in Inches					
Diam.					
Length	28.625	30.687	30.687	38.937	38.937
Width	30.25	30.25	30.25	30.25	30.25
Height	19.97	24.562	24.562	24.56	24.56
Propeller Shaft Ratio					
Dry Weight Pounds	182	217	224	282	295
A.T.C. No.	221	221	226	222	225

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Allied Monsoon</i>	<i>Allison C-15</i>	<i>Allison E-4</i>	<i>Allison F-3R</i>	<i>Allison XV-3420</i>
Type	Inline	Long Nose	( <sup>1</sup> )	Short Nose	( <sup>2</sup> )
Model Number	100	V-1710-33	V-1710-35	V-1710-39	VV-3420
No. of Cylinders	4	12	12	12	24
Blower		8.77:1	8.80 : 1	8.80 : 1	Restricted
Norm. H.P. Take-Off	100	1040	1150	1150	Restricted
R.P.M.	2285	3000	3000	3000	Restricted
Norm. H.P. Rtg. Alt.		1090 3000 13,200	1150 3000 12,000	1150 3000 12,000	Restricted Restricted Restricted
Fuel Octane No.	73	100	100	100	Restricted
Cubic Inch Displ'mt	243	1710	1710	1710	Restricted
Bore & Stroke	4.134 4.527	5.5 6	5.5 6	5.5 6	Restricted Restricted
Size in Inches					
Diam.					
Length	37.75	98 17/32	196 13/16	88 3/8	Restricted
Width	12.36	29 9/32	29 9/32	29 9/32	Restricted
Height	27.00	41 7/8	36 17/32	36 17/36	Restricted
Propeller Shaft Ratio		2 : 1	1.80 : 1	2 : 1	Restricted
Dry Weight Pounds	205	1340	1400	1310	Restricted
A.T.C. No.	208				

<sup>1</sup> Extension shelf and outboard reduction gear box.<sup>2</sup> Short nose, long nose or extension shaft.

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Continental</i>	<i>Continental</i>	<i>Continental</i>	<i>Continental</i>	<i>Continental</i>
Type	Radial	Radial	Radial	Opposed	Opposed
Model Number	W670 Series K	W670 Series M	W670 Series M1	A40	A50
No. of Cylinders	7	7	7	4	4
Blower	None	None	None	None	None
Norm. H.P. Take-Off	225	240	250	40	50
R.P.M.	2175	2200	2200	2575	1900
Norm. H.P. Rtg. Alt.					
Fuel Octane No.	73	80	80	72	65
Cubic Inch Displ <sup>mt</sup>	668	668	668	115	171
Bore & Stroke	5 1/8 4 5/8	5 1/8 4 5/8	5 1/8 4 5/8	3 1/8 3 3/4	3 7/8 3 5/8
Size in Inches					
Diam.	42 1/4	42 1/4	42 1/4		
Length				27 1/3	30 2/5
Width				26 11/25	31 7/10
Height				19 11/25	23
Propeller Shaft Ratio	Direct Drive	Direct Drive	Direct Drive	Direct Drive	Direct Drive
Dry Weight Pounds	465	465	465	( <sup>1</sup> )	( <sup>1</sup> )
A.T.C. No.	162	162	162	Ser. 4-72 Ser. 5-174	190

<sup>1</sup> Dry Weight in Pounds:A40, Series 4 — 144  
Series 5 — 154A50, Series 7 — 161  
Series 8 — 170  
Series 9 — 176

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Continental</i>	<i>Continental</i>	<i>Continental</i>	<i>Fletcher</i>	<i>Jacobs</i>
Type	Opposed	Opposed	Opposed	Radial	Radial
Model Number	A65	A75	A80	A-460	L-6MB
No. of Cylinders	4	4	4	7	7
Blower	None	None	None	None	None
Norm. H.P. Take-Off	65	75	80	144	330
R.P.M.	2300	2600	2700	2350	2200
Norm. H.P. Rtg. Alt.				130 2100 Sea Level	300 2100 3700
Fuel Octane No.	72	72	80	73	80
Cubic Inch Displ'mt	171	171	171	460	914
Bore & Stroke	3 7/8 3 5/8	3 7/8 3 5/8	3 7/8 3 5/8	4 3/8 4 3/8	5.5 5.5
Size in Inches					
Diam.				39 13/16	45.625
Length	30 2/5	30 1/5	30 1/5	31	
Width	31 7/10	31 7/10	31 7/10		
Height	22 1/5	22 1/5	22 1/5		
Propeller Shaft Ratio	Direct Drive	Direct Drive	Direct Drive	Direct Drive	1:1
Dry Weight Pounds	(1)	(1)	(1)	364	570
A.T.C. No.	Ser. 5-205	213	217	None	195

<sup>1</sup> Dry Weight in Pounds:

A65, Series 7 — 161  
Series 8 — 170  
Series 9 — 176

A75, Series 8 — 170  
Series 9 — 176

A80, Series 8 — 170  
Series 9 — 176

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Jacobs</i>	<i>Jacobs</i>	<i>Jacobs</i>	<i>Jacobs</i>	<i>Jacobs</i>
Type	Radial	Radial	Radial	Radial	Radial
Model Number	L-6M	L-5MB	L-5M	L-4MB	L-4M
No. of Cylinders	7	7	7	7	7
Blower	None	None	None	None	None
Norm. H.P. Take-Off	330	285	285	225	225
R.P.M.	2200	2000	2000	2000	2000
Norm. H.P. Rtg. Alt.	300 2100 3700	285 2000	285 2000	225 2000	225 2000
Fuel Octane No.	80	73	73	73	73
Cubic Inch Displ'mt	914	831	831	757	757
Bore & Stroke	5.5 5.5	5.5 5	5.5 5	5.25 5	5.25 5
Size in Inches Diam. Length Width Height	45.625	43 1/2	43 1/2	43 1/2	43 1/2
Propeller Shaft Ratio	1:1	1:1	1:1	1:1	1:1
Dry Weight Pounds	570	525	525	494	494
A.T.C. No.	195	156	156	121	121

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Kinner</i>	<i>Kinner</i>	<i>Kinner</i>	<i>Lenape</i> "Papoose"	<i>Lenape</i> "Papoose"
Type	Radial	Radial	Radial	Radial	Radial
Model Number	K-5	B-5 & B-54	R-5 & R-55	LM-3	LM-365
No. of Cylinders	5	5	5	3	3
Blower				None	None
Norm. H.P. Take-Off R.P.M.				50 2325	65 2350
Norm. H.P. Rtg. R.P.M. Alt.	100 1810	125 1925	160 1850	50 Sea Level	65 Sea Level
Fuel Octane No.	73	73	73	73	73
Cubic Inch Displ'mt	372	441	540	160.4	167
Bore & Stroke	4 1/4 5 1/4	4 5/8 5 1/4	5 5 1/2	4 1/8 4	4 1/8 4
Size in Inches Diam. Length Width Height	45 3/8 32 5/16	45 3/8 32 5/16	45 3/8 32 5/16	36	36
Propeller Shaft Ratio	Direct Drive	Direct Drive	Direct Drive	Direct Drive	Direct Drive
Dry Weight Pounds	275	295	330	138	140
A.T.C. No.	3	51	153	203	203



## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Lenape "Papoose"</i>	<i>Lenape "Brave"</i>	<i>Lenape "Brave"</i>	<i>Lenape "Chief"</i>	<i>Lycoming</i>
Type	Radial	Radial	Radial	Radial	Opposed
Model Number	LM-375	LM-5	LM-125		O-235
No. of Cylinders	3	5	5	7	4
Blower	None	None	None	None	None
Norm. H.P. Take-Off	75	95	125	150	100
R.P.M.	2450	2200	2450	2350	2550
Norm. H.P. Rtg.	75	95	125	150	100
R.P.M. Alt.	Sea Level	Sea Level	Sea Level	Sea Level	2550 Sea Level
Fuel Octane No.	73	73	73	73	73
Cubic Inch Displ'mt	170.5	267	267	378	233.30
Bore & Stroke	4 1/4 4	4 1/8 4	4 1/4 4	4 1/4 4	4.375 3.875
Size in Inches					
Diam.	36	36	36	36	
Length					33.25
Width					32.38
Height					25.02
Propeller Shaft Ratio	Direct Drive	Direct Drive	Direct Drive	Direct Drive	1 : 1
Dry Weight Pounds	142	192	192	275	221.11
A.T.C. No.	215	212			Pending

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Lycoming</i>	<i>Lycoming</i>	<i>Lycoming</i>	<i>Lycoming</i>	<i>Lycoming</i>
Type	Opposed	Opposed	Opposed	Opposed	Opposed
Model Number	O-235-A	O-290	O-290-A	O-350	O-350-A
No. of Cylinders	4	4	4	4	4
Blower	None	None	None	None	None
Norm. H.P.	100	125	125	150	150
Take-Off R.P.M.	2550	2550	2550	2550	2550
Norm. H.P. Rtg. R.P.M. Alt.	100 2550 Sea Level	125 2550 Sea Level	125 2550 Sea Level	150 2550 Sea Level	150 2550 Sea Level
Fuel Octane No.	73	73	73	73	73
Cubic Inch Displ'mt	233.30	289.00	289.00	349.50	349.50
Bore & Stroke	4.375 3.875	4.875 3.875	4.875 3.875	4.375 3.875	4.375 3.875
Size in Inches					
Diam.					
Length	31.39	33.25	31.39	40.91	38.09
Width	32.38	32.38	32.38	32.38	32.38
Height	25.20	25.02	25.20	26.36	26.25
Propeller Shaft Ratio	1 : 1	1 : 1	1 : 1	1 : 1	1 : 1
Dry Weight Pounds	223.11	231.11	233.11	322.76	324.76
A.T.C. No.	Pending	Pending	Pending	Pending	Pending

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Lycoming</i>	<i>Lycoming</i>	<i>Lycoming</i>	<i>Lycoming</i>	<i>Lycoming</i>
Type	Opposed	Opposed	Radial	Radial	Radial
Model Number	O-435	O-435-A	R-680-B4D	R-680-D5	R-680-D6
No. of Cylinders	4	4	9	9	9
Blower	None	None	1:1	1:1	1:1
Norm. H.P. Take-Off	175	175	225	260	245
R.P.M.	2350	2350	2100	2300	2300
Norm. H.P. Rtg. Alt.	175 2350 Sea Level	175 2350 Sea Level	225 2100 Sea Level	245 2100 Sea Level	225 2100 Sea Level
Fuel Octane No.	73	73	73	80	73
Cubic Inch Displ'mt	434.00	434.00	680.4	680.4	680.4
Bore & Stroke	4.875 3.875	4.875 3.875	4 5/8 4 1/2	4 5/8 4 1/2	4 5/8 4 1/2
Size in Inches					
Diam.			43 1/2	43 1/2	43 1/2
Length	40.91	38.09			
Width	32.38	32.38			
Height	26.61	26.50			
Propeller Shaft Ratio	1:1	1:1	1:1	1:1	1:1
Dry Weight Pounds	329.76	331.76	492	505	505
A.T.C. No.	Pending	Pending	108	172	173

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Lycoming</i>	<i>Lycoming</i>	<i>Lycoming</i>	<i>Lycoming</i>	<i>Lycoming</i>
Type	Radial	Radial	Radial	Opposed	Opposed
Model Number	R-680-E1	R-680-E2	R-680-E3A	O-145-A2 O-145-A3	O-145-B Series
No. of Cylinders	9	9	9	4	4
Blower	1:1	1:1	1:1	None	None
Norm. H.P. Take-Off	290	280	300	55	65
R.P.M.	2300	2300	2350	2300	2550
Norm. H.P. Rtg.	275	265	285	55	65
R.P.M. Alt.	2200	2200	2200	2300	2550
	Sea Level	Sea Level	Sea Level	Sea Level	Sea Level
Fuel Octane No.	80	73	87	73	73
Cubic Inch Displ <sup>mt</sup>	680.4	680.4	680.4	144.49	144.49
Bore & Stroke	4 5/8 4 1/2	4 5/8 4 1/2	4 5/8 4 1/2	3 5/8 3 1/2	3 5/8 3 1/2
Size in Inches					
Diam.	43 1/2	43 1/2	43 1/2		
Length				24.63 <sup>1</sup>	24.63 <sup>2</sup>
Width				29.56 <sup>1</sup>	29.56 <sup>2</sup>
Height				20.59 <sup>1</sup>	22.59 <sup>2</sup>
Propeller Shaft Ratio	1:1	1:1	1:1	1:1	1:1
Dry Weight Pounds	514	514	514	A2 165.5 A3 167.5	B2 165.5 B3 167.5
A.T.C. No.	202	202	202	199	210

<sup>1</sup> Applies to O-145-A2, B2 and C2.<sup>2</sup> Applies to O-145-A3, B3 and C3.

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Lycoming</i>	<i>Lycoming</i>	<i>Menasco Super Pirate</i>	<i>Menasco Super Pirate</i>	<i>Menasco Super Buccaneer</i>
Type	Opposed	Opposed	(*)	(*)	(*)
Model Number	O-145-C Series	GO-145-C Series	D4	D4B	C6S-4
No. of Cylinders	4	4	4	4	6
Blower	None	None		9.6 : 1	10.9 : 1
Norm. H.P. Take-Off	75	75	125	160	290
R.P.M.	3100	3200	2175	2300	2400
Norm. H.P. Rtg.	75	75	125	150	260
R.P.M. Alt.	3100 Sea Level	3200 Sea Level	2175	2250	2300
Fuel Octane No.	73	73	73	73	80
Cubic Inch Displ'mt	144.49	144.49	363	363	544.9
Bore & Stroke	3 5/8 3 1/2	3 5/8 3 1/2	4.75 5.125	4.75 5.125	4.75 5.125
Size in Inches					
Diam.					
Length	<sup>1,2</sup>	29.31	48 7/16	48 7/16	67 15/32
Width	29.56	29.56	19 13/16	19 7/16	16 1/2
Height	<sup>1,2</sup>	20.67 <sup>3</sup>	29 1/4	29 1/4	30 19/32
Propeller Shaft Ratio	1 : 1	27 : 17	1 : 1	1 : 1	1 : 1
Dry Weight Pounds	C2 165.5 C3 167.5	C2 193 C3 195	300	325	550
A.T.C. No.	210	210	67	Pending	197

<sup>1</sup> Applies to O-145-A2, B2 and C2.

<sup>2</sup> Applies to O-145-A3, B3 and C3.

<sup>3</sup> Applies to GO-145-C2. C3 is 22.67.

\* Inverted inline aircooled.

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Menasco</i>	<i>Pratt &amp; Whitney Wasp Jr.</i>	<i>Pratt &amp; Whitney Wasp Jr.</i>	<i>Pratt &amp; Whitney Wasp</i>	<i>Pratt &amp; Whitney Wasp</i>
Type	(1)	R-985	R-985	R-1340	R-1340
Model Number	D6S-G	SB3	T1B3	S1H1	S1H1-G
No. of Cylinders	6	9	9	9	9
Blower	11.1 : 1	10 : 1	10 : 1	12 : 1	12 : 1
Norm. H.P. Take-Off	390	450	450	600	600
R.P.M.	3000	2300	2300	2250	2250
Norm. H.P. Rtg. Alt.	355 2800	400 2200 5000	450 2300 Sea Level	550 2200 8000	550 2200 8000
Fuel Octane No.	95	80-87	87	87	87
Cubic Inch Displ <sup>mt</sup>	544.9	985	985	1344	1344
Bore & Stroke	4.75 5.125	5.187 5.187	5.187 5.187	5.75 5.75	5.75 5.75
Size in Inches					
Diam.		46.06	46.06	51.75	51.75
Length	76	42.38	42.38	42.93	47.73
Width	17 13/16				
Height	34 11/16				
Propeller Shaft Ratio	.667 : 1	Direct Drive	Direct Drive	Direct Drive	Geared 3 : 2
Dry Weight Pounds	610	*668	*668	*864	*930
A.T.C. No.	Pending	123	Pending	129	129

<sup>1</sup> Inverted inline aircooled.

\* Dry weight is with standard accessory equipment and includes: Automatic Valve Gear Lubrication, Standard Carburetor, complete Radio-Shielded Ignition System, Pressure Type Cooling Baffles, Oil Pump(s), Priming System and all Standard Accessory Drives.

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Pratt &amp; Whitney Wasp</i>	<i>Pratt &amp; Whitney Wasp</i>	<i>Pratt &amp; Whitney Twin Wasp</i>	<i>Pratt &amp; Whitney Twin Wasp</i>	<i>Pratt &amp; Whitney Twin Wasp</i>
Type	R-1340	R-1340	R-1830	R-1830	R-1830
Model Number	S3H1	S3H1-G	S1C3-G	S3C4-G	S4C4-G
No. of Cylinders	9	9	14	14	14
Blower	10 : 1	10 : 1	6.7 : 1	6.7 : 1	6.7 : 1
Norm. H.P. Take-Off	600	600	1200	1200	1200
R.P.M.	2250	2250	2700	2700	2700
Norm. H.P. Rtg.	550	550	1050	1100 (L) 1000 (H)	1050 (L) 900 (H)
R.P.M.	2200	2200	2550	2550 (L) 2550 (H)	2550 (L) 2550 (H)
Alt.	5000	5000	7500	6200 (L) 12,500 (H)	7500 (L) 15,400 (H)
Fuel Octane No.	80-87	80-87	90	95	90
Cubic Inch Displ'mt	1344	1344	1830	1830	1830
Bore & Stroke	5.75	5.75	5.50	5.50	5.50
Size in Inches					
Diam.	51.75	51.75	48.13	48.13	48.13
Length	42.93	47.73	60.94	62.75	62.75
Width					
Height					
Propeller Shaft Ratio	Direct Drive	Geared 3 : 2	Geared**	Geared**	Geared**
Dry Weight Pounds	*864	*930	*1438	*1460	*1460
A.T.C. No.	143	142	186	186	186

\* Dry weight is with standard accessory equipment and includes: Automatic Valve Gear Lubrication, Standard Carburetor, complete Radio-Shielded Ignition System, Pressure Type Cooling Baffles, Oil Pump(s), Priming System and all Standard Accessory Drives.

(L) Low. \*\* Optional gear ratios available.  
(H) High.

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Pratt &amp; Whitney Double Wasp</i>	<i>Pratt &amp; Whitney Double Wasp</i>	<i>Ranger</i>	<i>Ranger</i>	<i>Ranger</i>
Type	R-2800	R-2800	Inline <sup>1</sup>	Inline <sup>1</sup>	Inline <sup>1</sup>
Model Number	S1A6-G	S1A4-G	6-440C-2	6-440C-3	6-440C-4
No. of Cylinders	18	18	6	6	6
Blower	1 speed	2 speed	None	None	None
Norm. H.P. Take-Off	1850	1850	175	180	190
R.P.M.	2600	2600	2450	2450	2450
Norm. H.P. Rtg.	1500	1500 (L) 1450 (H)	175	180	190
R.P.M.	2400	2400 (L) 2400 (H)	2450	2450	2450
Alt.	7500	7500 (L) 13,000 (H)	Sea Level	Sea Level	Sea Level
Fuel Octane No.	100	100	65	73	80
Cubic Inch Displ'mt	2804	2804	441	441	441
Bore & Stroke	5.75 6.00	5.75 6.00	4.125 5.5	4.125 5.5	4.125 5.5
Size in Inches					
Diam.	52.25	52.25			
Length	75.56	75.56	52.062	52.062	52.062
Width			20.156	20.156	20.156
Height			30.968	30.968	30.968
Propeller Shaft Ratio	Geared**	Geared**	Direct Drive	Direct Drive	Direct Drive
Dry Weight Pounds	*2245	*2280	373	373	373
A.T.C. No.			216	216	216

\* Dry weight is with standard accessory equipment and includes: Automatic Valve Gear Lubrication, Standard Carburetor, complete Radio-Shielded Ignition System, Pressure Type Cooling Baffles, Oil Pump(s), Priming System and all Standard Accessory Drives.

(L) Low. \*\* Optional gear ratios available.

(H) High. <sup>1</sup> Inverted, inline, aircooled.



AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Ranger</i>	<i>Ranger</i>	<i>Ranger</i>	<i>Ranger</i>	<i>Rearwin Ken-Royce</i>
Type	Inline <sup>1</sup>	60°V <sup>2</sup>	60°V <sup>2</sup>	60°V <sup>2</sup>	Radial
Model Number	6-440C-5	V-880C-1	SGV-770B-7	GV-880C-1	5G
No. of Cylinders	6	12	12	12	5
Blower	None	None	9.5 : 1	None	
Norm. H.P. Take-Off	200	405	520	450	90
R.P.M.	2450	2400	3150	2800	2250
Norm. H.P. Rtg.	200	405	450	450	90
R.P.M. Alt.	2450 Sea Level	2400 Sea Level	3000 12,000	2800 Sea Level	2250 Sea Level
Fuel Octane No.	87	87	87	87	73
Cubic Inch Displ'mt	441	882	773	882	266
Bore & Stroke	4.125 5.5	4.125 5.5	4 5.125	4.125 5.5	4 1/4 3 3/4
Size in Inches					
Diam.					33.25
Length	52.062	60.625	62	62.185	23.75
Width	20.156	29.50	28	29.50	
Height	30.968	28.812	32.25	30.75	
Propeller Shaft Ratio	Direct Drive	Direct Drive	crankshaft: propeller 3 : 2	crankshaft: propeller 3 : 2	1 : 1
Dry Weight Pounds	373	610	730	650	226
A.T.C. No.	216	Pending	207	Pending	46

<sup>1</sup> Inverted, inline, aircooled.

<sup>2</sup> Inverted, 60°V, inline, aircooled.

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Rearwin Ken-Royce</i>	<i>Rearwin Ken-Royce</i>	<i>Warner Scarab</i>	<i>Warner Super Scarab Model 165</i>	<i>Wright Cyclone 18</i>
Type	Radial	Radial	Radial	Radial	Radial
Model Number	7G	5E	Series 50	Model 165	
No. of Cylinders	7	5	7	7	18
Blower					Restricted
Norm. H.P. Take-Off	120	70		175	2000
R.P.M.	2225	1950		2250	
Norm. H.P. Rtg.	120	70	125	165	Restricted
R.P.M. Alt.	2225	1950	2050	2100	Restricted
	Sea Level	Sea Level	Sea Level	Sea Level	Restricted
Fuel Octane No.	73	65	73	73	Restricted
Cubic Inch Displ'mt	372	250.5	422	499	Restricted
Bore & Stroke	4 1/4 3 3/4	4 1/8 3 3/4	4 1/4 4 1/4	4 5/8 4 1/4	Restricted Restricted
Size in Inches					
Diam.	33.25	33.25	36 9/16	37 1/4	Restricted
Length	24.56	23.75			Restricted
Width					
Height		37.375			
Propeller Shaft Ratio	1 : 1	1 : 1	Direct	Direct	Restricted
Dry Weight Pounds	285	245	285	332	Restricted
A.T.C. No.	52	48	2	214	

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	Wright Cyclone 14	Wright Cyclone 14	Wright Cyclone 14	Wright Cyclone 14	Wright Cyclone 14
Type	Radial	Radial	Radial	Radial	Radial
Model Number	GR2600 A2	GR2600 A2A	GR2600 A2B	GR2600 A5A	GR2600 A5B
No. of Cylinders	14	14	14	14	14
Blower	7.40 : 1	7 : 1	7 : 1	7.14 : 1 10 : 1	7.14 : 1 10 : 1
Norm. H.P. Take-Off	1550	1600	1600	1600	1600
R.P.M.	2400	2400	2400	2400	2400
Norm. H.P. Rtg. Alt.	1200 2100 5400	1350 2300 6200	1350 2300 5800	1350 2300 5000	1350 2300 5000
Fuel Octane No.	(*)	95	90	95	90
Cubic Inch Displ'mt	2603	2603	2603	2603	2603
Bore & Stroke	6.125 6.312	6.125 6.312	6.125 6.312	6.125 6.312	6.125 6.312
Size in Inches					
Diam.	55	55	55	55	55
Length	62.06	62.06	62.06	62.06	62.06
Width					
Height					
Propeller Shaft Ratio	.5625	.5625	.5625	.5625	.5625
Dry Weight Pounds	1935	1935	1935	1950	1950
A.T.C. No.	176	176	176		

\* Fuel required is octane plus 0.8cc Tetraethyl lead per gal. (CFR-ATM-1940)

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	Wright G-200	Wright G-200	Wright G-200	Wright G-100	Wright G-100
Type	Radial	Radial	Radial	Radial	Radial
Model Number	GR1820 G202A	GR1820 G203A	GR1820 G205A	GR1820 G102A	GR1820 G103A
No. of Cylinders	9	9	9	9	9
Blower	7 : 1	8.3 : 1	7.14 : 1 10 : 1	7 : 1	8.31 : 1
Norm. H.P. Take-Off	1200	1100	1200	1100	1000
R.P.M.	2500	2500	2500	2350	2350
Norm. H.P. Rtg.	1000	950	1000	900	860
R.P.M. Alt.	2300 6900	2300 9100	2300 4500	2300 6700	2300 11,100
Fuel Octane No.	90	90	90	90	90
Cubic Inch Displ <sup>mt</sup>	1823	1823	1823	1823	1823
Bore & Stroke	6.125 6.875	6.125 6.875	6.125 6.875	6.125 6.875	6.125 6.875
Size in Inches					
Diam.	55.125	55.125	55.125	55.10	55.10
Length	50.04	50.04	50.04	48.12	48.12
Width					
Height					
Propeller Shaft Ratio	.666 <sup>1</sup>	.666 <sup>1</sup>	.666 <sup>1</sup>	.6875 <sup>2</sup>	.6875 <sup>2</sup>
Dry Weight Pounds	1310	1310	1315	1275	1275
A.T.C. No.	219	Pending	Pending	169	180

<sup>1</sup> Also available with .5625.<sup>2</sup> Also available with .666.

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	Wright G-100	Wright G-100	Wright G	Wright G	Wright G
Type	Radial	Radial	Radial	Radial	Radial
Model Number	GR1820 G105A	GR1820 G105C	R & GR1820 G2	R & GR1820 G3	R & GR1820 G3B
No. of Cylinders	9	9	9	9	9
Blower	7.14 : 1 10 : 1	7.14 : 1 10 : 1	7 : 1	8.31 : 1	8.31 : 1
Norm. H.P. Take-Off	1100	1050	1000	875	900
R.P.M.	2350	2350	2200	2200	2350
Norm. H.P. Rtg. Alt.	900 2300 6700	900 2300 5000	820 2100 Sea Level	760 2100 Sea Level	820 2100 8800
Fuel Octane No.	90	90	87	87	87
Cubic Inch Displ <sup>mt</sup>	1823	1823	1823	1823	1823
Bore & Stroke	6.125 6.875	6.125 6.875	6.125 6.875	6.125 6.875	6.125 6.875
Size in Inches					
Diam.	55.10	55.10	54.25	54.25	54.25
Length	48.12	48.12	47.75 <sup>4</sup>	47.75 <sup>4</sup>	47.75 <sup>4</sup>
Width					
Height					
Propeller Shaft Ratio	.6875 <sup>2</sup>	.6875 <sup>2</sup>	.6875 <sup>3</sup>	.6875 <sup>3</sup>	.6875 <sup>3</sup>
Dry Weight Pounds	1287	1287	1198 <sup>4</sup>	1198 <sup>4</sup>	1198 <sup>4</sup>
A.T.C. No.	192	192	157	171	171

<sup>2</sup> Also available with .666.<sup>3</sup> Also with direct drive.<sup>4</sup> Refers to geared model only.

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	Wright G	Wright F-50	Wright F-50	Wright F-50	Wright F 50
Type	Radial	Radial	Radial	Radial	Radial
Model Number	R & GR1820 G5	R & GR1820 F52	R & GR1820 F53	R & GR1820 F56	R & GR1820 F55
No. of Cylinders	9	9	9	9	9
Blower	7.14 : 1 10 : 1	7 : 1	8.31 : 1	8.83 : 1	7.14 : 1 10 : 1
Norm. H.P. Take-Off	1000	875 <sup>4</sup>	770 <sup>4</sup>	770 <sup>4</sup>	875
R.P.M.	2200	2200	2200	2200	2200
Norm. H.P. Rtg.	850	760 <sup>4</sup>	730 <sup>4</sup>	740 <sup>4</sup>	675
R.P.M. Alt.	2100 6000	2100 5800	2100 9600	2100 11,300	2100 15,300
Fuel Octane No.	87	87	87	87	87
Cubic Inch Displ'mt	1823	1823	1823	1823	1823
Bore & Stroke	6.125 6.875	6.125 6.875	6.125 6.875	6.125 6.875	6.125 6.875
Size in Inches					
Diam.	54.25	54.12	54.12	54.12	54.12
Length	47.75 <sup>4</sup>	47.81 <sup>4</sup>	47.81 <sup>4</sup>	47.81 <sup>4</sup>	47.81 <sup>4</sup>
Width					
Height					
Propeller Shaft Ratio	.6875 <sup>3</sup>	.6875 <sup>3</sup>	.6875 <sup>3</sup>	.6875 <sup>3</sup>	.6875 <sup>3</sup>
Dry Weight Pounds	1210 <sup>4</sup>	1095 <sup>4</sup>	1095 <sup>4</sup>	1095 <sup>4</sup>	1012 <sup>4</sup>
A.T.C. No.	154	148	149	159	198

<sup>3</sup> Also with direct drive.

<sup>4</sup> Refers to geared model only.

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	Wright F60	Wright F60	Wright Whirlwind	Wright Whirlwind	Wright Whirlwind
Type	Radial	Radial	Radial	Radial	Radial
Model Number	R & GR1820 F62	R & GR1820 F65	R975 E1	R975 E3	R460 ET
No. of Cylinders	9	9	9	9	7
Blower	7 : 1	7.14 : 1 10 : 1	7.80 : 1	10.15 : 1	None
Norm. H.P. Take-Off	900	900	450	450	235
R.P.M.	2350	2350	2250	2250	2000
Norm. H.P. Rtg. Alt.	760 2100 5800	675 2100 15,300	365 2100 Sea Level	412 2200 Sea Level	235 2000 Sea Level
Fuel Octane No.	87	87	73	80	73
Cubic Inch Displ <sup>mt</sup>	1823	1823	973	973	756
Bore & Stroke	6.125 6.875	6.125 6.875	5.00 5.50	5.00 5.50	5.00 5.50
Size in Inches					
Diam.	54.12	54.12	45	45	45
Length	47.81 <sup>4</sup>	47.81 <sup>4</sup>	41.2	41.2	42.44
Width					
Height					
Propeller Shaft Ratio	.6875 <sup>3</sup>	.6875 <sup>3</sup>	Direct	Direct	Direct
Dry Weight Pounds	1000 <sup>4</sup>	1012 <sup>4</sup>	660	675	540
A.T.C. No.	148	198	87	125	126

<sup>3</sup> Also with direct drive.<sup>4</sup> Refers to geared model only.

## AIRCRAFT ENGINE SPECIFICATIONS

Name of Engine	<i>Wright Whirlwind</i>	<i>Wright Whirlwind</i>			
Type	Radial	Radial			
Model Number	R760 E1	R760 E2			
No. of Cylinders	7	7			
Blower	7.05 : 1	9.17 : 1			
Norm. H.P.	300	350			
Take-Off R.P.M.	2250	2400			
Norm. H.P. Rtg. R.P.M. Alt.	285 2100 Sea Level	320 2200 Sea Level			
Fuel Octane No.	73	80			
Cubic Inch Displ'mt	756	756			
Bore & Stroke	5.00 5.50	5.00 5.50			
Size in Inches					
Diam.	45	45			
Length	42.44	42.44			
Width					
Height					
Propeller Shaft Ratio	Direct	Direct			
Dry Weight Pounds	570	570			
A.T.C. No.	94	155			



## Directory Section

SUBJECT	PAGE
Directory of Manufacturers . . . . .	430-506
Aeronautical Chamber of Commerce of America, Inc. . . . .	508-509
Manufacturers Aircraft Association, Inc. . . . .	509
Air Transport Association of America . . . . .	509
Institute of the Aeronautical Sciences . . . . .	510
National Aeronautic Association of U. S. A. . . . .	510
Aircraft Owners and Pilots Association . . . . .	510
Society of Automotive Engineers, Inc. . . . .	512
The American Society of Mechanical Engineers . . . . .	512
Soaring Society of America, Inc. . . . .	512
U. S. Air Corps, War Department . . . . .	514
Office of Production Management . . . . .	514
Federal Communications Commission . . . . .	514
Bureau of Aeronautics, U. S. Navy . . . . .	516-517
Post Office Department Air Mail Service . . . . .	517
National Advisory Committee for Aeronautics . . . . .	520
Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce . . . . .	520
Civil Aeronautics Administration, U. S. Depart- ment of Commerce . . . . .	524
Civil Aeronautics Board, U. S. Department of Com- merce . . . . .	524
Congressional Committees Interested in Aviation	526-530
U. S. Forest Service, Department of Agriculture . . . . .	530
Diplomatic Service to the United States . . . . .	532
Flying and Ground Schools . . . . .	536-540
Airplane and Engine Mechanics' Schools . . . . .	542
Aeronautical Periodicals of the United States . . . . .	545
Aviation Writers Association . . . . .	545

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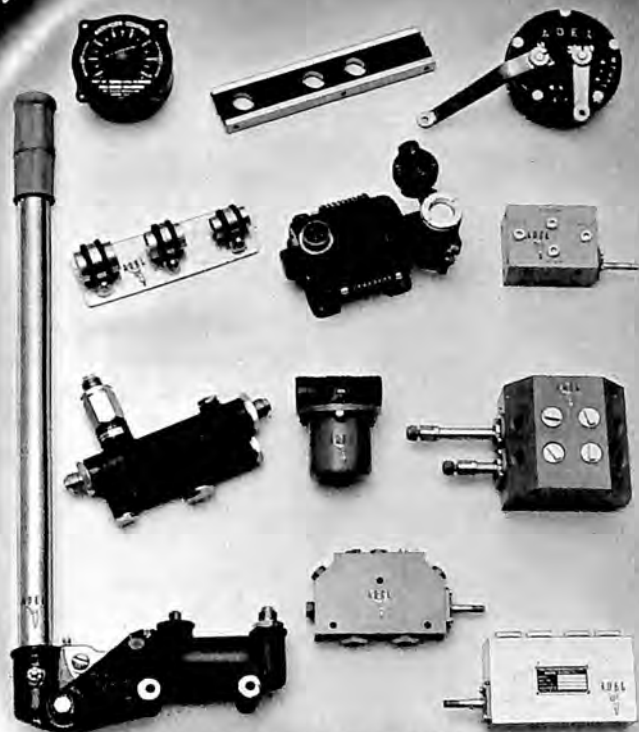
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 PRODUCTS: Spark plugs.

**AERO SUPPLY MFG. CO., INC.,** Corry, Pa.

PERSONNEL: Frank N. Ames, Pres.; S. J. Irvine, V. Pres.; L. E. Graham, Secy-Treas.; H. W. Jewell, Pur. Dir.  
 PRODUCTS: Turnbuckles; Thimbles; Tube clamps; Bolts; Shackles.

**AERO TOOL CO.,**

231 Olive St., Burbank, Calif.  
 PERSONNEL: Lester Deutsch, Pres.  
 PRODUCTS: Tools.

**AERO TRADES CO.,**

Roosevelt Field, Mineola, N. Y.  
 PERSONNEL: James G. McIntosh and Ernst Scheifele, partners.  
 PRODUCTS: Aircraft parts.

**AEROMARINE INSTRUMENT CO.,**

385 Gerard Ave., Bronx, N. Y.  
 PERSONNEL: Adolf Urfer, Pres.  
 PRODUCTS: Altimeters; Air speed indicators; Compasses; Tachometers; Gauges.

**AERONAUTICAL MFG. CORP.,**

377 Fourth St., Niagara Falls, N. Y.  
 PERSONNEL: Albert M. Patterson, Pres.; Clifford J. Lane, V. Pres.  
 PRODUCTS: Valves; Hydraulic and thermostatic controls.

**AEROPRODUCTS DIV., GENERAL MOTORS CORP.,** Dayton, O.

PERSONNEL: W. J. Blanchard, Gen. Mgr.; Herbert Layport, Pur. Dir.  
 PRODUCTS: Propeller assemblies.

**AEROQUIP CORP.,**

300 S. East Ave., Jackson, Mich.  
 PERSONNEL: Don T. McKone, Pres.; Chas. Hollerith, V. Pres.  
 PRODUCTS: Self-sealing couplings.

**AGAWAM AIRCRAFT PRODUCTS, INC.,**

Sag Harbor, N. Y.  
 PERSONNEL: Albert P. Loening.  
 PRODUCTS: Machined parts.

**AHLBERG BEARING CO.,**

3025 W. 47th St., Chicago, Ill.  
 PERSONNEL: F. O. Burkholder, V. Pres.;  
 PRODUCTS: Ball and roller bearings.

**AIR ASSOCIATES, INC.,**

Bendix Airport, Bendix, N. J.  
 PERSONNEL: F. Leroy Hill, Pres.; Harold I. Crow, V. Pres.; Geo. Kleverstrom, Secy-Treas.; Robt. E. Fowler, Pub. Dir.; John W. Andrews, Pers. Dir.; Peter Smith, Pur. Dir.  
 PRODUCTS: Anti-icer equipment; Instruments; Engine materials.

**AIR RADIO & INSTRUMENT CO.,**

Municipal Airport, Chicago, Ill.  
 PERSONNEL: H. T. Sagerf, Gen. Mgr.  
 PRODUCTS: Instruments.

**AIR REDUCTION SALES CO.,**

60 E. 42nd St., New York, N. Y.  
 PERSONNEL: C. S. Munson, Pres.  
 PRODUCTS: Airco oxygen, acetylene, oxyacetylene welding and cutting apparatus; Arc welding electrodes and machines; Lights.

**AIR-SAFE AIRCRAFT INSTRUMENTS, 1030**

N. Western Ave., Los Angeles, Calif.  
 PERSONNEL: John F. Carssow, Pres.  
 PRODUCTS: Instruments.

**AIR-SHIELDS, INC.,** Hatboro, Pa.

PERSONNEL: S. Y. Gibbon, Pres.  
 PRODUCTS: Spark plugs.

**AIRADIO, INC.,**

2 Selleck St., Stamford, Conn.  
 PERSONNEL: M. B. Andrews, Pres.; J. B. Cobrain, Secy-Treas.  
 PRODUCTS: Radio control boxes and parts.

**AIRCRAFT ACCESSORIES CORP.,**

166 W. Olive Ave., Burbank, Calif.  
 PERSONNEL: Randolph C. Walker, Pres.; Geo. A. Theobald, V. Pres.; James A. Habegger, Treas.; Wm. J. Hosmer, Secy.  
 PRODUCTS: Hydraulic actuating equipment.

**AIRCRAFT ASSOCIATES, INC.,**

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 PERSONNEL: Harvey N. Martin, Pres.  
 PRODUCTS: Tail wheels.

**AIRCRAFT ENGINEERING PRODUCTS, INC.,**

2 Ackerman Ave., Clifton, N. J.  
 PERSONNEL: Adam G. Roth, Pres.  
 PRODUCTS: Parts.

**AIRCRAFT HARDWARE MFG. CO., INC.,**

1381-91 Lafayette Ave., New York, N. Y.  
 PERSONNEL: O. Mazzei, Pres.; E. Mazzei, V. Pres.; A. J. Babboni, Secy.; S. Mazzei, Treas.  
 PRODUCTS: Aircraft screw machine work.

**AIRCRAFT MACHINERY CORP.,**

332 N. 1st St., Burbank, Calif.  
 PERSONNEL: Jerome Robins, Pres.  
 PRODUCTS: Milling machines; Dividing heads and vises.

**AIRCRAFT PRODUCTS & EQUIPMENT**

CORP., Franklin & Lacy Sts., West Chester, Pa.  
 PERSONNEL: Eugene K. Gray, V. Pres.  
 PRODUCTS: Sub-assemblies.

**AIRCRAFT RADIO CORP.,** Boonton, N. J.

PERSONNEL: L. M. Hull, Pres.  
 PRODUCTS: Radio equipment.

**AIRCRAFT SCREW PRODUCTS CO., INC.,**

47-23 35th St., Long Island City, N. Y.  
 PERSONNEL: Herbert Pain, Pres.  
 PRODUCTS: Screw thread system.

**AIRCRAFT TOOLS, INC.,**

750 E. Gage Ave., Los Angeles, Calif.  
 PERSONNEL: W. E. Miller, Pres.  
 PRODUCTS: Tools.

**AIRESEARCH MANUFACTURING CO.,**

Sepulveda Blvd. at Century, Los Angeles, Calif.  
 PERSONNEL: J. C. Garrett, Pres.  
 PRODUCTS: Coolers; Control valves; Aircraft anchors; Power shears.

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 PERSONNEL: T. W. Stemmler, Chairman.  
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**ALADDIN RADIO INDUSTRIES, INC.,**

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PRODUCTS: Forgings; Steel bars.
- ALLEGHENY LUDLUM STEEL CORP.,**  
Pittsburgh, Pa.  
PERSONNEL: H. G. Batcheller, Pres.  
PRODUCTS: Bars, castings and forgings.
- ALLEN ELECTRIC & EQUIPMENT CO.,**  
2101 N. Pitcher St., Kalamazoo, Mich.  
PERSONNEL: G. H. Allen, Pres.  
PRODUCTS: Generator and electric service laboratories; Testing equipment.
- ALLITH-PROUTY, INC.,**  
819 N. Bowman Ave., Danville, Ill.  
PERSONNEL: Donald E. Willard, Pres.  
PRODUCTS: Hardware.
- ALOFS MANUFACTURING CO.,** 1615 Madison Ave. S. E., Grand Rapids, Mich.  
PERSONNEL: H. G. Alofs, Gen. Mgr.  
PRODUCTS: Dies and stampings.
- ALPHA METAL & ROLLING MILLS, INC.,**  
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PERSONNEL: I. I. Shonberg, Pres.  
PRODUCTS: Sheetmetal.
- ALUMINUM COMPANY OF AMERICA,**  
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PERSONNEL: Roy A. Hunt, Pres.; George R. Gibbons, V. Pres. (Sales); George J. Stanley, V. Pres. & Gen. Mgr.  
PRODUCTS: Structural metals.
- ALUMINUM GOODS MANUFACTURING CO.,** Manitowoc, Wis.  
PERSONNEL: R. X. Stiefvater, Sales Mgr.  
PRODUCTS: Aluminum stamping.
- ALUMINUM INDUSTRIES, INC.,**  
2416-38 Beekman St., Cincinnati, O.  
PERSONNEL: John Eckerle, Pres.  
PRODUCTS: Aluminum and Magnesium Alloy Castings, Aluminum alloy pistons; Valves; Piston pins.
- AMERICAN AIRCRAFT RADIO,** 226 No Hawthorne Blvd., Hawthorne, Calif.  
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PRODUCTS: Transmitters and receivers.
- AMERICAN AIRPORT EQUIPMENT CO.,**  
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PRODUCTS: Wind direction indicators; Boundary marker cones; Electric signs.
- AMERICAN BLOWER CORP.,**  
6000 Russell St., Detroit, Mich.  
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PRODUCTS: Fans and blowers.
- AMERICAN BOSCH CORP.,**  
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PRODUCTS: Magnetos; Fuel injection equipment.
- AMERICAN CHAIN & CABLE CO., INC.,**  
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PERSONNEL: Geo. C. Moon, Gen. Mgr.  
PRODUCTS: Tinned aircraft cable; Cable assemblies.
- AMERICAN FELT CO.,** Glenville, Conn.  
PERSONNEL: J. F. Marshall, V. Pres.  
PRODUCTS: Acoustical felt; Mechanical parts Parachute seat pads.
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PRODUCTS: Testing equipment.
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PRODUCTS: Fire extinguishing equipment.
- AMERICAN NICKELOID CO.,** Peru, Ill.  
PERSONNEL: Carl C. Struever, V. Pres.  
PRODUCTS: Metal sheets and coils.
- AMERICAN NON-GRAN BRONZE CORP.,**  
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PERSONNEL: P. Exton Guckes, Pres.  
PRODUCTS: Bronze parts.
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PERSONNEL: Geo. B. Wells, Pres.  
PRODUCTS: Goggles.
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PRODUCTS: Airport barometers; Altimeters.
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PERSONNEL: Charles R. Hook, Pres.  
PRODUCTS: Stainless steel sheets; Electrica sheet steel.
- AMERICAN ROOF TRUSS CO.,**  
6851 Paxton Ave., Chicago, Ill.  
PERSONNEL: Wm. H. Waddington, Pres.  
PRODUCTS: Wood roof trusses.
- AMERICAN SCREW CO.,**  
21 Stevens St., Providence, R. I.  
PERSONNEL: Paul C. Nicholson, Pres.  
PRODUCTS: Wood machine and sheet metal screws.
- AMERICAN SCREW PRODUCTS,**  
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PERSONNEL: Alex Deutsch, owner.  
PRODUCTS: Screw machine products.
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PERSONNEL: C. F. Hood, Pres.  
PRODUCTS: Stainless steel strip; Aircraft control cords.
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PRODUCTS: Aircraft parts; Retractable landing gear.

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PERSONNEL: E. F. Andrews, Eng.  
PRODUCTS: Aircraft and accessories development.

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PRODUCTS: High velocity air diffuser and light.

**APEX MACHINE & TOOL CO.,**  
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PRODUCTS: Miscellaneous hardware.

**APEX TOOL CO., INC.,**  
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PERSONNEL: S. B. Swanson, Pres.  
PRODUCTS: Machine work.

**APPLETON ELECTRIC CO.,**  
1701-29 Wellington Ave., Chicago, Ill.  
PERSONNEL: A. I. Appleton, Pres.  
PRODUCTS: Airport boundary and obstruction lights.

**AQUA SYSTEMS, INC.,**  
385 Gerard Ave., New York, N. Y.  
PERSONNEL: A. C. Kaestner, V. Pres.  
PRODUCTS: Hydraulic gasoline systems.

**ARCH ROOF CONSTRUCTION CO., INC.,**  
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PRODUCTS: Hangars and factories.

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PERSONNEL: H. E. Wise, Pres.  
PRODUCTS: Paints and varnishes.

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PRODUCTS: Valves; Pumps; Regulators.

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PERSONNEL: D. E. Gilbert, Mgr.  
PRODUCTS: Manganese, aluminum, and gun-metal Bronze; Silicon aluminum.

**ARROW-HART & HEGEMAN ELECTRIC CO.,** 103 Hawthorn St., Hartford, Conn.  
PERSONNEL: R. Pierre, Asst. Mgr.  
PRODUCTS: Electric switches.

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PERSONNEL: Frank Anderson, Pres.  
PRODUCTS: Bronze castings.

**ATLAS CHROMIUM PLATING CO.,** 1206 E.  
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PRODUCTS: Electro-plating and processing.

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**AUTO-SOLER CO.,**  
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PERSONNEL: Wm. Wilkerson, Pres.  
PRODUCTS: Shoe machinery.

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PRODUCTS: Spark plugs; Elbows and sleeves for spark plugs; Service tools.

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PRODUCTS: Tractors and cranes.

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1133 W. 9th St., Cleveland, O.  
PERSONNEL: Lockwood Oliver, Pres.  
PRODUCTS: Turret lathes; Turret lathe tools.
- BARNARD AVIATION EQUIPMENT CO.,**  
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PERSONNEL: Samuel K. Mitchell, Pres.  
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- BARNES-GIBSON-RAYMOND DIV. of ASSOCIATED SPRINGS CORP.,** 6400 Miller Ave., Detroit, Mich.  
PERSONNEL: L. D. Adams, Gen. Mgr.  
PRODUCTS: Springs.
- A. P. BARTUSCH,**  
775 Walnut St., Lockport, N. Y.  
PERSONNEL: A. P. Bartusch, Mgr.  
PRODUCTS: Beam compasses.
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18 Grafton St., Worcester, Mass.  
PERSONNEL: R. F. Bath, Pres.  
PRODUCTS: Ground thread taps and gages; Micrometers.
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PRODUCTS: Sesamee locks.
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PRODUCTS: Aircraft finishes.
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PRODUCTS: Webbing yarns for parachute; Bomb slings; Gunners' belts.
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PRODUCTS: Finishing equipment.
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PRODUCTS: Portable electric tools.
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PRODUCTS: Wrenches; Torque indicators; Hydraulic jacks; Pipe benders.
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PRODUCTS: Aeronautical felt parts.
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PRODUCTS: Liquid level gages.
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PERSONNEL: H. B. Burley, Pres.  
PRODUCTS: Cables.
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PERSONNEL: R. H. Damon, Pres.  
PRODUCTS: Fuel consumption meters.
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PERSONNEL: LeRoy Baumgartl, Pres.  
PRODUCTS: Tailings; Edgings; Alloy steel or stainless steel stampings.
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PRODUCTS: Rust protective coatings.
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- BRIDGEPORT HARDWARE MANUFACTURING CORP.,** 461 Iranistan Ave., Bridgeport, Conn.  
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PRODUCTS: Tools.

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490 Broadway, Buffalo, N. Y.  
PERSONNEL: C. A. Booth, Gen. Mgr.  
PRODUCTS: Drilling Machines; Heating, ventilating and air conditioning equipment.

**BUHL STAMPING CO.**,  
2730 Scotten Ave., Detroit, Mich.  
PERSONNEL: L. D. Buhl, Pres.  
PRODUCTS: Exhaust manifold assemblies; Tail fins; Rudders; Miscellaneous fuselage sections and assemblies.

**BULLARD CO.**,  
286 Canfield Ave., Bridgeport, Conn.  
PERSONNEL: E. P. Bullard, Pres.  
PRODUCTS: Machine tools.

**E. D. BULLARD CO.**,  
275 Eighth St., San Francisco, Calif.  
PERSONNEL: E. W. Bullard, Pres.  
PRODUCTS: Safety equipment.

**BUNTING BRASS & BRONZE CO.**,  
715-755 Spencer St., Toledo, O.  
PERSONNEL: C. E. Bunting, Pres.  
PRODUCTS: Babbitt metals and bearings.

**BURDETT MANUFACTURING CO.**,  
19 N. Loomis St., Chicago, Ill.  
PERSONNEL: J. B. Burdett, Pres.  
PRODUCTS: Gas cylinder valves; Electrolytic cells.

**BURGESS BATTERY CO.**, Freeport, Ill.  
PERSONNEL: D. W. Hirtle, Pres.  
PRODUCTS: Batteries.

**BURNSIDE VENEER CO., INC.**,  
Burnside, Ky.  
PRODUCTS: Veneer.

**BURROUGHS WELLCOME & CO.**,  
9 E. 41st St., New York, N. Y.  
PERSONNEL: C. R. Brown.  
PRODUCTS: First aid equipment.

**BUTLER MANUFACTURING CO.**,  
Kansas City, Mo.  
PERSONNEL: E. E. Norquist, Pres.  
PRODUCTS: Steel hangars; Airplane refuelling units.

**BYRNE DOORS, INC.**,  
1150 Griswold St., Detroit, Mich.  
PERSONNEL: J. I. Byrne, Pres.  
PRODUCTS: Airplane hangars and doors.

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**C-O-TWO FIRE EQUIPMENT CO.**,  
10 Empire St., Newark, N. J.  
PERSONNEL: S. E. Allen, Pres.  
PRODUCTS: Extinguishing systems.

**CAMBRIDGE INSTRUMENT CO., INC.**,  
3732 Grand Central Terminal,  
New York, N. Y.  
PERSONNEL: R. H. Kruse, Pres.; H. N. Packard, V. Pres.; W. H. Jefferson, Secy.; L. Birdsall, Pur. Dir.  
PRODUCTS: Aero-mixture indicators; Aero-oxygen analyser; Temperature indicators; Precision instruments.

**CAMLOC FASTENER CO., INC.**,  
420 Lexington Ave., New York, N. Y.  
PERSONNEL: J. Mills Summers, Pres.  
PRODUCTS: Cowl fasteners.

**CANDLER-HILL CORP.**,  
2200 8th St., Detroit, Mich.  
PERSONNEL: J. Boyer Candler, Pres.  
PRODUCTS: Aircraft fuel pumps.

**CANTON DROP FORGING & MANUFACTURING CO.**, Canton, O.  
PERSONNEL: C. A. Brauchler, Pres.  
PRODUCTS: Drop forgings.

**CARDOX CORPORATION**,  
307 N. Michigan Ave., Chicago, Ill.  
PERSONNEL: Allyn Harris, Pres.  
PRODUCTS: Fire extinguishing systems.

**CHARLES W. CARLL SONS**,  
Cole St., & Reading R. R., Trenton, N. J.  
PRODUCTS: Aluminum parts.

**CARNEGIE-ILLINOIS STEEL CORP.**,  
Carnegie Bldg., Pittsburgh, Pa.  
PERSONNEL: J. L. Perry, Pres.  
PRODUCTS: Alloy, stainless and carbon steels.

**E. W. CARPENTER MANUFACTURING CO.**,  
Box 3035, Bridgeport, Conn.  
PERSONNEL: Wm. A. Patterson, Sales Mgr.  
PRODUCTS: Contract work.

**CARPENTER STEEL CO.**, Reading, Pa.  
PERSONNEL: J. H. Parker, Pres.  
PRODUCTS: Alloy steel.

**CARRIER CORPORATION**,  
12 S. 12th St., Philadelphia, Pa.  
PERSONNEL: A. P. Shanklin, Mgr.  
PRODUCTS: Ventilating equipment.

**CARTER MOTOR CO.**,  
1608 Milwaukee Ave., Chicago, Ill.  
PERSONNEL: A. J. Carter, Pres.  
PRODUCTS: Genemotors; Converters; Dynamotors; Magmotors.

**CATALIN CORPORATION**,  
1 Park Ave., New York, N. Y.  
PERSONNEL: William Theile, Pres.  
PRODUCTS: Plywood adhesive; Impregnating and surface coating resin.

## ARMORED SEATS and FITTINGS FOR AIRPLANE PILOTS

and light armor plate for all aircraft purposes

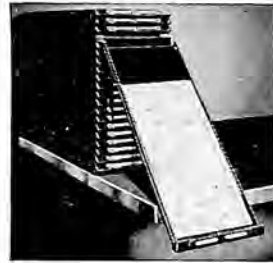
DIEBOLD has the greatest facilities for the complete fabrication of case hardened armor plate in thicknesses from  $\frac{3}{16}$ " to 1", meeting full requirements of U. S. Government.

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**CATERPILLAR TRACTOR CO.,** Peoria, Ill.  
 PRODUCTS: Diesel engines; Electric generator sets.

**CEDAR RAPIDS ENGINEERING CO. of DELAWARE,** Cedar Rapids, Ia.  
 PERSONNEL: R. H. Mcister, Pres.  
 PRODUCTS: Valve facing machines and seat grinders; Cylinder boring and line boring machines; Piston grinders.

**CEE BEE CHEMICAL CO., INC.,**  
 655 E. Gage Ave., Los Angeles, Calif.  
 PERSONNEL: S. C. Black, Pres. & Gen. Mgr.  
 PRODUCTS: Industrial cleaning compounds.

**CELLULOID CORP.,**  
 180 Madison Ave., New York, N. Y.  
 PERSONNEL: W. S. Landes, Pres.  
 PRODUCTS: Aero quality lumarith.

**CENTURY ELECTRIC CO.,**  
 1805 Pine St., St. Louis, Mo.  
 PERSONNEL: E. S. Pillsbury, Pres.; Geo. Smith, V. Pres.; R. J. Russell, Secy.; J. F. Culver, Treas.  
 PRODUCTS: Motors; generators.

**CLARENCE D. CHAMBERLIN CO.,**  
 Bendix, N. J.  
 PERSONNEL: Clarence D. Chamberlin.

**CHAMBERSBURG ENGINEERING CO.,**  
 Chambersburg, Pa.  
 PERSONNEL: Eugene C. Clarke, Pres.  
 PRODUCTS: Drop hammers and special machinery.

**CHAMPION AVIATION PRODUCTS CO.,**  
 1702-10 S. Flower St., Los Angeles, Calif.  
 PERSONNEL: H. P. Lester, Gen. Mgr.  
 PRODUCTS: Generators; Electric direct cranking starters.

**CHAMPION MACHINE & FORGING CO.,**  
 3695 E. 78th St., Cleveland, O.  
 PERSONNEL: H. W. Foster, Pres.  
 PRODUCTS: Drop forgings.

**CHAMPION SPARK PLUG CO.,** Toledo, O.  
 PERSONNEL: R. A. Stranahan, Pres.; Duane Stranahan, V. Pres.; F. D. Stranahan, Treas.; H. B. Speyer, Secy.  
 PRODUCTS: Spark plugs.

**CHANDLER-EVANS CORPORATION,**  
 South Meriden, Conn.  
 PERSONNEL: C. W. Deeds, Pres.; B. H. Gilpin, V. Pres. & Treas.; G. H. Day, Secy.  
 PRODUCTS: Fuel pumps; Non-icing carburetors; Protek plugs for anti-corrosion treatment; Miscellaneous parts.

**CHASE BRASS & COPPER CO.,**  
 Waterbury, Conn.  
 PERSONNEL: F. S. Chase, Pres.; C. E. Hart, Jr., V. Pres.; R. L. Coe, Sales Mgr.; S. S. Jackson, Secy.; J. H. Gilbert, Treas.  
 PRODUCTS: Engine accessories.

**L. C. CHASE & CO.,**  
 295 Fifth Ave., New York, N. Y.  
 PERSONNEL: Geo. B. Ogan, Gen. Mgr.  
 PRODUCTS: Upholstery fabrics.

**JOHN CHATILLON & SONS,**  
 89 Cliff St., New York, N. Y.  
 PERSONNEL: G. E. Chatillon, Pres.  
 PRODUCTS: Scales; Springs; Dynamometers.

**CHICAGO METAL HOSE CORP.,**  
 Maywood, Ill.  
 PERSONNEL: John P. Farrar, Pres.  
 PRODUCTS: Flexible shielding conduit; Fuel and oil line and hydraulic hose.

**CHICAGO PNEUMATIC TOOL CO.,**  
 6 E. 44th St., New York, N. Y.  
 PERSONNEL: H. A. Jackson, Pres.  
 PRODUCTS: Tools; Machines.

**CHICAGO THRIFT CO.,**  
 1215 W. Washington Blvd., Chicago, Ill.  
 PERSONNEL: A. C. Prince, Pres.  
 PRODUCTS: Name plates; Dials; Gauges.

**CHICAGO UNIFORM & CAP CO., INC.,**  
 208 W. Monroe St., Chicago, Ill.  
 PERSONNEL: Samuel Sugar, Pres.  
 PRODUCTS: Uniforms.

**CHRYSLER CORPORATION, AMPLEX DIV.,** 6501 Harper Ave., Detroit, Mich.  
 PERSONNEL: A. J. Langhammer, Pres.; R. H. Khuen, Sales Mgr.  
 PRODUCTS: Oilite self-lubricating bronze bearings.

**CINCINNATI GRINDERS, INC.,**  
 Cincinnati, O.  
 PERSONNEL: Frederick V. Geier, Pres.  
 PRODUCTS: Grinding machines.

**CINCINNATI MILLING MACHINE CO.,**  
 Cincinnati, O.  
 PERSONNEL: Frederick V. Geier, Pres.  
 PRODUCTS: Die sinking machines; Cutter sharpening machines.

**CINELIN COMPANY,**  
 Box 506, Indianapolis, Ind.  
 PERSONNEL: L. R. Sreinsky, Sales Mgr.  
 PRODUCTS: Plastics; Solutions.

**CIRCO PRODUCTS CO.,**  
 3088 W. 106 St., Cleveland, O.  
 PERSONNEL: John F. Black, Pres. & Treas.  
 PRODUCTS: Cleaning equipment.

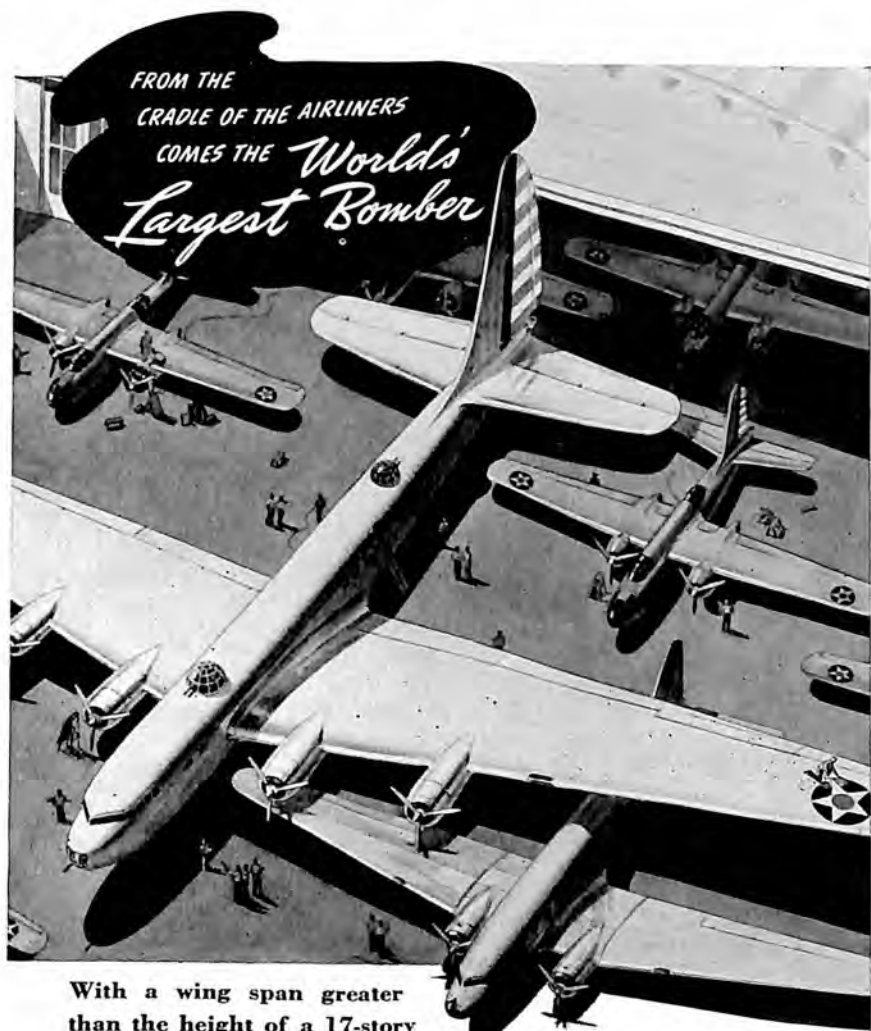
**CITIES SERVICE OIL CO.,**  
 70 Pine St., New York, N. Y.  
 PERSONNEL: J. S. Cordell, Gen. Mgr.; C. E. Foster, V. Pres.  
 PRODUCTS: Lubricants.

**E. D. CLAPP MANUFACTURING CO.,**  
 Auburn, N. Y.  
 PERSONNEL: E. D. Clapp, Pres.  
 PRODUCTS: Drop forgings.

**CLARK TRUCTRACTOR DIV. OF CLARK EQUIPMENT CO.,** Battle Creek, Mich.  
 PERSONNEL: E. W. Clark, V. Pres.  
 PRODUCTS: Tractors; Trucks.

**CLAROSTAT MANUFACTURING CO., INC.,**  
 281-7 N. 6th St., Brooklyn, N. Y.  
 PERSONNEL: John J. Mucher, Pres.  
 PRODUCTS: Theostats; Instrument panel assemblies.

**CLEVELAND METAL STAMPING CO.,**  
 31st St. & Payne Ave., Cleveland, O.  
 PERSONNEL: Chester R. Thompson, Sales Mgr.  
 PRODUCTS: Stampings.



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CRADLE OF THE AIRLINERS

COMES THE *World's  
Largest Bomber*

With a wing span greater than the height of a 17-story building the new Douglas B-19 carries a bomb load of 18 tons and can fly non-stop one third the way around the world. By serving the needs of both the Government and Civil Aviation, Douglas acquired the experience to make so great an airplane possible. Thus from the cradle of the airliners comes the world's largest bomber to help make America supreme in the air.

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FIRST AROUND  
THE WORLD

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**CLEVELAND PNEUMATIC TOOL CO.,**  
3734 E. 78th St., Cleveland, O.

PERSONNEL: L. W. Greve, Pres.; H. W. Foster, V. Pres.; A. F. Barner, Secy.; J. DeMooy, Treas.; E. J. Steger, Sales Mgr.; W. C. Wehnes, Pur. Dir.  
PRODUCTS: Landing gears; Retracting cylinders; Pneumatic tools; Pumps.

**CLEVELAND TRACTOR CO.,**  
19300 Euclid Ave., Cleveland, O.

PERSONNEL: W. King White, Pres.; H. P. Mee, V. Pres.; Grover Higgins, Secy.; E. M. Bell, Treas.  
PRODUCTS: Crawler tractors.

**CLIMAX MOLYBDENUM CO.,**  
500 Fifth Ave., New York, N. Y.

PERSONNEL: Max Schott, Pres.; J. B. Thorpe, V. Pres.  
PRODUCTS: Molybdenum.

**COLE-HERSEE CO.,**

54 Old Colony Ave., Boston, Mass.  
PERSONNEL: Leo Mayer, Pres.  
PRODUCTS: Accessory light switches.

**COLLINS & AIKMAN CORP.,**  
200 Madison Ave., New York, N. Y.

PERSONNEL: W. G. McCullough, Pres.;  
PRODUCTS: Upholstery fabrics.

**COLLINS SUPPLY & EQUIPMENT CO.,**  
Scranton, Pa.

PERSONNEL: H. E. Collins, Gen. Mgr.  
PRODUCTS: Wire forms; Stampings; Coil springs.

**COLUMBIA STEEL CO.,**  
San Francisco, Calif.

PERSONNEL: W. A. Ross, Pres.  
PRODUCTS: Aircraft tubing; Stainless steel; Alloy steels.

**COLVINEX CORPORATION,**  
250 E. 43 St., New York, N. Y.

PERSONNEL: Paul Gayne, Pres.  
PRODUCTS: Electrically-heated flight clothing.

**COMMONWEALTH INDUSTRIES, INC.,**  
5922 Commonwealth Ave., Detroit, Mich.

PRODUCTS: Heat treating.

**CONNECTICUT HARD RUBBER CO.,**  
407 East St., New Haven, Conn.

PERSONNEL: John A. Moffit, Pres.  
PRODUCTS: Plane parts.

**CONNECTICUT TELEPHONE & ELECTRIC CORP.,**  
Meriden, Conn.

PERSONNEL: H. W. Harwell, Pres.  
PRODUCTS: Radio interceptors; Jacket plugs; Headphones; Breast transmitters.

**CONNECTICUT TOOL & ENGINEERING CO.,**  
109 Holland Ave., Bridgeport, Conn.

PERSONNEL: Daniel J. Williams, Pres.  
PRODUCTS: Tools; Dies; Jigs; Fixtures; Gages; Precision machine parts.

**CONSOLIDATED INSTRUMENTS CORP.,**  
Michigan City, Ind.

PERSONNEL: J. H. Gardner, Pres.  
PRODUCTS: Air speed indicators; Gas flow meters; Gas totalizers.

**CONTINENTAL ELECTRIC CO.,**  
Newark, N. J.

PERSONNEL: E. L. Winquist, Mgr.  
PRODUCTS: Radio dynamotors and generators.

**CONTINENTAL MACHINES, INC.,**  
1301 Wash. Ave. S., Minneapolis, Minn.

PERSONNEL: L. A. Wilkie, Pres.  
PRODUCTS: Surface grinders.

**CONTINENTAL SCREW CO.,**  
New Bedford, Mass.

PERSONNEL: P. Sweeney, Pres.  
PRODUCTS: Screws; Bolts; Nuts; Rods; Rivets; Metals.

**COOPER ALLOY FOUNDRY CO.,**  
150 Broadway, Elizabeth, N. J.

PERSONNEL: H. A. Cooper, Pres.  
PRODUCTS: Stainless steel castings; Valves; Fittings.

**CORBIN SCREW CORP.,**  
High and Myrtle Sts., New Britain, Conn.

PERSONNEL: H. I. Lewis, Gen. Mgr.  
PRODUCTS: Screws and nuts.

**CORNING GLASS WORKS,**  
Corning, N. Y.

PERSONNEL: D. L. Killigrew, Mgr.  
PRODUCTS: Glassware for lighting.

**S.H. COUCH CO., INC.,**  
North Quincy, Mass.

PERSONNEL: A. T. Morrison, Pres.  
PRODUCTS: Code call system.

**COUSE LABORATORIES, INC.,**  
300 Passaic St., Newark, N. J.

PERSONNEL: K. W. Couse, Pres.  
PRODUCTS: Mobile airports; Maintenance units; Welding and machine shops.

**COX AND STEVENS AIRCRAFT CORP.,**  
Box 30, Mineola, N. Y.

PERSONNEL: Bo Sweeney, Pres.  
PRODUCTS: Aircraft computers.

**CRADDOCK UNIFORMS,**  
Kansas City, Mo.

PERSONNEL: Harry H. Craddock, Pres.  
PRODUCTS: Uniforms.

**R. W. CRAMER CO., INC.,**  
Centerbrook, Conn.

PERSONNEL: R. W. Cramer, Pres.  
PRODUCTS: Electrical timers; Time switches.

**CRESCENT CABLE CO.,**  
Pawtucket, R. I.

PERSONNEL: M. C. Sapinsley, Gen. Mgr.  
PRODUCTS: Insulated wire and cable.

**CRUCIBLE STEEL CO. OF AMERICA,**  
405 Lexington Ave., New York, N. Y.

PERSONNEL: R. E. Desvornine, Pres.  
PRODUCTS: Special purpose steels.

**CULLMAN WHEEL CO.,**  
1344 Altgold St., Chicago, Ill.

PERSONNEL: Otto Cullman, Pres.  
PRODUCTS: Machine tool drives.

**CUNO ENGINEERING CORP.,**  
Meriden, Conn.

PERSONNEL: C. H. Cuno, Pres.  
PRODUCTS: Filters for engine lubricating oil.

**CURRAN CORP.,**  
Dowling Bldg., Malden, Mass.

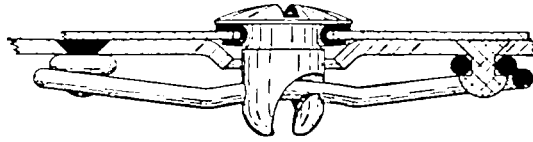
PERSONNEL: A. F. Curran, Pres.  
PRODUCTS: Carbon remover; Aluminum pistons.

**CURTIS LIGHTING, INC.,**  
6135 W. 65th St., Chicago, Ill.

PERSONNEL: Darwin Curtis, Pres.  
PRODUCTS: Industrial lighting equipment.



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19 New types—representing 59 ADDITIONAL STOCK SIZES—of Dzus Fasteners have been added to the line to meet the demand for larger and smaller sizes. They are now available in sizes ranging from 3/16" to 7/16" body diameter and in a variety of head styles. Any length of Fastener can be provided to accommodate the material thickness used.

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*Babylon, New York*

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**CURTIS PNEUMATIC MACHINERY CO.,**  
1905 Kienlen Ave., St. Louis, Mo.  
PERSONNEL: W. C. Hecker, Pres.  
PRODUCTS: Compressors; Cylinders; Fittings; Hoists; Receivers.

**CURTISS-WRIGHT CORP., PROPELLER DIV.,** Caldwell, N. J.  
PERSONNEL: Robert L. Earle, Gen. Mgr.; R. E. Minton, Sales Mgr.; John O. Harte, Pub. Dir.; N. A. Kirby, Pers. Mgr.  
PRODUCTS: Propellers.

**CUTLER-HAMMER INC.,**  
315 N. 12th St., Milwaukee, Wisc.  
PERSONNEL: G. S. Crane, V. Pres.; B. M. Horter, Sales Mgr.  
PRODUCTS: Beacon light and landing light switches.

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**DARDELET THREADLOCK CORP.,**  
55 Liberty St., New York, N. Y.  
PERSONNEL: A. F. Hebard, Pres.  
PRODUCTS: (Licensing company.)

**DAVEN CO.,** 158 Summit St., Newark, N. J.  
PRODUCTS: Filament rheostats; Laboratory equipment.

**DAVIS EMERGENCY EQUIPMENT CO., INC.,** 55 Van Dam St., New York, N. Y.  
PERSONNEL: F. R. Davis, Pres.  
PRODUCTS: First aid kits; Combustible gas indicators; Alarm units.

**DAYTON AIR PRODUCTS DIV., DAYTON TYPE, INC.,** 200 Davis Ave., Dayton, O.  
PERSONNEL: Otto L. Spaeth, Pres.  
PRODUCTS: Testing instruments; Propeller laps; Miscellaneous equipment.

**DAYTON MANUFACTURING CO.,** Dayton, O.  
PERSONNEL: H. D. Hendrick, Pres.  
PRODUCTS: Sanitary fittings.

**DEFIANCE STAMPING CO.,** Defiance, O.  
PERSONNEL: L. F. Serrick, Pres.  
PRODUCTS: Stampings.

**DEJUR-AMSCO CORP.,**  
6 Bridge St., Shelton, Conn.  
PRODUCTS: Electrical instruments; Voltmeters; Ammeters; Cylinder head thermometers.

**DENNING MANUFACTURING CO.,**  
1777 E. 87th St., Cleveland, O.  
PERSONNEL: P. Frank Denning, Pres.  
PRODUCTS: Tools; Dies; Stampings; Special parts.

**DESPATCH OVENS CO.,**  
622 9th St., S. E., Minneapolis, Minn.  
PERSONNEL: A. E. Grapp, Pres.  
PRODUCTS: Ovens.

**DETROIT GASKET & MANUFACTURING CO.,** 12640 Burt Rd., Detroit, Mich.  
PERSONNEL: L. H. Diehl, Pres.  
PRODUCTS: Manifolds and exhaust pipe flange gaskets; Diesel engine cylinder head gaskets.

**DETROIT MACOID CORP.,**  
12340 Cloverdale, Detroit, Mich.  
PERSONNEL: Arthur Gardner, Pres.; George Hendrie, V. Pres.; J. E. Gould, Treas.  
PRODUCTS: Extrusion and injection moldings of thermo-plastic materials.

**DETROIT REX PRODUCTS CO.,**  
13005 Hillview Ave., Detroit, Mich.  
PERSONNEL: W. W. Davidson, V. Pres.  
PRODUCTS: Degreasers; Solvents for degreasing.

**DETROIT STAMPING CO.,**  
350 Midland Ave., Detroit, Mich.  
PERSONNEL: Glendon H. Roberts, Pres.  
PRODUCTS: Metal stampings; Toggle clamps and pliers; Special washers.

**DETROIT SURFACING MACHINE CO.,**  
7433 W. Davison, Detroit, Mich.  
PERSONNEL: Frank D. Nunemaker, Mgr.  
PRODUCTS: Electric sander.

**DEVILBISS CO.,** 300 Phillips Ave., Toledo, O.  
PERSONNEL: A. D. Gutchess, Pres.  
PRODUCTS: Spray painting equipment; Exhaust systems; Air compressors.

**DIEBOLD SAFE & LOCK COMPANY,** Canton, O.  
PRODUCTS: Armored seats; Armor plate; Filing equipment.

**EUGENE DIETZGEN CO.,**  
2425 Sheffield Ave., Chicago, Ill.  
PRODUCTS: Drafting instruments and furniture.

**DILL MANUFACTURING CO.,**  
700 E. 82nd St., Cleveland, O.  
PERSONNEL: A. P. Williamson, Pres.  
PRODUCTS: Valve insides for strut shock absorbers; Tire gauges.

**DODGE CORK CO., INC.,** Lancaster, Pa.  
PERSONNEL: A. B. Dodge, Pres.  
PRODUCTS: All products manufactured from cork.

**DOEHLER DIE CASTING CO.,**  
386 Fourth Ave., New York, N. Y.  
PERSONNEL: C. Pack, Pres.  
PRODUCTS: Die castings.

**DOOLITTLE RADIO, INC.,**  
7421 S. Loomis Blvd., Chicago, Ill.  
PERSONNEL: E. M. Doolittle, Pres.  
PRODUCTS: Transmitters and receivers.

**DOW CHEMICAL CO.,** Midland, Mich.  
PERSONNEL: Dr. Willard H. Dow, Pres.; Leland I. Doan, V. Pres. & Gen. Mgr.  
PRODUCTS: Structural metals.

**DOWTY EQUIPMENT CORP.,**  
41-28 37th St., Long Island City, N. Y.  
PERSONNEL: A. E. Ulmann, Pres.  
PRODUCTS: Hydraulic equipment; Shock struts; Landing gears.

**DRAKE MANUFACTURING CO.,**  
1713 W. Hubbard St., Chicago, Ill.  
PERSONNEL: A. J. Foute, Mgr.  
PRODUCTS: Pilot light assemblies.

**DRY-ZERO CORP.,**  
222 N. Bank Drive, Chicago, Ill.  
PERSONNEL: Harvey B. Lindsay, Pres.  
PRODUCTS: Dry-Zero airplane blanket.

# FOR THE FLYING FORCES

**FAIRCHILD**— The Fairchild M-62 Trainer is the first low wing, cantilever monoplane to teach pilots to fly in the *kind* of ships they'll fight in. Like the F-24, the 4-place cabin monoplane which currently holds high the name of Fairchild throughout the world, the Trainer is serving from Canada to the tropics, with the Army, with the Norwegian Royal Air Force, with the Civilian Pilot Training Program and with private operators.

**RANGER**— The first in-line, air cooled motor to enter the tactical field with the high altitude, high performance 12-cylinder engine which puts more than 500 horsepower in the streamlined nose of the new Navy scout-observation ship by Curtiss. It is designed to carry on the reputation for rugged efficiency and serviceability earned by Ranger 6-cylinder engines through thousands of hours in hundreds of the Army's PT-19 trainers, as well as in private planes.

**DURAMOLD**—The moulded wood and plastic that makes possible logical aerodynamic design, strength from the skin inward, true monocoque construction. Stabilizers, spars and other parts are already in service. Now whole wing sections and other structural members are being economically moulded from this non-strategic material.

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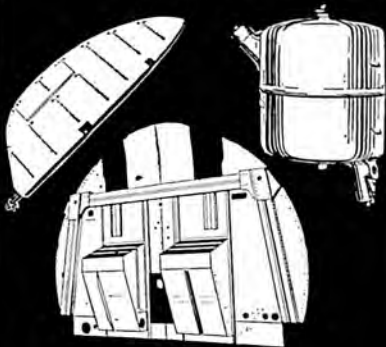
FARMINGDALE

- E. I. DU PONT DE NEMOURS & CO.,**  
PLASTICS DEPT., Arlington, N. J.  
PERSONNEL: W. A. Joslyn, Sales Mgr.  
PRODUCTS: Aeroplane sheeting; Resin; Cellulose acetate and nitrate sheeting.
- DUGAS ENGINEERING CORP.,**  
332 S. La Salle St., Chicago, Ill.  
PERSONNEL: H. V. Higley, Pres.  
PRODUCTS: Fire extinguishers.
- DUMORE CO.,** 1225 14th St., Racine, Wisc.  
PERSONNEL: L. H. Hamilton, Pres.  
PRODUCTS: Retractable landing gears; Parachute flare releases; Bomb releases.
- DURAKOOL, INC.,**  
1010 N. Main St., Elkhart, Ind.  
PERSONNEL: H. E. Bucklen, Jr., Pres.  
PRODUCTS: Mercury switches; Relays.
- DUREZ PLASTICS & CHEMICALS, INC.,**  
Walck Rd., North Tonawanda, N. Y.  
PERSONNEL: Harry M. Dent, Pres.  
PRODUCTS: Compounds; Varnishes; Resins; Impregnated paper; Plywood and veneer resins.
- DYCER AVIATION SUPPLIES,**  
11156 S. Main St., Los Angeles, Calif.  
PERSONNEL: Edward A. Dycer, Mgr.  
PRODUCTS: Supplies.
- DZUS FASTENER CO., INC.,** Babylon, N. Y.  
PERSONNEL: William Dzus.  
PRODUCTS: Fasteners.
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- E**
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- EASTERN ENGINEERING CO.,**  
45 Fox St., New Haven, Conn.  
PERSONNEL: J. J. Ivers, Gen. Mgr.  
PRODUCTS: Midget pumps; Centrifugal pumps.
- EASTMAN KODAK CO.,** Rochester, N. Y.  
PERSONNEL: Frank W. Lovejoy, Pres. & Gen. Mgr.; Thomas J. Hargrave, V. Pres. & Secy.  
PRODUCTS: Cameras.
- EATON MANUFACTURING CO.,**  
Cleveland, O.  
PERSONNEL: C. I. Ochs, Pres.; R. H. Daisley, V. Pres.  
PRODUCTS: Exhaust and intake engine valves; Hydraulic valve lifters; Valve seat inserts; Propeller shafts.
- EATON MANUFACTURING CO., RELIANCE SPRING WASHER DIV.,** Massillon, O.  
PERSONNEL: W. H. Crawford, Div. Mgr.; E. D. Cowlin, Sales Mgr.  
PRODUCTS: Washers; Woodruff keys; Springtite assemblies.
- ECLIPSE AVIATION DIV. OF BENDIX AVIATION CORP.,** Bendix, N. J.  
PERSONNEL: R. P. Lansing, Gen. Mgr.; A. E. Raabe, Sales Mgr.; J. T. Leeming, Pur. Dir.  
PRODUCTS: Starters and starter accessories; Generating equipment; Valves; Oil separators; Pumps; Flowmeters; Supercharger regulators; Controls; Other accessories.
- ECLIPSE FUEL ENGINEERING CO.,**  
711 S. Main St., Rockford, Ill.  
PRODUCTS: Feed water units; Heat treating; Forging; Metal melting and soldering furnaces.
- EDISON-SPLITDORF CORP.,**  
West Orange, N. J.  
PERSONNEL: A. J. Clark, Gen. Mgr.  
PRODUCTS: Magnetos; Indicators; Engine gauges; Spark plugs.
- EDO AIRCRAFT CORP.,** College Point, N. Y.  
PERSONNEL: Earl D. Osborn, Pres.; George B. Post, V. Pres.; K. D. Vosler, Secy.; S. E. Bostwick, Treas.  
PRODUCTS: All metal seaplane floats.
- EDWARDS MANUFACTURING CO.,**  
Fifth & Walnut Sts., Cincinnati, O.  
PERSONNEL: H. W. Edwards, Pres.; G. D. Myers, V. Pres.  
PRODUCTS: Hangars; Sheet metal products.
- F. EGGERS PLYWOOD & VENEER CO.,**  
Two Rivers, Wisc.  
PERSONNEL: F. D. Eggers, Secy.  
PRODUCTS: Plywood.
- EGYPTIAN LACQUER MFG. CO.,**  
1270 Sixth Ave., New York, N. Y.  
PRODUCTS: Finishes.
- EICOR,** 1060 West Adams St., Chicago, Ill.  
PERSONNEL: Joe Nader & R. D. Wright, Partners.  
PRODUCTS: Motors; Dynamotors; Converters; Generators.
- EISEMANN MAGNETO CORP.,**  
60 E. 42nd St., New York, N. Y.  
PERSONNEL: C. A. Brown, Pres.; S. D. Livingston, Gen. Mgr.  
PRODUCTS: High tension magnetos; Magneto drive couplings.
- EITEL-McCULLOUGH INC.,**  
San Bruno, Calif.  
PERSONNEL: W. W. Eitel, Pres.; J. A. McCullough, Treas.  
PRODUCTS: Transmitting tubes; Rectifiers; Vacuum condensers.
- ELASTIC STOP NUT CORP.,**  
2330 Vauxhall Rd., Union, N. J.  
PERSONNEL: K. A. Swanstrom, Pres.; D. C. Hungerford, V. Pres.  
PRODUCTS: Nuts; Self-locking fastenings.
- ELECTRIC AUTO-LITE CO.,** Toledo, O.  
PERSONNEL: R. G. Martin, Pres.; D. H. Kelly, V. Pres.  
PRODUCTS: Storage batteries; Gauges; Cables.
- ELECTRIC AUTO-LITE CO., MOTO METER, GAUGE & EQUIPMENT DIV.,** Chrysler Bldg., New York, N. Y.  
PERSONNEL: A. Weiss, Sales Mgr.  
PRODUCTS: Thermometers; Pressure gauges.
- ELECTRIC FURNACE CO.,**  
150 W. Wilson St., Salem, O.  
PERSONNEL: R. F. Benzinger, Pres.; C. L. West, V. Pres.  
PRODUCTS: Industrial furnaces.
- ELECTRIC STORAGE BATTERY CO.,** 19th St. & Allegheny Ave., Philadelphia, Pa.  
PERSONNEL: R. C. Norberg, Pres.; S. W. Rolph, V. Pres.  
PRODUCTS: "Exide" storage batteries.
- ELECTRONIC LABORATORIES, INC.,**  
122 W. New York St., Indianapolis, Ind.  
PERSONNEL: W. W. Garstang, V. Pres.  
PRODUCTS: Power converters; Fluorescent lighting; Instrument illumination; Fluorescent flood-lighting equipment; Transmitters.



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XB-T-12

STAINLESS STEEL AND  
ALUMINUM ALLOY SURFACES  
AND PARTS



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**ELECTRONIC SPECIALTY CO.,**  
4630 San Fernando Rd., Glendale, Calif.  
PERSONNEL: S. K. Babcock, Pres.  
PRODUCTS: Radio equipment.

**ELGIN NATIONAL WATCH CO.,** Elgin, Ill.  
PERSONNEL: T. A. Potter, Pres.  
PRODUCTS: Watches.

**ENDICOTT FORGING & MANUFACTURING CO., INC.,** 1923 North St., Endicott, N. Y.

PERSONNEL: A. W. Schaefer, Sales Mgr.; D. O. Freeman, Treas.  
PRODUCTS: Drop and upset forgings.

**ENGEL AIRCRAFT SPECIALTIES,**  
P. O. Box 697, Escondido, Calif.  
PERSONNEL: John H. Engel, Pres.  
PRODUCTS: Combination N. A. C. A. exhaust and speed-exhaust rings; N. A. C. A. cowlings.

**ENGIS EQUIPMENT CO.,**  
310 S. Michigan Ave., Chicago, Ill.  
PERSONNEL: J. Steindler, Pres.  
PRODUCTS: Clinometers.

**ERTEL MACHINE CO.,**  
1420 E. 20th St., Indianapolis, Ind.  
PERSONNEL: J. C. Ertel, Jr.  
PRODUCTS: Precision parts.

**ESSO MARKETERS,**  
26 Broadway, New York, N. Y.  
PERSONNEL: R. C. Oertel, Mgr.; H. W. Howze, Asst. Mgr.  
PRODUCTS: Gasoline; oils.

**ETHYL GASOLINE CORP.,**  
405 Lexington Ave., New York, N. Y.  
PERSONNEL: E. W. Webb, Pres.; G. Edgar, V. Pres.; S. D. Heron, Aero. Eng.  
PRODUCTS: Anti-knock compounds for gasoline.

**EVERET PROPELLER CORP.,** 1922 Baltimore Trust Bldg., Baltimore, Md.  
PERSONNEL: E. S. Stockbridge, Pres.  
PRODUCTS: Variable pitch propellers.

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## F

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**FAFNIR BEARING CO.,** New Britain, Conn.  
PERSONNEL: M. Stanley, Pres.  
PRODUCTS: Ball bearings.

**FAHLIN MANUFACTURING CO.,**  
1121-23 Wilkes Blvd., Columbia, Mo.  
PERSONNEL: Ole Fahlin, Pres.  
PRODUCTS: Wooden airplane propellers.

**FAIRBANKS, MORSE & CO.,**  
600 S. Michigan Ave., Chicago, Ill.  
PRODUCTS: Scales; Generating sets; Air conditioning.

**FAIRCHILD AVIATION CORP.,**  
88-06 Van Wyck Blvd., Jamaica, N. Y.  
PERSONNEL: J. S. Ogsbury, Pres.; Ernest Robinson, V. Pres. & Treas.; C. A. Harrison, Sales Mgr.; C. L. Terrill, Secy.  
PRODUCTS: Aerial cameras; Camera machine guns; Aerial surveys; Aerial photographs.

**FARNHAM MANUFACTURING CO.,**  
1646 Seneca St., Buffalo, N. Y.  
PERSONNEL: Paul Dubosclard, Pres.; Frank L. Boutet, Treas.; Arlon E. Farnham, Secy.  
PRODUCTS: Forming rolls for leading edge skins; Spar cap milling machines; Countersinkers; Routers; Stack drills.

**FARREL-BIRMINGHAM CO., INC.,**  
Ansonia, Conn.  
PERSONNEL: N. W. Pickering, Pres.  
PRODUCTS: Gears; Pinions; Presses.

**DUDLEY F. FASOLDT & SON,**  
Prospect Hgts., Rensselaer, N. Y.  
PERSONNEL: D. F. Fasoldt, Pres.  
PRODUCTS: Screw machine products; Clocks.

**J. A. FAY & EGAN CO.,** Colerain, Alfred & Cook Sts., Cincinnati, O.  
PERSONNEL: J. J. Schott, Pres.  
PRODUCTS: Woodworking machinery; Supplies.

**FEDERAL AIRCRAFT WORKS, 3456**  
Mississippi Drive., Minneapolis, Minn.  
PERSONNEL: Francis J. Ditter, Gen. Mgr.  
PRODUCTS: Aircraft skis; Ski riggers; Hydraulic jacks; Presses.

**FEDERAL METAL HOSE CORP.,**  
277 Military Road, Buffalo, N. Y.  
PERSONNEL: Harry C. Neff, Pres.; Ransom G. Yaeger, V. Pres.  
PRODUCTS: Flexible tubing.

**FEDERAL PRODUCTS CORP.,**  
1144 Eddy St., Providence, R. I.  
PERSONNEL: L. C. Tingley, Pres.; W. E. Carroll, V. Pres.; S. B. Reynolds, Secy.; C. N. Kingsford, Asst. Treas.; I. A. Hunt, Sales & Adv. Mgr.; J. G. Gunderson, Pur. Agt.  
PRODUCTS: Precision measuring instruments; Dial indicators; Dial indicator gages.

**FELLOWS GEAR SHAPER CO.,**  
Springfield, Vt.  
PERSONNEL: E. R. Fellows, Pres.  
PRODUCTS: Cutting, finishing and testing equipment.

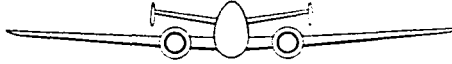
**FELTERS CO., INC.,**  
210 South St., Boston, Mass.  
PERSONNEL: W. C. King, Sr., Pres.  
PRODUCTS: Kapok Unisorb; Cowl pads; Felt; Felt parts; Dufelt.

**FERRACUTE MACHINE CO.,**  
Bridgeton, N. J.  
PERSONNEL: Geo. E. Bass, Pres.  
PRODUCTS: Power presses; Press brakes.

**FIBRE CONDUIT CO.,**  
292 Madison Ave., New York, N. Y.  
PERSONNEL: F. P. Comlier, Sales Mgr.  
PRODUCTS: Underfloor system raceways for power and cable services in control rooms.

**FINCH TELECOMMUNICATIONS, INC.,**  
Passaic, N. J.  
PERSONNEL: W. G. H. Finch, Pres.  
PRODUCTS: Facsimile equipment; Radio transmitting and receiving equipment.

**FIRESTONE TIRE & RUBBER CO.,** Akron, O.  
PERSONNEL: John W. Thomas, Pres.; Harvey S. Firestone, V. Pres.; J. J. Shea, Treas.; S. G. Carkhuff, Secy.  
PRODUCTS: Tires; Tubes; Wheels; Tail wheels; Airtex seat and back cushions; Parachute seats; Pilot seats.



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 Gun Firing Mechanism Gauges  
 Oil Temperature Thermometers  
 Carburetor Temperature Thermometers

De-Icer Gauges  
 Heating System Gauges  
 Engine Gauge Units  
 Oil Pressure Gauges  
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**FIRST AID SUPPLY CO.,**  
7 W. 22 St., New York, N. Y.  
PERSONNEL: Joseph Maslan, Mgr.  
PRODUCTS: First aid kits.

**FIRTH-STERLING STEEL CO.,**  
McKeesport, Pa.  
PERSONNEL: L. G. Firth, Pres.  
PRODUCTS: High speed steels; Tool steels; Stainless steels; Firthite tungsten.

**FISHER FURNACE CO.,**  
1740 N. Kolmar Ave., Chicago, Ill.  
PERSONNEL: W. P. Martin, Jr., Pres.  
PRODUCTS: Iron pot melting furnaces; Centrifugal blowers; Oil and gas burners.

**FISHER RESEARCH LABORATORY,**  
1961 University Ave., Palo Alto, Calif.  
PERSONNEL: G. R. Fisher, Pres.  
PRODUCTS: Radio direction finders; Telephones and receivers.

**FISKE BROTHERS REFINING CO.,**  
129 Lockwood St., Newark, N. J.  
PERSONNEL: Robert L. Watts, Mgr.  
PRODUCTS: Aeronautical lubricants.

**FITCHBURG GRINDING MACHINE CORP.,**  
67 Walnut St., Fitchburg, Mass.  
PERSONNEL: G. S. Gould, Pres.  
PRODUCTS: Grinding machines.

**FLEXIBLE SHAFT CO. OF NEW YORK,**  
72 Cortlandt St., New York, N. Y.  
PERSONNEL: Carl Ungeheuer, Mgr.  
PRODUCTS: Cores; Casings; Shaft machines; Grinders.

**FLORIAN MFG. CO.,** Plantsville, Conn.  
PERSONNEL: R. S. Florian, Mgr.  
PRODUCTS: Gages; Small aircraft parts.

**FLOTATION SYSTEMS, INC.,**  
4031 Goodwin Ave., Los Angeles, Calif.  
PERSONNEL: James O. Henry, Pres.  
PRODUCTS: Gasoline dispensing systems.

**FLOTTORP PROPELLER CO.,** Grand Rapids  
Airport, Grand Rapids, Mich.  
PERSONNEL: Ole Flottorp, Pres.  
PRODUCTS: Propellers.

**FOLMER GRAFLEX CORP.,**  
154 Clarissa St., Rochester, N. Y.  
PERSONNEL: N. L. Whitaker, Pres.  
PRODUCTS: Cameras; Accessories; Precision photographic apparatus.

**J. B. FORD SALES COMPANY,**  
Biddle Ave., Wyandotte, Mich.  
PERSONNEL: C. B. Robinson, Pres.  
PRODUCTS: Specialized cleaners.

**FORMICA INSULATION COMPANY,**  
4614 Spring Grove Ave., Cincinnati, O.  
PERSONNEL: D. J. O'Connor, Pres.; W. J. Gebhart, Treas.; J. R. White, Sales Mgr.  
PRODUCTS: Laminated phenolic sheets; Tubes; Rods; Special molded parts.

**FORSBERG MFG. CO.,** Bridgeport, Conn.  
PERSONNEL: Harold S. Forsberg, Pres.  
PRODUCTS: Tools.

**FOSTORIA PRESSED STEEL CORP.,**  
Fostoria, O.  
PERSONNEL: R. J. Carter, Pres.  
PRODUCTS: Non-magnetic lighting equipment for aircraft interiors.

**FOUR WHEEL DRIVE AUTO CO.,**  
Clintonville, Wisc.  
PERSONNEL: W. A. Olen, Pres.  
PRODUCTS: Trucks for airport snow removal; Airport fire trucks and crash units.

**S. G. FRANTZ CO., INC.,**  
161 Grand St., New York, N. Y.  
PERSONNEL: S. G. Frantz, Pres.  
PRODUCTS: Magnetic separators.

**FREEDMAN-BURNHAM ENGINEERING CORP.,** 659 E. 6th St., Cincinnati, O.  
PERSONNEL: G. L. Freedman, Pres.  
PRODUCTS: Wood propellers; Spinners; Plane tables.

**FRICK-GALLAGHER MANUFACTURING CO.,** Wellston, O.  
PERSONNEL: J. P. Gallagher, Pres.  
PRODUCTS: Revolving steel shelving.

**FUEL DEVELOPMENT CORP.,**  
62 William St., New York, N. Y.  
PERSONNEL: Robert B. Meyer, Pres.; Edgar C. Scanlon, V. Pres. & Secy.  
PRODUCTS: Anilol; Anilol pump; Anilol metering valve.

**FUEL INJECTION CORP.,** Muskegon, Mich.  
PERSONNEL: Carl F. High, Pres.  
PRODUCTS: Fuel injection equipment.

**W. P. FULLER & CO.,** 135 N. Los Angeles St., Los Angeles, Calif.  
PERSONNEL: Harold L. Acker, Mgr.  
PRODUCTS: Finishes.

**FULTON CO.,**  
1912 S. 82nd St., Milwaukee, Wisc.  
PERSONNEL: S. A. Fulton, Pres.  
PRODUCTS: Pilot sun visors.

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## G

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**G & O MANUFACTURING CO.,**  
138 Winchester Ave., New Haven, Conn.  
PERSONNEL: A. J. Verdi, Pres.  
PRODUCTS: Engine cooling radiators; Oil temperature regulators.

**GAERTNER SCIENTIFIC CORP.,**  
1201 Wrightwood Ave., Chicago, Ill.  
PERSONNEL: Wm. Gaertner, Pres.; S. Jacobsohn, V. Pres.; J. Mandel, Secy.; Wm. A. Schumacher, Pur. Dir.  
PRODUCTS: Oxygen regulator; Breathing masks; Bail-out equipment; Bomb sights; Mercurial barometers.

**GARDNER PROPELLER CO.,**  
1215 Circle Ave., Forest Park, Ill.  
PERSONNEL: Wm. H. Gardner, Pres.  
PRODUCTS: Propellers; Engine test clubs.

**GARLOCK PACKING CO.,** Palmyra, N. Y.  
PERSONNEL: Geo. L. Abbott, Pres.  
PRODUCTS: Gaskets; Packings; Oil and grease seals; Molded rubber and asbestos goods.

**GASKET SHOP,**  
435 Brannan St., San Francisco, Calif.  
PERSONNEL: W. E. Stevens, Gen. Mgr.  
PRODUCTS: Gaskets.

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*super-high-pressure*

## DIE CASTINGS

### HELP SPEED PRODUCTION

...Thousands of man hours have been saved in the production time of airplanes, by the use of Harvill super-high-pressure die castings . . . production costs of many parts have been cut as much as 85%.

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The long sought combination of *light weight, high strength* die castings is now a commercial reality . . . through new alloying and die casting processes pioneered and perfected by Harvill engineers.

#### 27,000 DIE CASTINGS PER DAY

The manufacturers receiving these Harvill die cast parts are not only saving vast sums of money, but also eliminating serious production delays that were associated with former fabrication or sand cast and machining methods. If you are interested in saving time and money, write for quotations.



A typical assortment of Harvill die cast parts, ranging in size from a 1/2" pulley to a 32" cover plate.



Exterior view of the new Harvill die casting plant, which adjoins the Los Angeles Municipal Airport.



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- GAY ENGINEERING CORP. OF CALIF.,**  
2730 E. 11th St., Los Angeles, Calif.  
PERSONNEL: Norman H. Gay, Pres.  
PRODUCTS: Precision bending and forming; Welding; Refrigeration and air conditioning.
- GENERAL AIRCRAFT EQUIPMENT, INC.,**  
444 Madison Ave., New York, N. Y.  
PERSONNEL: J. C. Daninos, Pres.  
PRODUCTS: Controls; Propulsive flame damping exhausts; Cowlings.
- GENERAL AIRCRAFT SUPPLY CORP.,**  
Detroit, Mich.  
PERSONNEL: Lawrence F. Zygmunt, Pres.  
PRODUCTS: Accessories.
- GENERAL ARMATURE CORP.,**  
Lock Haven, Pa.  
PERSONNEL: Lou Mervis, Pres.  
PRODUCTS: Generators; Starting motors.
- GENERAL CABLE CORP.,**  
420 Lexington Ave., New York, N. Y.  
PERSONNEL: D. R. G. Palmer, Pres.  
PRODUCTS: Ignition wire; Lighting and power wire.
- GENERAL ELECTRIC CO.,**  
1 River Rd., Schenectady, N. Y.  
PERSONNEL: John E. N. Hume, Mgr.; John C. Miller, Sales Mgr.  
PRODUCTS: Superchargers; Generators; Motors; Instruments.
- GENERAL FIRE TRUCK CORP.,**  
2200 E. Jefferson, Detroit, Mich.  
PERSONNEL: C. K. Huthsing, Pres.  
PRODUCTS: Fire extinguishers; Fire apparatus.
- GENERAL LEAD BATTERIES CO.,**  
125 Chapel St., Newark, N. J.  
PERSONNEL: John B. Pruyne, Pres.  
PRODUCTS: Storage batteries.
- GENERAL RADIO CO.,**  
30 State St., Cambridge, Mass.  
PERSONNEL: M. Eastham, Pres.  
PRODUCTS: Measuring and test equipment.
- GENERAL SCIENTIFIC EQUIPMENT CO.,**  
2735 N. Broad St., Philadelphia, Pa.  
PERSONNEL: M. Kline, Gen. Mgr.  
PRODUCTS: Hydrometers; Thermometers; Goggles; Respirators; Battery equipment.
- GENERAL TIRE & RUBBER CO., Akron, O.**  
PERSONNEL: Wm. O'Neil, Pres.  
PRODUCTS: Airplane tires.
- GEOMETRIC TOOL CO., New Haven, Conn.**  
PERSONNEL: G. S. Train, Sales Mgr.  
PRODUCTS: Die heads; Collapsing taps; Threading machines; Chaser grinders.
- E. A. GERLACH CO.,**  
3567-71 Sepviva St., Philadelphia, Pa.  
PERSONNEL: R. G. Gerlach, Pres.  
PRODUCTS: Degreasing, paint stripping, decarbonizing compounds.
- GILBERT & BARKER MANUFACTURING CO., Springfield, Mass.**  
PERSONNEL: S. C. Hope, Pres.  
PRODUCTS: Gasoline pumps; Aero pits.
- GISHOLT MACHINE CO., 1245 E. Washington Ave., Madison, Wisc.**  
PERSONNEL: G. H. Johnson, Pres.  
PRODUCTS: Lathes.
- GLENN-ROBERTS CO.,**  
1009 Fruitvale Ave., Oakland, Calif.  
PERSONNEL: G. G. Glenn, Pres.  
PRODUCTS: Arc welders.
- GOETZE GASKET & PACKING CO., INC**  
Allen Ave., New Brunswick, N. J.  
PERSONNEL: F. Goetze, Pres.  
PRODUCTS: Metallic gaskets.
- GOGGLE PARTS CO.,**  
Century Bldg., Cleveland, O.  
PERSONNEL: W. R. Paterson and J. D. Hill.  
PRODUCTS: Goggles.
- B. F. GOODRICH CO., Akron, O.**  
PERSONNEL: G. E. Brunner, Gen. Mgr.  
PRODUCTS: Tires and tubes; De-icers; Miscellaneous accessories.
- GOODYEAR TIRE & RUBBER CO., INC., Akron, O.**  
PERSONNEL: E. J. Thomas, Pres.; R. S. Wilson, Vice Pres.; W. D. Shilts, Secy.; Z. C. Oseland, Treas.; V. R. Jacobs, Mgr. Aeronautics Dept.  
PRODUCTS: Tires; Tubes; Wheels; Brakes; Miscellaneous rubber products.
- GOULD STORAGE BATTERY CORP.,**  
35 Neoga St., Depew, N. Y.  
PERSONNEL: H. G. Barnes, Gen. Mgr.  
PRODUCTS: Storage batteries.
- GRANBERG EQUIPMENT, INC.**  
1308-67th St., Oakland, Calif.  
PERSONNEL: A. J. Granberg, Pres.  
PRODUCTS: Refuelling pumps.
- GRATON & KNIGHT CO.,**  
356 Franklin St., Worcester, Mass.  
PERSONNEL: A. N. Bennett, Pres.  
PRODUCTS: Leather products.
- GRAY RADIO CO., 730 Okeechobee Rd., W. Palm Beach, Fla.**  
PERSONNEL: F. E. Gray, Pres.  
PRODUCTS: Radio equipment.
- GREENFIELD TAP AND DIE CORP., Greenfield, Mass.**  
PERSONNEL: H. M. Hubbard, Pres.  
PRODUCTS: Taps; Dies; Drills; Reamers; Gages; Pipe tools.
- GREIST MANUFACTURING CO.,**  
Blake St., New Haven, Conn.  
PERSONNEL: H. Ely, Pres.  
PRODUCTS: Precision stampings; Small machine and screw machine parts.
- GRIMES MANUFACTURING CO.,**  
515 N. Russell St., Urbana, O.  
PERSONNEL: W. G. Grimes, Pres.; L. B. Moore, Chief Eng.; D. O. Printz, Mgr.  
PRODUCTS: All types of aircraft lighting equipment.
- GULF OIL CORP.,**  
Gulf Bldg., Pittsburgh, Pa.  
PERSONNEL: Al Williams, Mgr.  
PRODUCTS: Aviation lubricants and fuels.
- EDWIN F. GUTH CO., St. Louis, Mo.**  
PERSONNEL: G. S. Watts, V. Pres.  
PRODUCTS: Electric lighting fixtures.
- GWINN AIRCRAFT CO.,**  
5182 Roxbury Rd., San Diego, Calif.  
PERSONNEL: J. M. Gwinn, Jr., Pres.  
PRODUCTS: (Licensor of patents.)

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**QUALITY...**



...In equipping the new JACOBS plant for volume production, the primary consideration of precision has never been compromised. The resultant highly efficient production, plus a commensurate increase in research and engineering facilities, are still further reflected

in the quality of JACOBS Engines. Thus step by step with increased production of over 2000 percent, the high standard of workmanship in Jacobs Engines has been raised to a still greater degree.

225 H.P.    285 H.P.    330 H.P.

**JACOBS**  
AIRCRAFT ENGINE CO.  
POTTSTOWN, PENNSYLVANIA, U. S. A.  
CABLES: JAECO

## H

**HALL MANUFACTURING CO.,**  
1560 Woodland Ave., Toledo, O.

PERSONNEL: E. A. Hall, Pres.  
PRODUCTS: Valve seat grinders; Valve refacer.

**HAMILTON FOUNDRY & MACHINE CO.,**  
1551 Lincoln Ave., Hamilton, O.

PERSONNEL: Peter E. Rentschler, Pres.  
PRODUCTS: Gray iron and meehanite castings.

**HAMILTON STANDARD PROPELLERS,  
DIV. OF UNITED AIRCRAFT CORP.,**  
East Hartford, Conn.

PERSONNEL: S. A. Stewart, Gen. Mgr.; H. M. Ellis, Sales Mgr.; L. D. Lyman, Dir. Pub. Rel.; A. C. Wolz, Pur. Dir.  
PRODUCTS: Propellers.

**HAMILTON STEEL CO.,** Cleveland, O.

PERSONNEL: H. K. Hamilton, Pres.  
PRODUCTS: Aircraft bars.

**HARBOR PLYWOOD CORP.,**  
Hoquiam, Wash.

PERSONNEL: E. W. Daniels, Pres.  
PRODUCTS: Plywood.

**HARDWICK, HINDLE, INC.,**  
40 Hermon St., Newark, N. J.

PERSONNEL: A. H. Hardwick, Pres.  
PRODUCTS: Resistors; Rheostats.

**HARRIS CALORIFIC CO.,**

5501 Cass Ave., N. W., Cleveland, O.  
PERSONNEL: Lorn Campbell, Jr., Pres.  
PRODUCTS: Oxygen regulators; Welding torches.

**HARTFORD SPECIAL MACHINERY CO.,**

287 Homestead Ave., Hartford, Conn.  
PERSONNEL: Joseph Merritt, Pres.  
PRODUCTS: Engine and airplane parts.

**HARTZELL PROPELLER CO., DIV. OF  
HARTZELL INDUSTRIES, INC.,** Box  
909, Piqua, O.

PERSONNEL: R. N. Hartzell, Pres.; R. Peck, Secy.; R. V. Hartzell, Treas.; R. W. Zimmerlin, Sales Mgr.  
PRODUCTS: Wood propellers and test clubs; Aluminum alloy propeller blades.

**HARVEY RADIO LABORATORIES, INC.,**

447 Concord Ave., Cambridge, Mass.  
PERSONNEL: Frank Lyman, Pres.  
PRODUCTS: Radio equipment (military).

**HASKELITE MFG. CORP.,** 208 W. Wash-

ington St., Chicago, Ill.  
PERSONNEL: G. R. Meyercord, Jr., Pres.  
PRODUCTS: Plywoods.

**HARVILL AIRCRAFT DIE CASTING CORP.,**

6251 W. Century Blvd., Inglewood, Calif.  
PERSONNEL: H. L. Harvill, Pres. & Gen. Mgr.  
PRODUCTS: Die castings; Die casting dies; Die casting machines.

**HAYES INDUSTRIES, INC.,** Jackson, Mich.

PERSONNEL: C. B. Hayes, Pres.; Chas. Hollerith, V. Pres.; E. C. Hetherwick, Secy.; W. H. Maxson, Chief Eng.  
PRODUCTS: Aircraft wheels; Brakes; Axles.

**HEALD MACHINE CO.,** Worcester, Mass.

PERSONNEL: R. N. Heald, Pres.  
PRODUCTS: Precision grinding and finishing machines.

**HEATH CO.,** Benton Harbor, Mich.

PERSONNEL: Howard E. Anthony, Gen. Mgr.  
PRODUCTS: Aircraft components.

**HEIM CO.,** 46 Sanford St., Fairfield, Conn.

PERSONNEL: L. R. Heim, Pres.  
PRODUCTS: Polishing machines; Roller bearings; Dowel pins.

**HEINEMANN CIRCUIT BREAKER CO.,**

96 Plum St., Trenton, N. J.  
PRODUCTS: Circuit breakers.

**HEINTZ AND KAUFMAN, LTD.,**

S. San Francisco, Calif.  
PERSONNEL: H. M. Lorber, Pres.  
PRODUCTS: Motor driven antenna reel.

**HERBRAND CORP.,** Fremont, O.

PERSONNEL: A. C. Gropp, Sales Mgr.  
PRODUCTS: Hand tools.

**HERRICK IRON WORKS,**

18th & Campbell Sts., Oakland, Calif.  
PERSONNEL: S. Herrick, Gen. Mgr.  
PRODUCTS: Hangar frames; Hangar doors.

**HEYMAN MANUFACTURING CO.,**

Michigan Ave., Kenilworth, N. J.  
PERSONNEL: Horace W. Heyman, Pres.  
PRODUCTS: Metal stampings.

**HEYWOOD-WAKEFIELD CO.,**

Central St., Gardner, Mass.  
PERSONNEL: Geo. E. Cornwall, Sales Mgr.  
PRODUCTS: Seats.

**HICKOK ELECTRICAL INSTRUMENT CO.,**

10514 Dupont Ave., Cleveland, O.  
PERSONNEL: R. D. Hickok, Pres.  
PRODUCTS: Instruments.

**HIGHBRIDGE-INTERNATIONAL CO.,**

Morris Hgts. Sta., New York, N. Y.  
PRODUCTS: Forgings; Stampings.

**HILL AIRCRAFT STREAMLINERS CO.,**

700 W. 6th St., Cincinnati, O.  
PERSONNEL: John A. Hill, Pres.  
PRODUCTS: Cowlings; Wheel pants; Speed rings; Nacelles.

**HILLS-McCANN A CO.,**

2349-59 Nelson St., Chicago, Ill.  
PERSONNEL: Keith Carpenter, Pres.  
PRODUCTS: Pumps; Valves; Lubricators; Protection tubes.

**HILO VARNISH CORP.,**

42 Stewart Ave., Brooklyn, N. Y.  
PERSONNEL: Carl J. Schumann, Pres.  
PRODUCTS: Finishes.

**HOBART BROS. CO.,** 1 Hobart Sq., Troy, O.

PERSONNEL: E. A. Hobart, Pres.  
PRODUCTS: Arc welding machines; Electrodes; Accessories.

**R. HOE & CO., INC.,**

910 E. 138 St., New York, N. Y.  
PERSONNEL: H. M. Tillinghast, Pres.  
PRODUCTS: Engine parts.

*-remember*



**KOLLSMAN**  
PRECISION AIRCRAFT INSTRUMENTS  
*Division of*  
**SQUARE D COMPANY**  
ELMHURST, NEW YORK • GLENDALE, CALIFORNIA  
DETROIT, MICHIGAN

**HOLISTER COIL SPRING MFG. CO.,**  
7100 Avalon Blvd., Los Angeles, Calif.  
PERSONNEL: Frank O. Holister, Mgr.  
PRODUCTS: Coil springs; Wire forms; Metal stampings; Tools; Dies.

**HOLLEY CARBURETOR CO.,** Detroit, Mich.  
PERSONNEL: Earl Holley, Pres.  
PRODUCTS: Carburetors.

**HOLO-KROME SCREW CORP.,**  
Hartford, Conn.  
PERSONNEL: W. A. Purtell, Pres.  
PRODUCTS: Screws; Pipe plugs; Bolts; Keys.

**HOUDE ENGINEERING CORP.,**  
537 E. Delavan Ave., Buffalo, N. Y.  
PERSONNEL: Ralph F. Peo, Gen. Mgr.  
PRODUCTS: Shock absorbers; Shimmy dampeners.

**E. F. HOUGHTON & CO.,**  
Philadelphia, Pa.  
PERSONNEL: A. E. Carpenter, Pres.  
PRODUCTS: Leather packings and belting; Lubricants.

**HUMBLE OIL & REFINING CO.,**  
Humble Bldg., Houston, Tex.  
PERSONNEL: C. C. Scott, Mgr.  
PRODUCTS: Gasoline; Lubricants.

**MARK HURD MANUFACTURING CORP.,**  
1313 3rd Ave., S. Minneapolis, Minn.  
PERSONNEL: Theodore W. Bennett, Pres.  
PRODUCTS: Precision cameras; View finder mounts; Shutter testers; Remote control instruments.

**HYDRAULIC PRESS MANUFACTURING CO.,** Mount Gilead, O.  
PERSONNEL: H. F. MacMillin, Pres.  
PRODUCTS: Hydraulic presses; Generators; Controls; Hydraulic systems.

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## I

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**IDEAL CLAMP MANUFACTURING CO., INC.,** 200 Bradford St., Brooklyn, N. Y.  
PERSONNEL: Phil Rauch, Pres.  
PRODUCTS: Clamps; Clips; Fasteners.

**IDEAL ELECTRIC & MANUFACTURING CO.,** Mansfield, O.  
PERSONNEL: S. Glen Vinson, Pres.  
PRODUCTS: Motors; Generators.

**IDEAL POWER LAWN MOWER CO.,**  
700 E. Kalamazoo St., Lansing, Mich.  
PERSONNEL: C. S. Roe, Pres.  
PRODUCTS: Industrial sweepers and mowers.

**ILLINOIS TESTING LABORATORIES, INC.,**  
420 N. La Salle St., Chicago, Ill.  
PERSONNEL: J. A. Obermaier, Pres.  
PRODUCTS: Pyrometers; Resistance thermometers; Air velocity instruments.

**IMPERIAL BRASS MANUFACTURING CO.,**  
1280 W. Harrison St., Chicago, Ill.  
PERSONNEL: J. T. Greenlee, Mgr.  
PRODUCTS: Tools.

**INDEPENDENT PNEUMATIC TOOL CO.,**  
600 W. Jackson Blvd., Chicago, Ill.  
PERSONNEL: N. C. Hurley, Pres.  
PRODUCTS: Tools.

**INGERSOLL-RAND CO.,**  
11 Broadway, New York, N. Y.  
PERSONNEL: D. C. Keefe, Pres.  
PRODUCTS: Tools.

**INSULITE,** 1100 Builders Exchange Bldg.,  
Minneapolis, Minn.  
PERSONNEL: E. W. Morrill, Gen. Mgr.  
PRODUCTS: Insulation board.

**INTERCONTINENT AIRCRAFT CORP.,**  
Miami, Fla.  
PERSONNEL: B. G. Leighton, Pres.  
PRODUCTS: Aircraft parts and accessories.

**INTERNATIONAL DERRICK & EQUIPMENT DIV., INTERNATIONAL-STACEY CORP.,** 875 Michigan Ave.,  
Columbus, O.  
PERSONNEL: O. M. Havekotte, Pres.  
PRODUCTS: Hangars; Industrial buildings.

**INTERNATIONAL ENGINEERING WORKS, INC.,** Waverly St., Framingham, Mass.  
PERSONNEL: J. J. Prindiville, Pres.  
PRODUCTS: Steel shelving; Boilers.

**INTERNATIONAL FLARE SIGNAL** (see Kilgore Manufacturing Co.)

**INTERNATIONAL STEEL CO.,**  
1321 Edgar St., Evansville, Ind.  
PERSONNEL: Henry Bohnsack, Pres.  
PRODUCTS: Hangars; Roofing; Doors.

**INTERSTATE AIRCRAFT & ENGINEERING CORP.,** 2600 W. Imperial Highway, El Segundo, Calif.  
PERSONNEL: Don P. Smith, Pres.; W. E. Hirstensteiner, V. Pres.; L. B. Cameron, Secy.-Treas.  
PRODUCTS: Hydraulic units; Machine gun chargers; Pressure valves; Other precision products.

**IRVING AIR CHUTE CO., INC.,**  
1670 Jefferson Ave., Buffalo, N. Y.  
PERSONNEL: George Waite, Pres.  
PRODUCTS: Parachutes; Parachute equipment.

**IRVINGTON VARNISH & INSULATOR CO.,**  
6 Argyle Terrace, Irvington, N. J.  
PERSONNEL: A. E. Jones, Pres.; F. A. Shoemaker, Sales Mgr.  
PRODUCTS: Finishes.

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## J

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**JACK & HEINTZ, INC.,**  
809 Hanna Bldg., Cleveland, O.  
PERSONNEL: Wm. S. Vail, Pres.  
PRODUCTS: Electric starters.

**JAEGER WATCH CO., INC.,**  
304 E. 45th St., New York, N. Y.  
PERSONNEL: Edgar L. Vail, Pres.  
PRODUCTS: Aviation clocks; Tachometers; Air-speed indicators.

**JESSOP STEEL CO.,** Washington, Pa.  
PERSONNEL: R. E. Emery, Pres.  
PRODUCTS: Carbon, alloy, stainless and composite steels.



# LEECE NEVILLE

VOLTAGE REGULATED  
ELECTRIC  
GENERATING SYSTEMS  
AND RELAYS  
*for*  
AIRCRAFT

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THE LEECE-NEVILLE COMPANY  
CLEVELAND, OHIO, U. S. A.

**JOHNS-MANVILLE,**  
22 East 40th St., New York, N. Y.  
PERSONNEL: T. K. Mial, V. Pres.  
PRODUCTS: Packings; Insulation; Flooring;  
Roofing.

**JOHNSON & JOHNSON,**  
New Brunswick, N. J.  
PRODUCTS: First aid kits.

**JOHNSON BRONZE CO.,** New Castle, Pa.  
PERSONNEL: P. J. Flaherty, Pres.  
PRODUCTS: Bearings; Bushings.

**CARLYLE JOHNSON MACHINE CO.,**  
52 Main St., Manchester, Conn.  
PERSONNEL: S. H. Simon, Pres.  
PRODUCTS: Clutches.

**JOHNSON NATIONAL INSIGNIA CO.,**  
INC., 314 W. 14th St., New York, N. Y.  
PERSONNEL: W. P. Esling, Pres.  
PRODUCTS: Emblems; Trophies.

**JONES-DABNEY CO.,**  
47 Green St., Malden, Mass.  
PERSONNEL: G. A. Litchfield, Mgr.  
PRODUCTS: Aircraft protective coatings.

**HOWARD B. JONES,**  
2300 Wabansia Ave., Chicago, Ill.  
PERSONNEL: W. A. Bockius, Sales Mgr.  
PRODUCTS: Terminals; Sockets; Fuse mounts;  
Electrical connecting devices.

**JONES-MOTROLA SALES CO.,**  
432 Fairfield Ave., Stamford, Conn.  
PERSONNEL: C. E. Rees, Mgr.  
PRODUCTS: Tachometers; Mechanical fuel  
pumps; Portable electric drills.

**W. B. JONES SPRING CO.,**  
124 E. 7th St., Cincinnati, O.  
PERSONNEL: W. B. Jones, Pres.  
PRODUCTS: Coiled wire springs.

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## K

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**KAY & ESS CO.,** 820 Kiser St., Dayton, O.  
PERSONNEL: H. G. Kittredge, Pres.  
PRODUCTS: Finishes.

**KAY PRODUCTS CO.,**  
4825 Cabot St., Detroit, Mich.  
PERSONNEL: Stanley E. Knauss, Pres.  
PRODUCTS: Parts; Assemblies.

**KELITE PRODUCTS, INC.,**  
909 E. 60th St., Los Angeles, Calif.  
PERSONNEL: L. C. Sorensen, Pres.  
PRODUCTS: Aircraft cleaning compounds.

**KELLOGG SWITCHBOARD & SUPPLY CO.,**  
6650 S. Cicero Ave., Chicago, Ill.  
PERSONNEL: M. K. McGrath, Pres.  
PRODUCTS: Electrical communications products.

**KENYON TRANSFORMER CO., INC.,**  
840 Barry St., Bronx, N. Y.  
PERSONNEL: F. P. Kenyon, Pres.  
PRODUCTS: Transformers.

**KESTER SOLDER CO.,** Chicago, Ill.  
PERSONNEL: F. C. Engelhart, Pres.  
PRODUCTS: Solders; Fluxes.

**KEY CO.,** East St. Louis, Ill.  
PERSONNEL: R. L. Dutton, Pres.  
PRODUCTS: Electric steel castings; Pipe joint  
compound.

**WALTER KIDDE & CO., INC.,**  
140 Cedar St., New York, N. Y.  
PERSONNEL: C. L. Griffin, Sales Mgr.  
PRODUCTS: Fire extinguishing equipment; Flo-  
tation gear; Oxygen breathing apparatus; Life  
rafts and jackets.

**KILGORE MFG. CO., INTERNATIONAL**  
FLARE-SIGNAL DIV., Tipp City, O.  
PERSONNEL: A. F. Hubbard, V. Pres.; D. L.  
Reed, Asst. to V. Pres.  
PRODUCTS: Flares and signals; Pyrotechnics;  
Fusees; Flashlight pistols and cartridges.

**KIRK & BLUM MANUFACTURING CO.,**  
2852 Spring Grove Ave., Cincinnati, O.  
PERSONNEL: S. W. Kirk, Pres.  
PRODUCTS: Dust collecting and fume exhaust  
systems; Tanks; Stainless steel work.

**KIRKHILL RUBBER CO.,**  
811 W. 58th St., Los Angeles, Calif.  
PERSONNEL: T. Kirk Hill, Pres.  
PRODUCTS: Molded goods; Extruded goods;  
Sheet stock.

**KLIEGL BROS. UNIVERSAL ELECTRIC**  
STAGE LIGHTING CO., INC., 321 W.  
50th St., New York, N. Y.  
PERSONNEL: John H. Kiegl, Pres.  
PRODUCTS: Floodlights; Connectors; Plug out-  
lets; Spotlights.

**KLINE SPRING CO.,**  
19100 Firwood Rd., Cleveland, O.  
PERSONNEL: Allen B. Kline, Pres.  
PRODUCTS: Mechanical springs.

**KNU-VISE INC.,**  
16841 Hamilton, Detroit, Mich.  
PERSONNEL: Frank L. McKenna, Pres.; Robt.  
D. Squiers, V. Pres.  
PRODUCTS: Toggle action clamping devices.

**KOLLSMAN INSTRUMENT DIV. OF**  
SQUARE D CO., 80-08 45th Ave., Elm-  
hurst, N. Y.

PERSONNEL: F. W. Magin, Pres.; Henry Mor-  
gan, Secy. & Treas.; Paul Kollman, V. Pres.;  
Wesley C. Bonn, Sales Mgr.; J. Goodrich, Pur.  
Dir.  
PRODUCTS: Accelerometers; Climb, speed and  
direction indicators; Altimeters; Barometers;  
Clocks; Compasses; Anti-icing and de-icer  
equipment; Dynamotors; Engine accessories;  
Pitot static tubes; Synchrosopes; Telegon re-  
mote indicators; Thermometers.

**E. KONIGSLOW STAMPING AND TOOL**  
CO., 3401 Vega Ave., Cleveland, O.  
PERSONNEL: H. F. Stuhr, Pres.  
PRODUCTS: Dies; Metal stampings.

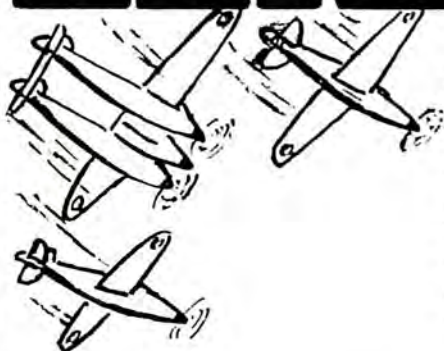
**OTTO KONIGSLOW MANUFACTURING**  
CO., 3610 Perkins Ave., Cleveland, O.  
PERSONNEL: C. A. Thompson.  
PRODUCTS: Metal stampings.

**KOPPERS COMPANY, Baltimore, Md.**  
PERSONNEL: Allen W. Morton, V. Pres.; John  
A. Worthington, Gen. Mgr.; J. E. Aldridge  
Pur. Dir.  
PRODUCTS: Hammered piston rings.

# LENZ

## WIRES & CABLES FOR

### AIRCRAFT WIRING



Lenz Wires and Cables can be made to meet the requirements of Aircraft Manufacturers and Government specifications. Such desirable qualities as flame resistance, moisture resistance and high dielectric strength are developed to a high degree. Some of the Lenz Wires that have found particularly wide acceptance among Manufacturers of Aircraft and Aircraft Instruments are described below.

#### AEROLAC

A combination of wrapped acetate tape and cotton textile impregnated with a flame resistant compound. Voltage breakdown at room temperature 9000 Volts. Voltage breakdown after 24 hours immersion in water 4000 Volts.

#### SPIBRAC

Insulation consists of spiral wrapped varnished cambric with cotton braid and impregnated with flame resistant compound. High Voltage Breakdown. Made to U. S. Government Specifications.

#### LENCEL

A wire of high dielectric characteristics but small diameter, extremely desirable for use in cables where size must be kept to a minimum.

#### LENGLAS

A flameproof Fiberglas insulated wire. Insulation will not support combustion even when conductor is heated to incandescence.

#### AEROGLAS

A combination of spiral wrapped acetate tape and double Fiberglas braid, lacquer impregnated. Offers extremely high voltage breakdown and excellent flame resistant qualities.

#### LENZ R. F. HOOK-UP WIRE

Patent No. 2120306  
Especially recommended for High Frequency Instrument Wiring. Offers high voltage breakdown, high insulation resistance and low power factor under adverse climatic conditions. Used for aircraft radio receivers and direction finding equipment.

#### LENZ SHIELDED WIRES & CABLES

All Lenz Wires are furnished in various sizes of conductors in both solid and stranded construction and with color coded insulation.



**LENZ ELECTRIC  
MANUFACTURING CO.**

1751 North Western Avenue  
CHICAGO ILLINOIS

ENJOYING ITS 37th YEAR OF SUCCESSFUL BUSINESS

**KUHN PAINT & VARNISH WORKS,**  
4020 Center St., Houston, Tex.  
PERSONNEL: H. J. Kuhn, Pres.  
PRODUCTS: Finishes.

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**L**

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**L. M. GEAR CO.,**  
23120 Gratiot Ave., E. Detroit, Mich.  
PERSONNEL: Julian C. Meier, Gen. Mgr.  
PRODUCTS: Pump, distributor and timing gears.

**LACKAWANNA LEATHER CO.,**  
Hackettstown, N. J.  
PERSONNEL: R. C. Good, Pres.  
PRODUCTS: Upholstery leather.

**LAIDLAW CO., INC.,**  
16 W. 60th St., New York, N. Y.  
PERSONNEL: A. P. Laidlaw, Pres.  
PRODUCTS: Upholstery.

**LAMINATED SHIM CO., INC.,**  
Glenbrook, Conn.  
PERSONNEL: C. N. Aborn, Pres.  
PRODUCTS: Shims; Shim stock.

**LAMSON & SESSIONS CO.,**  
1971 W. 85th St., Cleveland, O.  
PERSONNEL: A. E. R. Peterka, Mgr.  
PRODUCTS: Cutters; Nuts; Pins; Bolts.

**LANGLEY INSTRUMENT AND MACHINE CO.,**  
660 2nd Ave., San Diego, Calif.  
PERSONNEL: Wayman Crow, Pres.  
PRODUCTS: Flight control mechanisms.

**LANSING STAMPING CO.,** Lansing, Mich.  
PERSONNEL: Geo. F. Conway, Pres.  
PRODUCTS: Stampings; Pressed metal products.

**LAWRANCE ENGINEERING & RESEARCH CORP.,** Linden, N. J.  
PERSONNEL: C. L. Lawrance, Pres.  
PRODUCTS: Auxiliary power plants.

**LAWSON MACHINE & TOOL CO.,**  
131-149 Exchange St., Malden, Mass.  
PERSONNEL: Chester M. Lawson, Pres.  
PRODUCTS: Small engine parts.

**JOHN W. LEAHY,**  
130 White St., Danbury, Conn.  
PERSONNEL: John W. Leahy, Pres.  
PRODUCTS: Bolts; Parts.

**LEAR AVIA, INC.,** Dayton, O.  
PERSONNEL: Wm. P. Lear, Pres.; T. S. Harris, V. Pres.; E. Henderson, Treas.; M. A. Steele, Secy.; J. G. Gordon, Pur. Dir.; R. S. Van Cleve, Sales Mgr.; H. W. Roberts, Pub. Dir.  
PRODUCTS: Transmitters; Receivers; Direction finders; Miscellaneous radio equipment; Clutches; Aircraft accessories.

**R. K. LEBLOND MACHINE TOOL CO.,**  
Madison & Edwards Rds., Cincinnati, O.  
PERSONNEL: R. E. LeBlond, Pres.  
PRODUCTS: Lathes.

**LEECE-NEVILLE CO.,** 5362 Hamilton Ave.  
N. W., Cleveland, O.  
PERSONNEL: B. M. Leece, Pres.; P. H. Neville, V. Pres.; Geo. S. Cole, Secy.-Treas.; A. A. Skinner, Sales Mgr.  
PRODUCTS: Electrical equipment; Generators.

**LEEDS & NORTHRUP CO.,**  
4970 Stenton Ave., Philadelphia, Pa.  
PERSONNEL: C. S. Redding, Pres.  
PRODUCTS: Instruments; Controls; Telemeters.

**LEMPCO PRODUCTS, INC.,** Bedford, O.  
PERSONNEL: J. F. Strand, Pres.  
PRODUCTS: Grinders; Presses.

**LENZ ELECTRIC MANUFACTURING CO.,**  
1751 N. Western Ave., Chicago, Ill.  
PERSONNEL: J. Mayo Bigger, Pres.  
PRODUCTS: Shielded cords, cables and wires.

**LEWIS ENGINEERING CO.,**  
Naugatuck, Conn.  
PERSONNEL: Harris Whittemore, Jr., Pres.  
PRODUCTS: Temperature measuring instruments.

**LIBBEY-OWENS-FORD GLASS CO.,**  
Nicholas Bldg., Toledo, O.  
PERSONNEL: John D. Biggers, Pres.  
PRODUCTS: Window glass.

**LIBERTY AIRCRAFT PRODUCTS,**  
Motor Ave., Farmingdale, N. Y.  
PERSONNEL: Robert Simon, Pres.; G. H. Hauser, V. Pres.; Wm. G. Holman, Secy.  
PRODUCTS: Machine parts.

**LIBRASCOPE, INC.,**  
72 N. Tujunga Ave., Burbank, Calif.  
PERSONNEL: Lewis W. Imm, Pres.  
PRODUCTS: Balance computers; Flight computers; Control equipment.

**LIGHTS, INC.,**  
1107 So. Fremont Ave., Alhambra, Calif.  
PERSONNEL: Thayer Thorndike, Pres.; V. Osburne, V. Pres.; D. L. Butler, Secy.-Treas.  
PRODUCTS: Lighting equipment for aircraft and landing fields.

**LINEAR PACKING & RUBBER CO.,**  
State Rd. & Levick St., Philadelphia, Pa.  
PERSONNEL: A. W. Swartz, Pres.  
PRODUCTS: Airplane packings.

**LINK AVIATION DEVICES, INC.,**  
Binghamton, N. Y.  
PERSONNEL: E. A. Link, Jr., Pres.  
PRODUCTS: Link trainers.

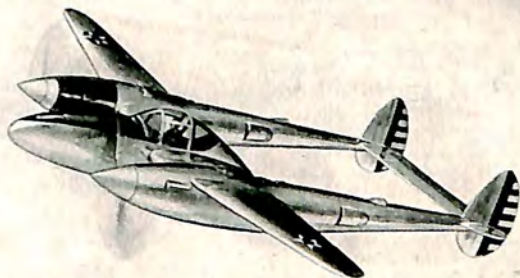
**LIQUIDOMETER CORP.,** 36-16 Skillman Ave., Long Island City, N. Y.  
PERSONNEL: C. A. deGiers, Pres.; H. T. Cullinan, V. Pres.; H. A. Kurowski, Treas.  
PRODUCTS: Instruments; gauges.

**LISLE CORP.,** Clarinda, Ia.  
PERSONNEL: C. V. Lisle, Pres.  
PRODUCTS: Machine tools.

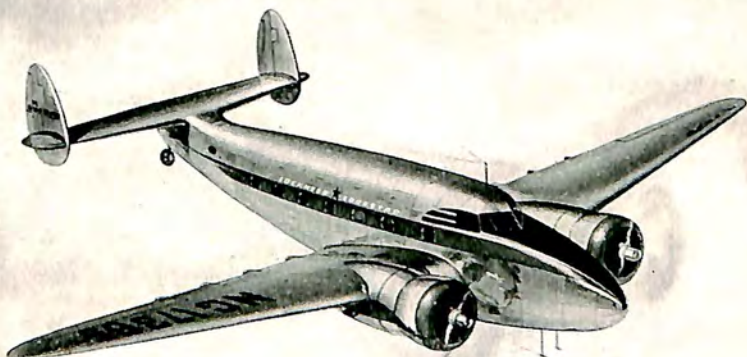
**LITTELFUSE, INC.,**  
4757 Ravenswood Ave., Chicago, Ill.  
PERSONNEL: E. V. Sundt, Pres.; Bernard Kolath, V. Pres.; T. M. Blake, Secy.-Treas.  
PRODUCTS: Fuses.

**LODGE & SHIPLEY MACHINE TOOL CO.,**  
3055 Colerain Ave., Cincinnati, O.  
PERSONNEL: W. L. Dolle, Pres.; F. Albrecht, V. Pres.  
PRODUCTS: Lathes.

**LORD MANUFACTURING CO.,**  
1635 W. 12th St., Erie, Pa.  
PERSONNEL: H. C. Lord, Pres.  
PRODUCTS: Parts for radial and inline engines; Cows; Radio equipment; Instrument panels.



For the **SWORDS** of today...



and the **PLOWSHARES** of tomorrow...

LOOK TO *Lockheed* FOR LEADERSHIP IN BOTH

LOCKHEED AIRCRAFT CORPORATION, BURBANK, CALIFORNIA, U. S. A.

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CHICAGO, ILLINOIS, 135 South La Salle Street • DALLAS, TEXAS, Hangar No. 4, Love Field

*Representatives Throughout The World*

**H. K. LORENTZEN, INC.,**  
391 W. Broadway, New York, N. Y.  
PERSONNEL: H. K. Lorentzen, Pres.  
PRODUCTS: Stampings; Welding.

**LORENZEN PROPELLER CO.,**  
Municipal Airport, Niles, Mich.  
PERSONNEL: Roger E. Lorenzen, Pres.  
PRODUCTS: Propellers; Flight instruments.

**LOWE BROTHERS CO.,**  
3d & Wayne Ave., Dayton, O.  
PERSONNEL: C. H. Hampton, Mgr.  
PRODUCTS: Finishes.

**LUCAS SCREW PRODUCTS CO.,**  
24 Verona St., Rochester, N. Y.  
PERSONNEL: G. E. Lucas, Pres.  
PRODUCTS: Automatic screw products; Turret lathes.

**LUFKIN RULE CO., Saginaw, Mich.**  
PERSONNEL: R. G. Thompson, Pres.  
PRODUCTS: Precision and measuring tools.

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**WARREN McARTHUR CORP.,**  
1 Park Ave., New York, N. Y.  
PERSONNEL: Warren McArthur, Pres.  
PRODUCTS: Aircraft seats.

**McCAULEY STEEL PROPELLER CO.,**  
2900 W. 2nd St., Dayton, O.  
PERSONNEL: E. G. McCauley, Pres.  
PRODUCTS: Propellers.

**MCCORD RADIATOR & MANUFACTURING CO.,** Detroit, Mich.  
PERSONNEL: A. C. McCord, Pres.  
PRODUCTS: Radiators.

**McCULLOCH ENGINEERING CO.,**  
3227 N. 31st St., Milwaukee, Wisc.  
PERSONNEL: Robert P. McCulloch, Pres.  
PRODUCTS: Cabin superchargers.

**McQUAY-NORRIS MANUFACTURING CO.,** St. Louis, Mo.  
PERSONNEL: W. K. Norris, Pres.  
PRODUCTS: Pistons; Pins; Valves.

**MACWHYTE CO., Kenosha, Wisc.**  
PERSONNEL: James A. Weagle, Ch. Eng.  
PRODUCTS: Tire rods; Aircraft cables.

**MAGNAFLUX CORP.,** 5908 Northwest Highway, Chicago, Ill.  
PERSONNEL: A. V. deForest, Pres.  
PRODUCTS: Inspection equipment.

**MAGNESIUM PRODUCTS, INC.,**  
1119 Santa Fe Ave., Los Angeles, Calif.  
PERSONNEL: Earl R. Clayton, Pres.  
PRODUCTS: Castings.

**MAGNUS CHEMICAL CO., INC.,**  
South Ave., Garwood, N. J.  
PERSONNEL: W. M. Campbell, Pres.  
PRODUCTS: Cleaners.

**MANHATTAN RUBBER MANUFACTURING DIV. OF RAYBESTOS-MANHATTAN, INC.,** 61 Willett St., Passaic, N. J.  
PERSONNEL: C. L. Frink, Adv. Mgr.  
PRODUCTS: Mountings; Connections; Packing; Fuel hose; Rubber goods.

**MANNING, MAXWELL & MOORE, INC.,**  
11 Elias St., Bridgeport, Conn.  
PERSONNEL: R. R. Wason, Pres.  
PRODUCTS: Gauges; Indicators; Thermometers.

**MARKAL CO.,** 6 E. Lake St., Chicago, Ill.  
PERSONNEL: B. Lytton, Mgr.  
PRODUCTS: Paint.

**MARQUETTE METAL PRODUCTS CO.,**  
1145 Galewood Dr., Cleveland, O.  
PERSONNEL: Herbert Gleitz, Pres.  
PRODUCTS: Engine and propeller parts.

**MARTIN-DECKER CORP.,**  
3441 Cherry Ave., Long Beach, Calif.  
PRODUCTS: Control cable; Indicators.

**MARVEL-SCHEBLER CARBURETER DIV.,**  
1910 St. John St., Flint, Mich.  
PERSONNEL: S. W. Gray, Pres.  
PRODUCTS: Carbureters.

**MARYLAND METAL BUILDING CO.,**  
Race & McComas St., Baltimore, Md.  
PERSONNEL: C. H. Michel, Pres.  
PRODUCTS: Hangars.

**W. L. MAXSON CORP.,**  
460 W. 34th St., New York, N. Y.  
PERSONNEL: W. L. Maxson, Pres.  
PRODUCTS: Computing and control mechanisms.

**MEISEL PRESS MANUFACTURING CO.,**  
944 Dorchester Ave., Boston, Mass.  
PERSONNEL: C. A. Meisel, Pres.  
PRODUCTS: Gears.

**MELLUS BROTHERS & CO.,**  
305 E. 4th St., Los Angeles, Calif.  
PERSONNEL: L. R. Mellus, Pres.  
PRODUCTS: Paulins; Covers; Cushions.

**MET-L-WOOD CORP.,**  
6755 W. 65th St., Chicago, Ill.  
PERSONNEL: C. C. Kendrick, Pres.  
PRODUCTS: Floor boards; Sheet metal stampings.

**METAL & THERMIT CORP.,**  
120 Broadway, New York, N. Y.  
PERSONNEL: F. H. Hirschland, Pres.  
PRODUCTS: Welding equipment; Metals and alloys.

**MICA INSULATOR COMPANY,**  
200 Varick St., New York, N. Y.  
PERSONNEL: M. A. Chapman, Pres.  
PRODUCTS: Fabricating service.

**MICHIGAN TOOL CO.,**  
7171 E. McNichols Rd., Detroit, Mich.  
PERSONNEL: F. E. Birtch, Mgr.  
PRODUCTS: Gears; Speed reducers.

**MICRO SWITCH CORP.,** Freeport, Ill.  
PERSONNEL: W. B. Schulte, Pres.  
PRODUCTS: Switches.

**MICRO-WESTCO, INC.,** Bettendorf, Ia.  
PERSONNEL: E. J. Bettendorf, Pres.  
PRODUCTS: Water systems; Pumps.

**MID STATE MANUFACTURING CO.,**  
Waupun, Wisc.  
PERSONNEL: Wm. Fleming, Jr., Pres.  
PRODUCTS: Aluminum, Monel, iron, copper and brass rivets.

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**MCDONNELL AIRCRAFT  
CORPORATION**

**LAMBERT-ST. LOUIS MUNICIPAL  
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**MANUFACTURERS  
OF AIRCRAFT  
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SUBCONTRACTORS OF  
ALL TYPES OF  
AIRFRAME PARTS**



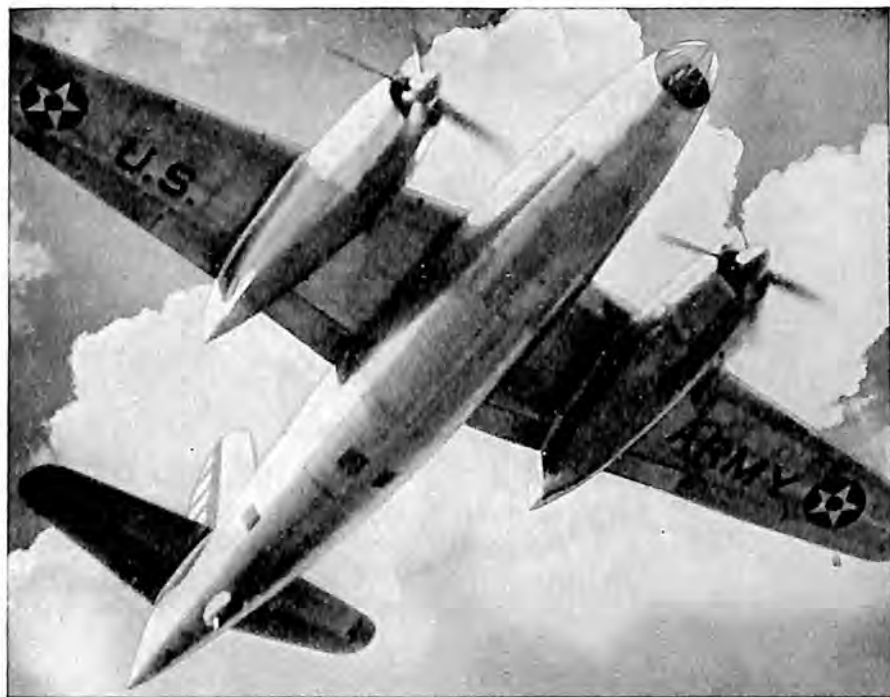


**P**ILOT'S Seat No. 162, for use in Martin Military Bombers, one of many types of aircraft seating, designed, engineered and manufactured for leading aircraft builders by the Warren McArthur Corporation.

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# *A New* **MARTIN BOMBER**



*— packed with Power!*

AN ARSENAL for bombardment and self-defense in air combat . . . the new Martin B-26 flying torpedo for the U. S. Army is now in mass-production. A streamlined, semi-high-wing medium bomber . . . with retracting tricycle landing gear . . . two 18-cylinder, 1850-horsepower engines . . . gross weight of 26,625 pounds . . . the B-26 is the single mass-production type which Martin is manufacturing for the Army. Defense is on the wing!

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## **Martin** **B-26 BOMBER**

Builders of Dependable  Aircraft Since 1909  
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**ALEXANDER MILBURN CO.,**  
1426 W. Baltimore St., Baltimore, Md.  
PERSONNEL: Alexander F. Jenkins, Pres.  
PRODUCTS: Welding and cutting apparatus;  
Gas regulators; Air regulators.

**MILFORD RIVET AND MACHINE CO.,**  
Milford, Conn.  
PERSONNEL: Fred H. Merwin, Pres.  
PRODUCTS: Rivets; Screws.

**MILLER MANUFACTURING CO.,**  
1220 Kaighn Ave., Camden, N. J.  
PERSONNEL: Wm. I. Miller, Pres.  
PRODUCTS: Gasket compounds; Organic com-  
pounds.

**MILLER RUBBER CO., INC.,**  
So. High St., Akron, O.  
PERSONNEL: J. F. Johnston, Mgr.  
PRODUCTS: Oil seals; Piston cups; Boots.

**MILLERS FALLS CO., Greenfield, Mass.**  
PERSONNEL: Philip Rogers, Pres.  
PRODUCTS: Hand tools.

**MINE SAFETY APPLIANCES CO.,**  
Pittsburgh, Pa.  
PERSONNEL: N. R. Chillingworth, Sales Mgr.  
PRODUCTS: All safety appliances.

**MOLDED INSULATION CO.,**  
335 E. Price St., Philadelphia, Pa.  
PERSONNEL: V. I. Zelov, Pres.  
PRODUCTS: Communication equipment; Pul-  
leys; Radio accessories.

**MONDIE FORGE CO., INC.,**  
10274-10300 Berea Rd., Cleveland, O.  
PERSONNEL: M. A. Monaghan, Pres.  
PRODUCTS: Forgings; Dies; Special parts.

**MONITE WATERPROOF GLUE CO.,**  
1628 N. 2nd St., Minneapolis, Minn.  
PERSONNEL: H. L. Prestholdt, Pres.  
PRODUCTS: Glue.

**MONSANTO CHEMICAL CO., MERRIMAC**  
DIV., Everett Sta., Boston, Mass.  
PERSONNEL: W. M. Rand, Gen. Mgr.  
PRODUCTS: Finishes.

**MONSANTO CHEMICAL CO., PLASTICS**  
DIV., Springfield, Mass.  
PERSONNEL: J. C. Brooks, Gen. Mgr.; J. H.  
Clark, Sales Mgr.  
PRODUCTS: Molding materials.

**MOORE DROP FORGING CO.,**  
38 Walter St., Springfield, Mass.  
PERSONNEL: J. M. Collins, Pres.  
PRODUCTS: Drop forgings; Machine parts.

**MOORE-EASTWOOD & CO.,**  
537 E. Monument Ave., Dayton, O.  
PERSONNEL: H. C. Moore.  
PRODUCTS: Parts and assemblies; Machine  
tools.

**MORRIS ENGINEERING CO.,**  
Bay Cities Bldg., Santa Monica, Calif.  
PERSONNEL: Wm. C. Morris, Pres.  
PRODUCTS: Clamps.

**MULLINS MANUFACTURING CORP.,**  
Salem, O.  
PRODUCTS: Stampings.

**MURRAY CORPORATION OF AMERICA,**  
7700 Russell St., Detroit, Mich.  
PERSONNEL: E. A. Ruggles, Gen. Mgr.  
PRODUCTS: Inner wings.

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**NATIONAL AIRCRAFT EQUIPMENT CO.,**  
2525 E. 99th St., Los Angeles, Calif.  
PERSONNEL: R. T. Kinney, Pres.; W. A. Kin-  
ney, V. Pres.  
PRODUCTS: Riveting equipment.

**NATIONAL AIRCRAFT MATERIALS CORP.,**  
P. O. Box 469, Rutland, Vt.  
PERSONNEL: P. R. Eaton, Pres.; M. J. Eaton,  
Treas.; M. V. Quigley, Secy.  
PRODUCTS: Wood parts of airplanes.

**NATIONAL AUTOMATIC TOOL CO.,**  
Richmond, Ind.  
PERSONNEL: H. W. Bockhoff, Pres.  
PRODUCTS: Spindle drilling, boring and tapping  
machines.

**NATIONAL CO., INC.,**  
61 Sherman St., Malden, Mass.  
PERSONNEL: Wm. A. Ready, Pres.; W. H.  
Balcke, Treas.  
PRODUCTS: Radio receivers, transmitters and  
components.

**NATIONAL COPPER & SMELTING CO.,**  
1862 E. 123d St., Cleveland, O.  
PERSONNEL: H. B. Smith, Pres.; Curtis L.  
Smith, Gen. Mgr.  
PRODUCTS: Copper and brass tubing.

**NATIONAL ENGINEERING CO.,** 1410 De La  
Torre Way, Los Angeles, Calif.  
PERSONNEL: C. W. Glanz, Pres.; M. G. Phil-  
lips, Secy.  
PRODUCTS: Aluminum, brass and steel stamp-  
ings.

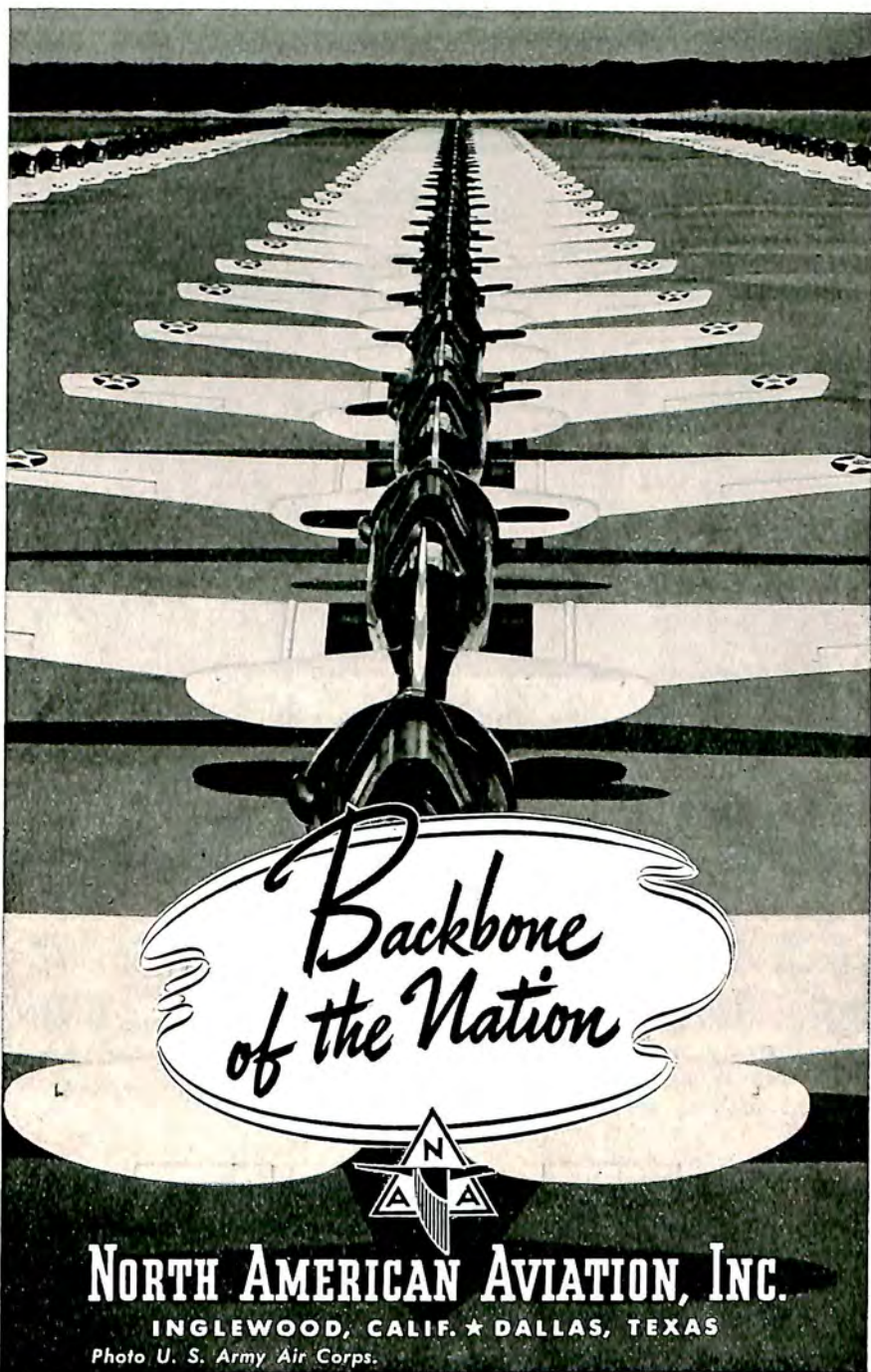
**NATIONAL MACHINE PRODUCTS,**  
150 W. Slauson Ave., Los Angeles, Calif.  
PERSONNEL: L. H. Seagrave, Pres.; R. F.  
Sopris, V. Pres. & Gen. Mgr.  
PRODUCTS: Aircraft parts.

**NATIONAL VULCANIZED FIBRE CO.,**  
P. O. Box 311, Wilmington, Del.  
PERSONNEL: J. W. Marshall, Pres.; J. K. John-  
ston, V. Pres.; W. M. Shoemaker, Secy.; J. P.  
Eckles, Pur. Agt.  
PRODUCTS: Vulcanized fibre; Phenolite; Peer-  
less insulation.


**NEPTUNE METER CO.,**  
50 W. 50th St., New York, N. Y.  
PRODUCTS: Meters for airport fueling opera-  
tions.

**NEW JERSEY FULGENT CO., INC.,**  
Whitman Ave., Metuchen, N. J.  
PERSONNEL: Samuel D. Wiley, Pres.  
PRODUCTS: Emergency landing flares; Military  
pyrotechnics.

**NEWARK WIRE CLOTH CO.,**  
351 Verona Ave., Newark, N. J.  
PERSONNEL: L. C. Campbell, Secy.  
PRODUCTS: Wire cloth; Strainers.



*Backbone  
of the Nation*



**NORTH AMERICAN AVIATION, INC.**  
INGLEWOOD, CALIF. ★ DALLAS, TEXAS  
*Photo U. S. Army Air Corps.*



### **WORLD'S FASTEST MILITARY SEAPLANE...**

"Payload"—2,200 pounds of bombs (or one 2,000 pound torpedo)...ammunition for six heavy calibre machine guns...a crew of three...two pontoons and the heavy equipment required for modern air warfare. Yet, despite this load, the new Northrop N-3PB Patrol Bomber attains a speed of 250 miles per hour—making it the fastest military seaplane in the world.

Basically of proven, conventional design, the N-3PB achieves its remarkable efficiency through exclusive Northrop engineering features. That a conventional type plane could be so designed as to become the fastest seaplane in the world is one more proof of this company's outstanding engineering skill ...and another reason to WATCH NORTHROP.

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**NORTHROP AIRCRAFT, INC.**  
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**927 North Sycamore Avenue**  
**Los Angeles** **California**

**AVIATION  
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SPECIALISTS**

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**NEWTON-NEW HAVEN CO.,**  
680 3d Ave., West Haven, Conn.  
PERSONNEL: W. G. Newton, Pres.; B. F. English, Treas.  
PRODUCTS: Aluminum castings; Zinc die castings.

**NICHOLSON FILE CO.,**  
23 Acorn St., Providence, R. I.  
PERSONNEL: Wm. W. Anderson, Sales Mgr.  
PRODUCTS: Files; Rasps.

**NIXON NITRATION WORKS,** Nixon, N. J.  
PERSONNEL: S. W. Nixon, V. Pres.  
PRODUCTS: Cellulose acetate and nitrate sheets, rods and tubes; Cellulose acetate molding powder.

**NORMA-HOFFMAN BEARINGS CORP.,**  
Stamford, Conn.  
PERSONNEL: O. P. Wilson, Pres.; H. J. Ritter, V. Pres.; C. B. Malone, Gen. Mgr.  
PRODUCTS: Precision ball, roller and thrust bearings.

**NORTH AMERICAN ELECTRIC LAMP CO.,**  
1014 Tyler St., St. Louis, Mo.  
PERSONNEL: Chas. M. Rice, Pres.; D. R. Cohen, V. Pres.; Louis Lander, Secy.-Treas.  
PRODUCTS: Nalco carbon and Dritherm infrared ray drying lamps; Portable drying units and strips.

**NORTHWEST AIR SERVICE INC.,**  
Boeing Field, Seattle, Wash.  
PERSONNEL: Alan L. Blum, Pres.  
PRODUCTS: Propeller pitch setter.

**NORWICH NICKEL-CHROMIUM PLATING CO.,** 77 Hamilton Ave., Norwich, Conn.  
PERSONNEL: Norman Mosesia, Pres.  
PRODUCTS: Electro plating.

## O

**M. L. OBERDORFER BRASS CO.,**  
Syracuse, N. Y.  
PERSONNEL: J. L. Goodman, Pres.; Harold P. Digney, V. Pres.; H. A. Digney, Treas.; M. O. Goodman, Secy.  
PRODUCTS: Castings; Pumps.

**OHIO PISTON CO.,**  
5337 St. Clair Ave., Cleveland, O.  
PERSONNEL: Dan P. Shaw, Mgr.  
PRODUCTS: Pistons; Piston pins; Cylinder sleeves.

**OHIO SEAMLESS TUBE CO.,** Shelby, O.  
PERSONNEL: W. C. Connelly, Pres.; W. W. Van Horn, V. Pres.; E. W. McNeill, Secy.-Treas.  
PRODUCTS: Seamless and electric welded steel tubing.

**OHLSSON & RICE MANUFACTURING CO.,**  
3340 Emery St., Los Angeles, Calif.  
PERSONNEL: I. G. Ohlsson, Sales Mgr.; O. L. Rouillard, Pur. Agt.  
PRODUCTS: Miniature motors; Precision parts; Die castings.

**OHMITE MANUFACTURING CO.,**  
4835 W. Flournoy St., Chicago, Ill.  
PERSONNEL: Roy S. Laird, Gen. Sales Mgr.  
PRODUCTS: Rheostats; Resistors; tap switches.

**OLIVER FARM EQUIPMENT CO.,**  
400 W. Madison St., Chicago, Ill.  
PERSONNEL: J. M. Tucker, V. Pres. & Sales Mgr.  
PRODUCTS: Airport tractors.

**OLMSTED & STILES, INC.,**  
511 S. Redondo Blvd., Inglewood, Calif.  
PERSONNEL: L. W. Olmsted, Pres.; L. M. Stiles, V. Pres.; J. C. Stephens, Secy.-Treas.  
PRODUCTS: Machining and assembly of aircraft parts.

**D. W. ONON & SONS,**  
43 Royalston Ave., Minneapolis, Minn.  
PERSONNEL: D. W. Onon and C. W. Onon, Partners.  
PRODUCTS: Electric generating plants; Motor generator sets.

**KARL ORT,** York, Pa.  
PERSONNEL: Karl Ort, Pres.  
PRODUCTS: Pilots clothing and equipment.

**J. A. OTTERBEIN,**  
59-61 Hubbard St., Middletown, Conn.  
PERSONNEL: J. A. Otterbein, Pres.  
PRODUCTS: Tools; Dies; Metal stampings.

**OWENS-CORNING FIBERGLAS CORP.,**  
Nicholas Bldg., Toledo, O.  
PERSONNEL: Harold Boeschstein, Pres.; Games Slayter, V. Pres.  
PRODUCTS: Insulation products.

**OZALID PRODUCTS DIV., GENERAL ANILINE AND FILM CORP.,** Anasco Rd., Johnson City, N. Y.  
PERSONNEL: F. W. von Meister, Gen. Mgr.; E. V. Brewer, Gen. Sales Mgr.  
PRODUCTS: Photographic equipment.

## P

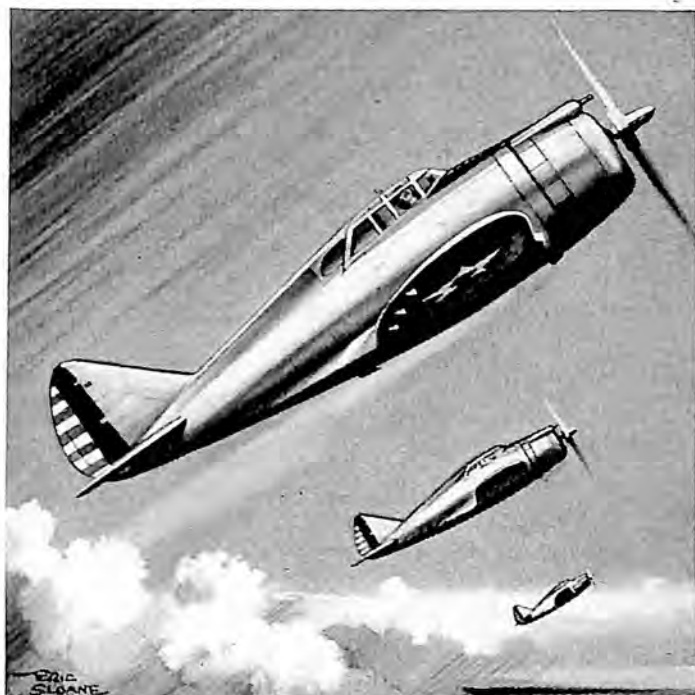
**PAASCHE AIRBRUSH CO.,**  
1909 Diversey Pkwy., Chicago, Ill.  
PERSONNEL: Jens A. Paasche, Pres.  
PRODUCTS: Airpainting and coating equipment.

**PACIFIC AIRMOTIVE, DIV., AIRPLANE MANUFACTURING AND SUPPLY CORP.,** Union Air Terminal, Burbank, Calif.  
PERSONNEL: E. R. Herring, Pres.; E. H. Conerton, V. Pres.; E. O. Locher, Secy.-Treas.  
PRODUCTS: Tanks; Batteries; Propeller parts; Tail wheels; Instruments; Accessories.

**PACIFIC AVIATION, INC.,** 927 N. Sycamore Ave., Los Angeles, Calif.  
PERSONNEL: H. V. Reynolds, Pres.; T. E. Springer, V. Pres.; P. J. Brady, Secy.-Treas.; Ed Rustin, Pur. Dir.  
PRODUCTS: Valves; Pumps; Struts; Brake cylinders.

**PACKARD ELECTRIC DIV., GENERAL MOTORS CORP.,** Warren, O.  
PERSONNEL: B. N. MacGregor, Gen. Mgr.  
PRODUCTS: Electric cables.

**PACKLESS METAL PRODUCTS CORP.,**  
37-14 29th St., Long Island City, N. Y.  
PRODUCTS: Hose; Couplings; Absorbers; Assemblies.



## *High Altitude Interceptor Aircraft*

Republic "Lancer" —A single seat Fighter with super-charged engine. *For export.*

Republic "Warrior" —A single seat Fighter with super-charged engine. *For export.*

Republic P-43 —For the U. S. Army Air Corps.

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Republic EP-1 —Single seat Fighter. *For export.*

Republic 2-PA "Guardman"—Two place Fighter and Bomber. *For export.*

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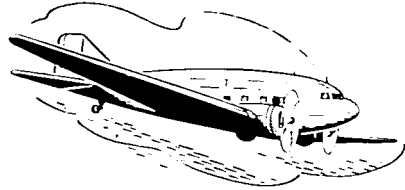
*... for today's job and tomorrow's*

- PALNUT CO.,**  
61 Cordier St., Irvington, N. J.  
PERSONNEL: J. R. Hotchkin, Pres.  
PRODUCTS: Locknuts.
- PANORAMIC RADIO CORP.,**  
298 Broadway, New York, N. Y.  
PERSONNEL: M. Wallace, Pres.  
PRODUCTS: Beacons; Receivers.
- PARACHUTE CORP. OF AMERICA,**  
3206 Los Feliz Blvd., Los Angeles, Calif.  
PERSONNEL: Ward Williams, Pres.  
PRODUCTS: Parachutes; Airplane accessories.
- PARK DROP FORGE CO.,** Cleveland, O.  
PERSONNEL: George C. Gordon, Pres.  
PRODUCTS: Crankshafts; Master rods; Connecting rods.
- PARKER APPLIANCE CO.,**  
17325 Euclid Ave., Cleveland, O.  
PERSONNEL: A. L. Parker, Pres.  
PRODUCTS: Fittings; Valves; Panels.
- PARKER STAMP WORKS, INC.,**  
Hartford, Conn.  
PERSONNEL: H. L. Bitter, Pres.  
PRODUCTS: Steel stamps; Etching fixtures.
- THOMAS PAULSON & SON, INC.,**  
450 Union St., Brooklyn, N. Y.  
PERSONNEL: Wm. E. Paulson, Pres.  
PRODUCTS: Brass, bronze and aluminum castings.
- PAULSON TOOLS, INC.,** Wallingford, Conn.  
PERSONNEL: C. H. Loucks, Pres.  
PRODUCTS: Hand and pneumatic tools; Drop and upset forgings.
- C. F. PEASE CO.,**  
2601 W. Irving Park Rd., Chicago, Ill.  
PERSONNEL: Thomas Lord, Pres.  
PRODUCTS: Blueprinting machinery and paper.
- PECK, STOW & WILCOX CO.,**  
Southington, Conn.  
PERSONNEL: M. J. Lacey, Pres.  
PRODUCTS: Hand tools.
- PENNZOIL CO.,** Oil City, Pa.  
PERSONNEL: W. S. Zehrung, Pres.; M. A. Brewster, Treas.; R. A. Browne, Secy.  
PRODUCTS: Motor oils and lubricants.
- PERMATEX CO., INC.,**  
1720 Ave. Y, Brooklyn, N. Y.  
PERSONNEL: C. A. Benoit, Pres.  
PRODUCTS: Gaskets.
- PERRY-AUSTEN MFG. CO.,** Grasmere, N. Y.  
PERSONNEL: F. T. Perry, Pres.  
PRODUCTS: Finishes.
- PERRY SPORTSWEAR INC.,**  
54 Liberty St., Newburgh, N. Y.  
PERSONNEL: Louis Herbert, Treas.  
PRODUCTS: Aviation clothing.
- PETROLEUM SOLVENTS CORP.,**  
331 Madison Ave., New York, N. Y.  
PERSONNEL: L. A. Staff, Pres.; S. V. Hirshman, Secy.-Treas.  
PRODUCTS: Solvents.
- PHENIX AIRCRAFT PRODUCTS CO.,**  
Williamsville, N. Y.  
PERSONNEL: N. S. Hopkins, Pres.  
PRODUCTS: Aircraft dopes; Radio cement.
- PHEOLL MANUFACTURING CO.,**  
5700 Roosevelt Rd., Chicago, Ill.  
PERSONNEL: Mason Phelps, Pres.; E. M. Whiting, V. Pres.; J. J. Schwander, Secy.-Treas.; J. A. Perry, Sales Mgr.  
PRODUCTS: Screws; Washers; Bolts; Nuts.
- PHILLIPS BRONZE BUSHING WORKS,**  
1460 E. Washington Blvd., Los Angeles, Calif.  
PERSONNEL: R. Warren Phillips, Pres.  
PRODUCTS: Bearings; Bushings; Castings.
- PHILLIPS PETROLEUM CO.,**  
Bartlesville, Okla.  
PERSONNEL: K. S. Adams, Pres.; A. M. Hughes, V. Pres.  
PRODUCTS: Aviation gasoline.
- PHOENIX OIL CO.,**  
9505 Cassius Ave., Cleveland, O.  
PERSONNEL: M. J. Murphy, Pres.  
PRODUCTS: Compounds; Lubricants; Cleaners.
- PIERCE & STEVENS, INC.,**  
710 Ohio St., Buffalo, N. Y.  
PERSONNEL: R. D. Stevens, Pres.  
PRODUCTS: Cleaners.
- PIONEER INSTRUMENT DIV. OF BENDIX AVIATION CORP.,** Bendix, N. J.  
PERSONNEL: R. P. Lansing, Gen. Mgr.; W. A. Reichel, Ch. Eng.; R. H. Isaacs, Sales Mgr.  
PRODUCTS: Flight instruments; Engine instruments; Navigation instruments; Miscellaneous instruments.
- PIONEER PARACHUTE CO., INC.,**  
Manchester, Conn.  
PERSONNEL: Henry R. Mallory, Pres.; J. Floyd Smith, V. Pres.  
PRODUCTS: Parachutes.
- PILOT PROPELLER INC.,**  
1101 Meridian Ave., Alhambra, Calif.  
PERSONNEL: W. E. Greenwood, Pres.  
PRODUCTS: Propellers.
- PLASKON CO., INC.,**  
2112 Sylvan Ave., Toledo, O.  
PRODUCTS: Glue; Molding compounds.
- PLXWEVE AIRCRAFT CO.,** 5245 W. San Fernando Rd., Los Angeles, Calif.  
PERSONNEL: Ralph Hemphill, Pres.; Rene Olin, Secy.-Treas.  
PRODUCTS: Aircraft components.
- PLYWOOD PRODUCTS CORP.,**  
Bay City, Mich.  
PERSONNEL: Bernard B. Shaw, Pres.  
PRODUCTS: Plywood.
- JOSEPH POLLAK CORP.,**  
81 Freeport St., Boston, Mass.  
PRODUCTS: Electric switches; Lamps; Connectors.
- PORCUPINE CO.,** Bridgeport, Conn.  
PERSONNEL: J. K. Williamson, Pres.  
PRODUCTS: Steel fabrication; Heat treating tanks.
- PORTER MACHINE CO.,**  
3139 Enyart Ave., Cincinnati, O.  
PRODUCTS: Pins; Screw products.





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JOHN A. ROEBLING'S SONS CO., TRENTON, N. J.

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**J. V. G. POSEY & CO.,**  
1008 S. W. 6th Ave., Portland, Ore.  
PRODUCTS: Aircraft spruce.

**PRATT & LAMBERT, INC.,**  
75 Tonawanda St., Buffalo, N. Y.  
PERSONNEL: H. E. Webster, Pres.  
PRODUCTS: Finishes.

**PRECISE TOOL & MANUFACTURING CO.,**  
33431 Grand River Ave., Farmington,  
Mich.  
PERSONNEL: John A. Lutz, Pres.  
PRODUCTS: Tools; Fixtures.

**PRECISION BEARINGS, INC.,**  
1706 S. Grand Ave., Los Angeles, Calif.  
PERSONNEL: O. P. Wilson, Pres.  
PRODUCTS: Bearings.

**PREST-O-LITE BATTERY CO., INC.,**  
Box 1655, Indianapolis, Ind.  
PERSONNEL: J. H. McDuffee, Pres.; H. E.  
Komitch, V. Pres.; F. H. Landwehr, Secy.;  
W. V. Flood, Treas.  
PRODUCTS: Storage batteries.

**PRODUCTION TOOL & DIE CO., INC.,**  
Springfield, Mass.  
PERSONNEL: R. J. Gaudreau, Pres.  
PRODUCTS: Tools.

**PROGRESSIVE BRASS MANUFACTURING  
CO. OF TULSA, 1702 E. 6th St., Tulsa,  
Okla.**  
PERSONNEL: N. A. Doolittle, Pres.  
PRODUCTS: Castings.

**PROGRESSIVE WELDER CO.,**  
3050 E. Outer Dr., Detroit, Mich.  
PERSONNEL: F. H. Johnson, Pres.; L. M.  
Benkert, Gen. Mgr.  
PRODUCTS: Welding equipment; Piercing  
equipment.

**PROTECTOSEAL CO.,**  
1920 S. Western Ave., Chicago, Ill.  
PERSONNEL: R. J. Anschicks, Pres.; H. W.  
Barber, Treas.  
PRODUCTS: Fill fittings.

**PUMP ENGINEERING SERVICE CORP.,**  
12910 Taft Ave., Cleveland, O.  
PERSONNEL: D. E. Gamble, Pres.  
PRODUCTS: Pumps; Accessories.

**PURE OIL CO.,**  
35 E. Wacker Dr., Chicago, Ill.  
PERSONNEL: C. B. Watson, Asst. to Pres.  
PRODUCTS: Motor oils.

**PUROLATOR PRODUCTS, INC.,**  
Newark, N. J.  
PERSONNEL: R. R. Layte, Exec. V. Pres.  
PRODUCTS: Fuel filters; Oil filters.

**PLYE-NATIONAL CO.,**  
1334 N. Kostner Ave., Chicago, Ill.  
PERSONNEL: J. A. Amos, Pres.  
PRODUCTS: Lighting equipment.

**PURENE MANUFACTURING CO.,**  
560 Belmont Ave., Newark, N. J.  
PERSONNEL: E. A. Clapp, Pres.  
PRODUCTS: Fire extinguishers.

## Q

**QUALITY ELECTRIC CO., LTD., 1235 E.  
Olympic Blvd., Los Angeles, Calif.**  
PERSONNEL: J. O. Case, Pres.  
PRODUCTS: Motors; Assemblies; Dynamotors;  
Switches.

**QUIGLEY CO., INC.,**  
56 W. 45th St., New York, N. Y.  
PERSONNEL: W. S. Quigley, Pres.  
PRODUCTS: Refractory and insulating products.

## R

**RCA MANUFACTURING CO., INC.,**  
Camden, N. J.  
PERSONNEL: Meade Brunet, Mgr. Eng. Div.;  
H. M. Hucke, Mgr. Aviation Section.  
PRODUCTS: Radio receivers; Transmitters; Di-  
rection finders; Amplifiers; Antennas; Filters;  
Microphones; Headphones; Test equipment.

**R E F AIRCRAFT CORP., Syosset, N. Y.**  
PERSONNEL: Lester E. Faust, Pres.; Raymond  
H. Faust, Secy. & Treas.  
PRODUCTS: Welding; Sheetmetal parts; Tool  
and die fabrication; Machined parts.

**RADEL LEATHER MANUFACTURING CO.,**  
Wilson & Hyatt Ave., Newark, N. J.  
PERSONNEL: Frank J. Radel.  
PRODUCTS: Upholstery leather.

**RADIATOR SPECIALTY CO.,**  
Charlotte, N. C.  
PERSONNEL: I. D. Blumenthal, Pres.; H. F.  
Meltsner, Sales Mgr.  
PRODUCTS: Radiator service products.

**RADIO RECEPTOR CO., INC.,**  
251 W. 19th St., New York, N. Y.  
PERSONNEL: Ludwig Arnsou, Pres.  
PRODUCTS: Transmitters.

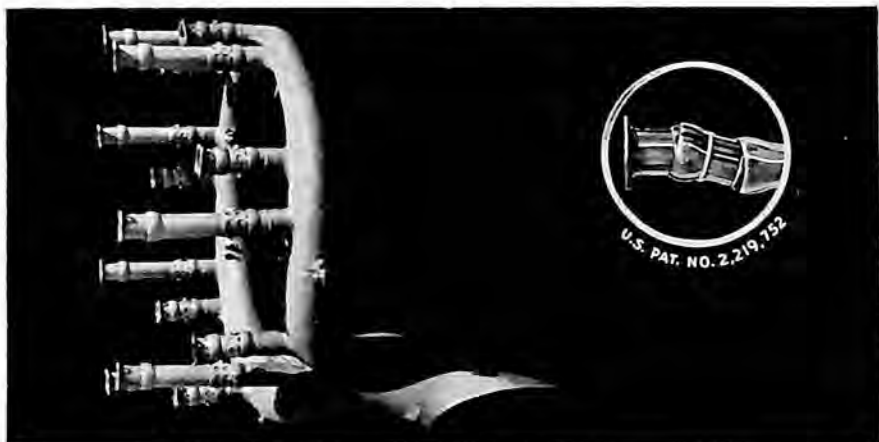
**RAMSEY ACCESSORIES MANUFACTUR-  
ING CORP., 3693 Forest Park Blvd.,  
St. Louis, Mo.**  
PERSONNEL: J. A. Ramsey, Pres.  
PRODUCTS: Piston rings.

**RANDALL GRAPHITE PRODUCTS CORP.,**  
609 W. Lake St., Chicago, Ill.  
PERSONNEL: W. P. Thacher, Pres.  
PRODUCTS: Bearings.

**RANDOLPH FINISHING PRODUCTS CO.,**  
Carlstadt, N. J.  
PERSONNEL: W. G. Randolph, Pres.  
PRODUCTS: Airplane dopes, primers, enamels.

**RAYMOND MANUFACTURING CO., DIV.  
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PERSONNEL: E. W. Feldt, Gen. Mgr.  
PRODUCTS: Coil springs; Flat springs; Forms;  
Stampings.

**READING BATTERIES, INC., Reading, Pa.**  
PERSONNEL: D. R. Bomberger, Pres.  
PRODUCTS: Storage batteries.



## **RYAN Universal Joint EXHAUST MANIFOLDS** **Are Standard Equipment** **On America's Leading Airplanes**

**S**INCE their development over three years ago, Ryan Universal-Joint Manifolds have been produced in large quantities for leading aircraft manufacturers and are now standard equipment on 19 types of America's most modern military and commercial airplanes.

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**REDA MANUFACTURING CO.,**  
Chicopee, Mass.

PERSONNEL: D. B. Gish, Pres.  
PRODUCTS: Couplings; Unions; Machine products.

**REPUBLIC AIRCRAFT PRODUCTS DIV.,  
THE AVIATION CORP., 5914 Federal  
Ave., Detroit, Mich.**

PERSONNEL: W. F. Wise, V. Pres.  
PRODUCTS: Engine and propeller parts.

**REPUBLIC STEEL CORP.,**  
Republic Bldg., Cleveland, O.

PERSONNEL: R. J. Wysor, Pres.; D. B. Gillies,  
V. Pres.; W. W. Hancock, Secy.-Treas.  
PRODUCTS: Carbon and alloy steels; Pipe;  
Bars; Bolts; Nuts.

**RESISTOFLEX CORP., Belleville, N. J.**

PERSONNEL: Edgar S. Peierls, Pres.; Herman  
E. Krebs, V. Pres.  
PRODUCTS: Fuel oil, hydraulic and instrument  
hose assemblies.

**REYNOLDS METALS CO., Federal Reserve  
Bank Bldg., Richmond, Va.**

PERSONNEL: R. S. Reynolds, Pres.; J. L. Rey-  
nolds, V. Pres.; I. P. Macaulay, Sales Mgr.;  
R. S. Reynolds, Jr., Treas.  
PRODUCTS: Aluminum; Aluminum paint pig-  
ments; Labels; Reflective metal insulation.

**M. H. RHODES, INC.,**

50 Bartholomew Ave., Hartford, Conn.  
PERSONNEL: M. H. Rhodes, Pres.  
PRODUCTS: Switches; Timers.

**RICHMOND RING CO., Souderton, Pa.**

PERSONNEL: Edwin H. Burk, Mgr.  
PRODUCTS: Piston rings.

**RIEHLE TESTING MACHINE DIV., AMERI-  
CAN MACHINE & METALS, INC., E.  
Moline, Ill.**

PERSONNEL: Alfred Sonntag, Ch. Eng.  
PRODUCTS: Testing machines; Instruments.

**ROBERTSON AIRCRAFT CORP., Lambert-  
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PERSONNEL: Major Wm. B. Robertson, Pres.;  
Norton Schuyler, V. Pres.; C. A. Bacon, Secy.  
PRODUCTS: Airplane parts.

**H. H. ROBERTSON CO., 2400 Farmers Bank  
Bldg., Pittsburgh, Pa.**

PERSONNEL: H. H. Robertson, Pres.; J. H.  
Young, V. Pres.  
PRODUCTS: Ventilators; Metal for hangars.

**ROCHESTER MANUFACTURING CO., INC.,  
Rochester, N. Y.**

PERSONNEL: Wm. Mulcahy, Pres.  
PRODUCTS: Gauges.

**ROCHESTER ROPES, INC., Jamaica, N. Y.**

PERSONNEL: Wm. L. Rochester, Pres.  
PRODUCTS: Wire rope and strand; Cable and  
fittings; Swaged terminals.

**ROCKWOOD SPRINKLER CO.,**

38 Harlow St., Worcester, Mass.  
PERSONNEL: W. J. Carroll, Pres.  
PRODUCTS: Automatic sprinkler for airplane  
hangars; Pressed metal fabrications.

**RODDIS LUMBER & VENEER CO.,**

Marshfield, Wisc.  
PERSONNEL: Hamilton Roddis, Pres.  
PRODUCTS: Aircraft plywood.

**JOHN A. ROEBLING'S SONS CO.,**

640 S. Broad St., Trenton, N. J.  
PERSONNEL: W. A. Anderson, Pres.; C. G.  
Williams, V. Pres.; C. R. Tyson, Secy.-Treas.;  
E. C. Low, Sales Mgr.; L. H. Van Dike, Pur.  
Dir.  
PRODUCTS: Control cord; Aircraft strand and  
wire; Ferrules; Swaged terminals; Wire rope  
and Grommet slings; Electrical wires and  
cables; Welding wire; Aircraft thimbles.

**ROLOCK, INC., Southport, Conn.**

PERSONNEL: R. P. Welles, Pres.; L. A. Beadle,  
V. Pres.  
PRODUCTS: Baskets; Crates; Screens; Trays;  
Wire cloth.

**ROMEC PUMP CO.,**

345 E. Bridge St., Elyria, O.  
PERSONNEL: P. E. Ryan, Pres.; W. L. Davis,  
V. Pres.  
PRODUCTS: Pumps; Air compressors.

**ROME-TURNEY RADIATOR CO.,**

Rome, N. Y.  
PERSONNEL: W. L. Lynch, Pres.  
PRODUCTS: Radiators; Coils; Tubing.

**ROUGH WEAR CLOTHING CO.,**

93 Worth St., New York, N. Y.  
PERSONNEL: I. Kirschenbaum, Pres.  
PRODUCTS: Coats; Jackets.

**RUCKSTELL BURKHARDT ENGINEERING**

CO., 320 Security Bldg., Phoenix, Ariz.  
PERSONNEL: G. E. Ruckstell, Pres.; F. B. Pat-  
terson, Secy.-Treas.  
PRODUCTS: Auxiliary power engines.

**RUEMELIN MANUFACTURING CO.,**

3860 N. Palmer St., Milwaukee, Wisc.  
PERSONNEL: R. Ruemelin, Jr., Pres.  
PRODUCTS: Sand blast machinery and equip-  
ment; Air dryers.

**RUSSELL UNIFORM CO.,**

1600 Broadway, New York, N. Y.  
PERSONNEL: H. Ziemer, Mgr.  
PRODUCTS: Uniforms.

**JOSEPH T. RYERSON & SON, INC.,**

16th & Rockwell Sts., Chicago, Ill.  
PERSONNEL: E. D. Graff, Pres.  
PRODUCTS: Steel.

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**S**


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**S A E STEELS, 1420 E. 47th St., Cleveland, O.**

PERSONNEL: A. B. Betz, Pres.  
PRODUCTS: Alloy steel.

**S K F INDUSTRIES, INC., Front St. & Erie  
Ave., Philadelphia, Pa.**

PERSONNEL: W. L. Batt, Pres.  
PRODUCTS: Ball and roller bearings.

**SAFETEE GLASS CO.,**

4717 Stenton Ave., Philadelphia, Pa.  
PERSONNEL: R. A. Gibbs, Pres.  
PRODUCTS: Laminated glass.

**SAL METAL PRODUCTS CO., INC.,**

26 Bleecker St., New York, N. Y.  
PERSONNEL: Sam Goldman, Pres.  
PRODUCTS: Machining.

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- Guidegage
- Nitrigages, Pipe Thread
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1 Exchange Pl., Jersey City, N. J.  
PERSONNEL: W. L. Smith, Pres.  
PRODUCTS: Rubber products.
- SAYLOR-BEALL MANUFACTURING CO.,**  
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Mich.  
PERSONNEL: Chas. S. Fisher, Gen. Mgr.  
PRODUCTS: Machined plane parts.
- SAYLOR ELECTRIC PRODUCTS CORP.,**  
1014 Lynn St., Detroit, Mich.  
PERSONNEL: W. R. Saylor, V. Pres.  
PRODUCTS: Non-metallic tubing; Armored  
tubing.
- GEORGE SCHERR CO., INC.,**  
128 Lafayette St., New York, N. Y.  
PERSONNEL: Geo. Scherr, Pres.  
PRODUCTS: Gauges; Micrometers.
- SCHLEGEL MANUFACTURING CO.,**  
277 N. Goodman St., Rochester, N. Y.  
PERSONNEL: C. P. Schlegel, Pres.  
PRODUCTS: Welting; Weatherstripping; Bind-  
ing.
- A. SCHRADER'S SON DIV. OF SCOVILL  
MANUFACTURING CO., INC., Brook-  
lyn, N. Y.**  
PERSONNEL: W. T. Hunter, V. Pres. & Gen.  
Mgr.  
PRODUCTS: Tire valves and gauges.
- SCHWARZENBACH HUBER CO.,**  
498 7th Ave., New York, N. Y.  
PERSONNEL: Ernest Glaesel, Pres.  
PRODUCTS: Silk flares and parachute cloth.
- SCINTILLA MAGNETO DIV. OF BENDIX  
AVIATION CORP., Sidney, N. Y.**  
PERSONNEL: H. Hanni, Gen. Mgr.; T. Z. Fagan,  
Sales Mgr.; A. Egli, Prod. Mgr.; A. Bekker,  
Pur. Dir.  
PRODUCTS: Magnetos; Spark plugs; Harness;  
Switches; Fuel pumps.
- SCULLY BROS., INC., 725 E. Washington  
Blvd., Los Angeles, Calif.**  
PERSONNEL: W. R. Scully, Pres.  
PRODUCTS: Leather products; Aviation helmets.
- SEALED POWER CORP., Muskegon, Mich.**  
PERSONNEL: C. E. Johnson, Pres.  
PRODUCTS: Piston rings; Cylinder sleeves;  
Liners.
- SEAMAN PAPER CO.,**  
222 W. Adams St., Chicago, Ill.  
PERSONNEL: C. W. Sherman, Pres.  
PRODUCTS: Insulation.
- SEAMLEX CO., INC.,**  
5-20 48th Ave., Long Island City, N. Y.  
PERSONNEL: F. Jacobson, Pres.  
PRODUCTS: Flexible seamless tubing.
- SEIDEN PNEUMATIC TOOL CO.,**  
423 Barrett St., Jackson, Mich.  
PERSONNEL: Elmer J. Seiden, Pres.  
PRODUCTS: Planishing hammers; Lubricators.
- SEIDLITZ PAINT & VARNISH CO.,**  
18th & Garfield Sts., Kansas City, Mo.  
PERSONNEL: C. N. Seidlitz, Pres.  
PRODUCTS: Finishes.
- SELECTAR MANUFACTURING CORP.,**  
30 W. 15th St., New York, N. Y.  
PERSONNEL: W. A. Bruno, Pres.  
PRODUCTS: Cable fittings; Connectors; Com-  
munication equipment.
- SELLSTROM MANUFACTURING CO.,**  
615 N. Aberdeen St., Chicago, Ill.  
PERSONNEL: G. E. Sellstrom, Pres.  
PRODUCTS: Goggles; Safety shields.
- SEMON BACHE & CO.,**  
636 Greenwich St., New York, N. Y.  
PERSONNEL: Joe Dreyfuss, Pres.  
PRODUCTS: All glass specialties.
- SENSENICH BROS., Lititz, Pa.**  
PERSONNEL: Harry M. Sensenich and Martin  
M. Sensenich, Partners; Martin S. Erb, Pur.  
Dir.  
PRODUCTS: Wood propellers.
- SERVICE REORDER CO.,**  
1375 Euclid Ave., Cleveland, O.  
PERSONNEL: H. R. Cool, Pres.  
PRODUCTS: Time clock.
- SERVICE STEEL CO.,**  
1435 Franklin St., Detroit, Mich.  
PERSONNEL: C. M. Poster, R. S. Van Pelt, and  
D. C. Van Pelt, Partners.  
PRODUCTS: Steel tubing.
- SHAKEPROOF LOCK WASHER CO.,**  
2501 N. Keeler Ave., Chicago, Ill.  
PERSONNEL: Harold Byron Smith, Pres.  
PRODUCTS: Lock washers; Terminals; Screws;  
Clips.
- SHAKESPEARE PRODUCTS CO., 261 E.  
Kalamazoo Ave., Kalamazoo, Mich.**  
PERSONNEL: H. G. Shakespeare, Pres.  
PRODUCTS: Throttles; Lights; Pumps; Controls.
- SHEFFIELD GAGE CORP., Dayton, O.**  
PERSONNEL: C. H. Reynolds, Pres.  
PRODUCTS: Gauges; Checking and measuring  
instruments; Vibration frequency meters.
- SHELL OIL CO., INC.,**  
50 W. 50th St., New York, N. Y.  
PERSONNEL: R. T. Goodwin, Mgr.; M. Hamon,  
Asst. Mgr.  
PRODUCTS: Petroleum products.
- SHERWIN-WILLIAMS CO., Cleveland, O.**  
PERSONNEL: W. J. Montgomery, Gen. Mgr.  
PRODUCTS: Finishes.
- SHINN DEVICES CO., Butler, Pa.**  
PERSONNEL: B. H. Shinn, Pres.  
PRODUCTS: Wheels; Brakes; Accessories.
- SHORE INSTRUMENT & MANUFACTUR-  
ING CO., INC., 9025 Van Wyck Ave.,  
Jamaica, N. Y.**  
PERSONNEL: W. F. Shore, Pres.  
PRODUCTS: Instruments.
- SHULER AXLE CO., INC., Louisville, Ky.**  
PERSONNEL: J. P. Potter, Pres.  
PRODUCTS: Drop forgings; Axles; Brakes.
- SHURE BROS., 225 W. Huron St., Chicago, Ill.**  
PERSONNEL: S. N. Shure, Gen. Mgr.; J. A.  
Berman, Sales Mgr.  
PRODUCTS: Microphones; Acoustic devices.

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BROOKLYN, NEW YORK



- SIEBENTHALER DIV. AIRCRAFT ACCESSORIES CORP.**, Fairfax Airport, Kansas City, Mo.  
**PERSONNEL:** Donald M. Stoner, Exec. Dir., John D. Williams, Pur. Mgr.  
**PRODUCTS:** Radio transmitting and receiving equipment; Antennae; Direction finders; Measuring instruments; Propeller governor.
- SIGMA INSTRUMENTS, INC.**,  
 76-78 Freeport St., Boston, Mass.  
**PERSONNEL:** S. B. Allen, Pres.  
**PRODUCTS:** Sensitive relays; Frequency relays; Acoustic switches.
- SIMMONDS AEROCESSORIES, INC.**,  
 10 Rockefeller Plaza, New York, N. Y.  
**PERSONNEL:** W. R. Enyart, Pres.; Robert T. Leadbetter, Asst. to Gen. Mgr.; E. M. Dowd, Secy.  
**PRODUCTS:** Power plugs; Controls; Gauges; Flooring; Precision parts and sub-assemblies.
- SIMMONS MANUFACTURING CO.**,  
 Ashland, O.  
**PERSONNEL:** C. F. Groth, Pres.  
**PRODUCTS:** Machining.
- SIMONDS SAW AND STEEL CO.**,  
 Fitchburg, Mass.  
**PERSONNEL:** G. K. Simonds, Pres.  
**PRODUCTS:** Saws; Files.
- SINCLAIR REFINING CO.**,  
 630 Fifth Ave., New York, N. Y.  
**PERSONNEL:** D. S. Bixler, Asst. Mgr.  
**PRODUCTS:** Oil; Lubricants.
- SKYVIEW CAMERA CO.**, Olmsted Falls, O.  
**PERSONNEL:** D. Worster, Pres.  
**PRODUCTS:** Aerial cameras.
- SMITH WELDING EQUIPMENT CORP.**,  
 2633-4th St. S. E., Minneapolis, Minn.  
**PERSONNEL:** Elmer H. Smith, Pres.  
**PRODUCTS:** Welding equipment.
- SNAP-ON TOOLS CORP.**, Kenosha, Wisc.  
**PERSONNEL:** J. Johnson, Pres.; R. Palmer, V. Pres.  
**PRODUCTS:** Tools.
- SNOW REMOVAL EQUIPMENT CO.**,  
 400 Seventh St., San Francisco, Calif.  
**PERSONNEL:** Norris K. Davis, Pres.  
**PRODUCTS:** Rotary snow plows.
- SOCONY-VACUUM OIL CO., INC.**,  
 26 Broadway, New York, N. Y.  
**PERSONNEL:** H. W. Lake, Mgr.  
**PRODUCTS:** Gas; Oil.
- SOLAR AIRCRAFT CO.**,  
 1212 W. Juniper St., San Diego, Calif.  
**PERSONNEL:** E. T. Price, Pres.; C. S. Marston, V. Pres.; A. W. Briggs, Treas.  
**PRODUCTS:** Exhaust manifolds; Airplane parts and accessories.
- SOUTH BEND LATHE WORKS**,  
 425 E. Madison St., South Bend, Ind.  
**PERSONNEL:** R. E. Frushour, Pres.  
**PRODUCTS:** Precision lathes.
- SOUTHERN CALIFORNIA PLATING CO.**,  
 4444 Sunset, Los Angeles, Calif.  
**PERSONNEL:** Leonard De Bell, Pres.  
**PRODUCTS:** Metal spinings; Die castings; Plating.
- SPARKS-WITHINGTON CO.**, Jackson, Mich.  
**PERSONNEL:** W. J. Corbett, V. Pres.  
**PRODUCTS:** Horns; Sirens.
- SPARTAN SCHOOL OF AERONAUTICS**,  
 Tulsa, Okla.  
**PERSONNEL:** M. W. Balfour, Dir.  
**PRODUCTS:** Radio transmitters and receivers.
- SPAULDING FIBRE CO., INC.**,  
 310 Wheeler St., Tonawanda, N. Y.  
**PERSONNEL:** R. H. Spaulding, Pres.  
**PRODUCTS:** Fibre; Insulation.
- SPECIAL MACHINE TOOL ENGINEERING WORKS, INC.**, 254 Canal St., New York, N. Y.  
**PERSONNEL:** Walter Silber, Pres.  
**PRODUCTS:** Precision machine parts.
- SPENCER THERMOSTAT CO.**,  
 34 Forest St., Attleboro, Mass.  
**PERSONNEL:** V. G. Vaughan, Mgr.  
**PRODUCTS:** Circuit breakers; Switches; Thermal valves and controls.
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**PERSONNEL:** R. E. Gillmor, Pres.; P. R. Bassett, V. Pres.; R. B. Lea, Sales Mgr.; H. H. Thompson, Secy.; James E. Webb, Treas.; Harris Hull, Pub. Dir.  
**PRODUCTS:** Gyroplane; Radio direction finder Directional gyro.
- SPERRY PRODUCTS, INC.**,  
 1505 Willow Ave., Hoboken, N. J.  
**PERSONNEL:** J. B. Farwell, Pres.; E. A. Sperry, V. Pres.; J. D. Peace, Jr., Mgr. Aviation Sales.  
**PRODUCTS:** Exactor hydraulic control.
- SPRIESCH TOOL AND MANUFACTURING CO., INC.**, 10 Howard St., Buffalo, N. Y.  
**PERSONNEL:** J. Cheney, Pres.  
**PRODUCTS:** Airplane parts and assemblies; Armament equipment.
- SPRINGFIELD BRASS CO.**,  
 821-827 W. Main St., Springfield, O.  
**PERSONNEL:** William Kelley, Gen. Mgr.  
**PRODUCTS:** Aircraft fittings.
- STANDARD AIRCRAFT PRODUCTS, INC.**,  
 121 Franklin St., Dayton, O.  
**PERSONNEL:** R. N. Webster, Pres.  
**PRODUCTS:** Sheet metal products; Lighting equipment; Precision machined parts.
- STANDARD FELT CO.**,  
 29-115 So. Palm Ave., Alhambra, Calif.  
**PERSONNEL:** H. S. Cook, V. Pres.  
**PRODUCTS:** Wool felt.
- STANDARD MACHINERY CO.**, 351 Indiana Ave., N. W., Grand Rapids, Mich.  
**PRODUCTS:** Machine tools.
- STANDARD MACHINERY CO.**,  
 Mystic, Conn.  
**PERSONNEL:** Norton C. Wheeler, Pres.  
**PRODUCTS:** Plastic molding presses.
- STANDARD OIL CO. OF CALIFORNIA**,  
 225 Bush St., San Francisco, Calif.  
**PERSONNEL:** R. F. Bradley, Mgr.  
**PRODUCTS:** Lubricants.



**REDUCE  
WEIGHT**

Landing Gear Leg  
4" O. D. tapered  
in 5 Steps to 2½"  
O. D.

Tail Wheel Drag  
Link 2½" O. D.  
tapered to both  
ends.

3½" O. D. Torque  
Tube tapered to  
2½" O. D.

3½" O. D. double  
taper to 2" O. D.  
at ends for wheel  
fork

*With*  
**Less Welding**  
*at*  
**Lower Cost**  
with a gain in weight  
strength ratio

Now that most plants  
are on a production  
basis, it is possible to utilize  
the tapered and formed  
tubes being produced by  
Summerill to obtain  
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**STANDARD OIL CO., INC. OF KENTUCKY,**  
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PERSONNEL: W. E. Smith, Pres.  
PRODUCTS: Gasolines; Lubricants; Industrial Fuel and Greases; Tires; Batteries.

**STANDARD OIL CO. (Ohio),**  
Midland Bldg., Cleveland, O.  
PERSONNEL: W. T. Holliday, Pres.  
PRODUCTS: Gasoline.

**STANLEY WORKS, PRESSED METAL DIV.,**  
New Britain, Conn.  
PERSONNEL: C. F. Bennett, Pres.  
PRODUCTS: Hardware; Metal stampings.

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PERSONNEL: LeRoy H. Stanton, Pres.  
PRODUCTS: Propeller wood stock.

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PERSONNEL: E. C. Alden, Pres.  
PRODUCTS: Terminal blocks; Woven resistors.

**STEEL-FORMING CORP.,** 1619 S. Alameda Ave., Los Angeles, Calif.  
PERSONNEL: L. T. Sepin, Pres.  
PRODUCTS: Corrugated sheets; Cowling rings; Cockpit tracks; Tubing.

**STEEL PRODUCTS ENGINEERING CO., INC.,** Springfield, O.  
PERSONNEL: J. E. McAdams, Pres. & Treas.; S. L. Tatum, V. Pres.; I. W. Clark, Secy.  
PRODUCTS: Instruments.

**STEWART IRON WORKS CO., INC.,**  
Box 1039, Cincinnati, O.  
PRODUCTS: Wire fences and gates.

**M. C. STEWART, Arlington, Mass.**  
PRODUCTS: Weather instruments.

**STONE PROPELLER CO., Wichita, Kans.**  
PERSONNEL: M. J. Stone, Pres.  
PRODUCTS: Propellers.

**STREETER-AMET CO.,**  
4101 Ravenswood Ave., Chicago, Ill.  
PRODUCTS: Micrometer; Machined parts.

**STRUTHERS DUNN, INC.,**  
1315 Cherry St., Philadelphia, Pa.  
PERSONNEL: J. Struthers Dunn, Pres.  
PRODUCTS: Control equipment.

**B. F. STURTEVANT CO., Hyde Park, Mass.**  
PRODUCTS: Fans; Blowers; Aircraft heating and ventilating systems.

**SULLIVAN MACHINERY CO.,**  
Woodland Ave., Michigan City, Ind.  
PERSONNEL: F. W. Copeland, Pres.  
PRODUCTS: Compressors.

**SUMMERILL TUBING CO., Bridgeport, Pa.**  
PERSONNEL: E. L. Parker, Pres.; R.R. Lawson, V. Pres.; Geo. E. Parker, Gen. Mgr.; C. W. Johnson, Pur. Dir.  
PRODUCTS: Seamless steel tubing.

**SUNCOOK MILLS,**  
40 Worth St., New York, N. Y.  
PERSONNEL: J. Linzee Weld, Pres.  
PRODUCTS: Fabric; Tapes.

**SUNDSTRAND MACHINE TOOL CO.,**  
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PERSONNEL: H. L. Olson, Pres.  
PRODUCTS: Machine tools.

**SUNNEN PRODUCTS CO.,**  
7900 Manchester Ave., St. Louis, Mo.  
PERSONNEL: Joe Sunnen, Pres.  
PRODUCTS: Precision honing machines.

**SUPERIOR TUBE CO., Norristown, Pa.**  
PERSONNEL: S. L. Gabel, Gen. Mgr.; R. H. Gabel, V. Pres.; H. B. Brown, Jr., Sales Mgr.  
PRODUCTS: Tubing.

**SWEDLOW AEROPLASTICS CORP.,**  
1505 Gardena Ave., Glendale, Calif.  
PERSONNEL: Dave Swedlow, Pres.  
PRODUCTS: Windshields; Cockpit enclosures  
Gun turrets; Lenses.

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**C. J. TAGLIABUE MANUFACTURING CO.,**  
Park & Nostrand Aves., Brooklyn, N. Y.  
PERSONNEL: George A. Turhune, Adv. Mgr.  
PRODUCTS: Gages; Valves; Thermometers.

**TALLMADGE CO.,**  
132 W. 14th St., New York, N. Y.  
PERSONNEL: D. B. Tallmadge, Pres.  
PRODUCTS: Upholstery; Carpeting; Headlinings.

**TANNEWITZ WORKS, 315 Front Ave., N. W.,**  
Grand Rapids, Mich.  
PERSONNEL: C. E. Tannewitz, Pres.  
PRODUCTS: Saws.

**TAYLOR AIRPHONE PRODUCTS, INC.,**  
Hangar 15, Municipal Airport, Long Beach, Calif.  
PERSONNEL: M. B. Taylor, Pres.; D. Helbig, V. Pres.; J. M. Levy, Secy.-Treas.  
PRODUCTS: Radio equipment.

**TAYLOR FIBRE CO., Norristown, Pa.**  
PERSONNEL: John M. Taylor, Pres.; L. T. McCloskey, V. Pres.  
PRODUCTS: Laminated plastics; Fibres.

**TAYLOR WINFIELD CORP., Warren, O.**  
PERSONNEL: J. A. Anderson, Pres.; W. A. Anderson, V. Pres.; N. H. Cobb, Secy.-Treas.; S. M. Humphrey, Ch. Eng.  
PRODUCTS: Electric welding machines.

**TECHNICAL PLY-WOODS,**  
228 N. LaSalle St., Chicago, Ill.  
PERSONNEL: James R. Fitzpatrick, Director.  
PRODUCTS: Aircraft plywood.

**TECHNICAL PRODUCTS,**  
6670 Lexington Ave., Los Angeles, Calif.  
PERSONNEL: E. R. Chilcott, Pres.  
PRODUCTS: Sound recording and airplane timing equipment.

**TEICHER MANUFACTURING CORP.,**  
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PERSONNEL: A. A. Teicher, Pres.; G. B. Cluett, V. Pres.; L. L. Wilke, Secy.  
PRODUCTS: Sheet metal parts.



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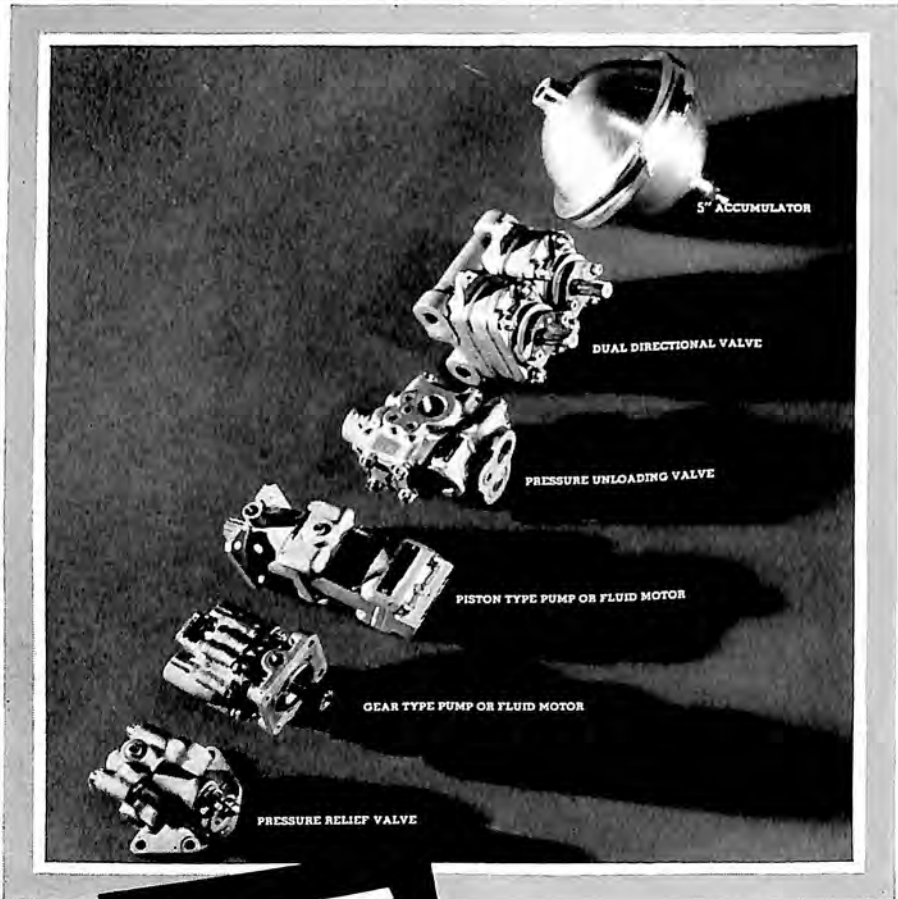
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1020 S. Central Ave., Chicago, Ill.  
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 PRODUCTS: Cowls; Flaps; Tanks.

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 PRODUCTS: Moulded plastic products.

**THOMAS WIRE & SPRING CO., INC.,**

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 PRODUCTS: Grinding machines.

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 PRODUCTS: Profile saws; Hack saw and metal cutting band saw blades.

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 PRODUCTS: Valves; Precision parts for aircraft engines.

**J. H. THORP & CO., INC.,**

250 Park Ave., New York, N. Y.  
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**TIDE WATER ASSOCIATED OIL CO.,**

17 Battery Place, New York, N. Y.  
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 PRODUCTS: Petroleum products.

**TIETZMANN ENGINEERING CO.,**

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 PRODUCTS: Dies; Jigs; Gages; Fixtures.

**TIMBER ENGINEERING CO., 1337 Connecticut Ave., N. W., Washington, D. C.**

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 PRODUCTS: Timber connectors; Termite shields.

**TIMKEN ROLLER BEARING CO.,**

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 PRODUCTS: Roller bearings; Tubing.

**TINIUS OLSEN TESTING MACHINE CO.,**

500 N. 12th St., Philadelphia, Pa.  
 PERSONNEL: T. Y. Olsen, Pres.; J. F. Sutton, Secy.  
 PRODUCTS: Testing machines; Precision measuring instruments.

**TINNERMAN PRODUCTS, INC.,**

2038 Fulton Rd., Cleveland, O.  
 PERSONNEL: A. H. Tinnerman, Pres.; G. A. Tinnerman, V. Pres.; A. T. Buttriss, Secy.  
 PRODUCTS: Nuts; Clips.

**TITANINE, INC.,**

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 PRODUCTS: Dopes; Primers; Surfacer; Lacquers and thinners.

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 PRODUCTS: Radio shielded ignition harnesses; Flexible metal fuel lines.

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 PRODUCTS: Castings; Special tools; Jigs; Dies.

**TORRINGTON CO.,**

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 PERSONNEL: F. T. Case, Sales Mgr.  
 PRODUCTS: Needle roller and ball bearings.

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 PERSONNEL: L. M. Sears, Pres.  
 PRODUCTS: Lift trucks and tractors.

**TRANE CO., La Crosse, Wis.**

PERSONNEL: R. H. Anderegg, Ch. Eng.  
 PRODUCTS: Coils; Heating specialties.

**TRANSMITTER EQUIPMENT MFG. CO.,**

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 PRODUCTS: Radio transmitter and receiving apparatus; Ground equipment.

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 PERSONNEL: J. R. Gorman, Pres.  
 PRODUCTS: Drop forgings.

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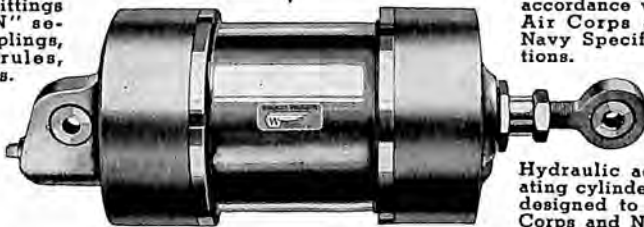
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Vacuum selector valves—two and three positions, Weatherhead design to Air Corps and Navy Specifications.



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PERSONNEL: Chas. A. Bottorff, Gen. Mgr.  
PRODUCTS: Headsets; Phone plugs.

**TRIPLETT ELECTRICAL INSTRUMENT**  
**CO.,** Harmon Rd., Bluffton, O.  
PERSONNEL: R. L. Triplett, Pres.  
PRODUCTS: Indicating instruments.

**TROY TOOL & GAGE CO.,**  
5736-12th St., Detroit, Mich.  
PERSONNEL: E. M. Douglas, Gen. Mgr.  
PRODUCTS: Precision gages.

**W. W. & C. F. TUCKER, INC.,**  
618 Capitol Ave., Hartford, Conn.  
PERSONNEL: H. B. Tucker, Pres.  
PRODUCTS: Oil cups; Oil hole covers.

**TUNGSTEN ELECTRIC CORP.,**  
540-39th St., Union City, N. J.  
PERSONNEL: J. A. Storrs, Sales Mgr.  
PRODUCTS: Carbide blanks and tools.

**TURBO ENGINEERING CORP.,**  
143 Liberty St., New York, N. Y.  
PERSONNEL: G. D. Besler, Pres.  
PRODUCTS: Superchargers.

**TURCO PRODUCTS, INC.,** P. O. Box 2649,  
Terminal Annex, Los Angeles, Calif.  
PERSONNEL: S. G. Thornbury, Pres.; Ray  
Sanders, Gen. Mgr.  
PRODUCTS: Cleaning and Metal Processing  
Compounds

**TUTHILL SPRING CO.,**  
760 Polk St., Chicago, Ill.  
PERSONNEL: H. T. Moore, Pres.  
PRODUCTS: Tail skid springs.

**TWIN CITY TOOL CO.,** 1511-15 Lowry Ave.  
N., Minneapolis, Minn.  
PERSONNEL: S. J. Leba and J. J. Leba Partners.  
PRODUCTS: Stampings.

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**UNIFORM HOOD LACE CO.,**  
1609 College Ave., Indianapolis, Ind.  
PERSONNEL: James L. Anthony, Pres.  
PRODUCTS: Webbing; Cotton belting.

**UNILOY ACCESSORIES CORP.,**  
Lancaster, N. Y.  
PERSONNEL: Earle M. Scott, Pres.; G. E. Scott,  
Secy.; R. D. Pollock, Treas.  
PRODUCTS: Tail wheel assemblies; Aluminum  
alloy castings.

**UNION DRAWN STEEL DIV., REPUBLIC**  
**STEEL CORP.,** Harsh Ave., S. E.,  
Massillon, O.  
PERSONNEL: R. J. Wysor, Pres.  
PRODUCTS: Shaftings.

**UNION MANUFACTURING CO.,**  
New Britain, Conn.  
PERSONNEL: C. S. Neumann, Pres.  
PRODUCTS: Lathe and drill chucks; Hoists;  
Castings.

**UNION OIL CO. OF CALIFORNIA,**  
617 W. 7th St., Los Angeles, Calif.  
PERSONNEL: Reese H. Taylor, Pres.; W. L.  
Stewart, Jr., V. Pres.; W. R. Edwards, Secy.;  
H. W. Sanders, Treas.  
PRODUCTS: Petroleum products.

**UNION SPECIAL MACHINE CO.,**  
400 N. Franklin St., Chicago, Ill.  
PRODUCTS: Industrial sewing machines.

**UNITED AIRCRAFT PRODUCTS, INC.,**  
480 Huffman Ave., Dayton, O.  
PERSONNEL: H. L. Bill, Pres.; R. G. Dykeman,  
W. W. Cowan, V. Pres.; John Shotwell, Treas.;  
F. E. Crist, Secy.; E. A. Enderle, Pur. Dir.  
PRODUCTS: Oil temperature regulators; Fuel  
pumps and systems; Solenoids; Strainers;  
Valves; Assemblies.

**UNITED AIRCRAFT PRODUCTS, INC.,**  
2929 Santa Fe Ave., Los Angeles, Calif.  
PERSONNEL: F. W. Wilkins, Gen. Mgr.  
PRODUCTS: Hydraulic struts; Valves; Cylinders.

**UNITED-CARR FASTENER CORP.,**  
31 Ames St., Cambridge, Mass.  
PERSONNEL: Sinclair Weeks, Pres.  
PRODUCTS: Fasteners; Nuts; Screws; Stamp-  
ings; Plastics; Radio parts.

**UNITED LUBRICANT CO.,**  
2890 E. 83rd St., Cleveland, O.  
PERSONNEL: F. C. Moore, Pres. & Treas.  
PRODUCTS: Lubricants; Compounds.

**UNITED PRECISION PRODUCTS CO.,**  
4618 W. Huron St., Chicago, Ill.  
PERSONNEL: N. W. Redmer, Pres.  
PRODUCTS: Gages.

**UNITED STATES ELECTRICAL TOOL CO.,**  
2488-96 W. 6th St., Cincinnati, O.  
PERSONNEL: Geo. E. Smith, Sales Mgr.  
PRODUCTS: Drills; Refacers; Grinding equip-  
ment; Polishers.

**UNITED STATES GAUGE CO.,**  
44 Beaver St., New York, N. Y.  
PERSONNEL: J. W. Place, Pres.  
PRODUCTS: Pressure and vacuum gauges; Dial  
thermometers; Instruments.

**U. S. HAMMERED PISTON RING CO., INC.,**  
Stirling, N. J.  
PERSONNEL: B. J. Wenzel, Pres.  
PRODUCTS: Piston rings.

**U. S. PLYWOOD CORP.,**  
616 W. 46th St., New York, N. Y.  
PERSONNEL: L. Ottinger, Pres.  
PRODUCTS: Plywood; Glue.

**UNITED TRANSFORMER CORP.,**  
150 Varick St., New York, N. Y.  
PERSONNEL: I. A. Mitchell, Pres.  
PRODUCTS: Transformers; Reactors; Voltage  
regulators; Filters; Rectifiers.

**UNIVERSAL MICROPHONE CO., LTD.,**  
Inglewood, Calif.  
PERSONNEL: James R. Fouch, Pres.  
PRODUCTS: Microphones.



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 Fort Erie, Ontario, Canada

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**VALENTINE & CO., INC.,**

11 E. 36th St., New York, N. Y.  
 PERSONNEL: T. J. Campbell, Pres.  
 PRODUCTS: Dopes; Finishes.

**VARD MECHANICAL LABORATORY, 2961**

E. Colorado St., Pasadena, Calif.  
 PERSONNEL: Vard B. Wallace.  
 PRODUCTS: Drafting machines; Scales; Optical instruments.

**VASCOLOY-RAMET CORP., N. Chicago, Ill.**

PERSONNEL: R. J. Aitchison, Pres.  
 PRODUCTS: Cutting tools; Dies; Resisting parts.

**VEEDER-ROOT, INC.,**

Garden & Sargeant Sts., Hartford, Conn.  
 PERSONNEL: G. H. Anthony, Pres.; J. H. Chaplin, V. Pres.  
 PRODUCTS: Counters; Tachometers.

**VELLUMOID CO.,**

54 Rockdale St., Worcester, Mass.  
 PERSONNEL: R. B. Stanley, Pres.  
 PRODUCTS: Sheet packings; Non-metallic gaskets.

**VICKERS, INC.,**

1400 Oakman Blvd., Detroit, Mich.  
 PERSONNEL: H. F. Vickers, Pres.  
 PRODUCTS: Hydraulic equipment.

**VICTOR MANUFACTURING & GASKET**

CO., 5750 Roosevelt Rd., Chicago, Ill.  
 PERSONNEL: J. H. Victor, Pres.  
 PRODUCTS: Millboard; Gaskets; Oil seals; Grease retainers; Sheet packings.

**VIMALERT CO., LTD.,**

807 Garfield Ave., Jersey City, N. J.  
 PERSONNEL: Robert Cuse, Pres.; B. J. Flynn, V. Pres.; H. A. Schaufelberger, Treas.; H. Shapiro, Secy.  
 PRODUCTS: Overhauling and rebuilding of engines.

**VINCO CORP., 9111 Schaefer Highway,**

Detroit, Mich.  
 PERSONNEL: J. J. Osplack, Pres.  
 PRODUCTS: Gages; Gears; Special machinery.

**VOGES MANUFACTURING CO., INC.,**

99th St., Ozone Park, N. Y.  
 PERSONNEL: F. Voges, Pres.  
 PRODUCTS: Plastic materials; Fuel gauges; Machined parts.

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**PAUL G. WAGNER CO., 2965 E. Washington**

Bldv., Los Angeles, Calif.  
 PERSONNEL: Paul G. Wagner.  
 PRODUCTS: Hydraulic units; Tools.

**WAILES DOVE-HERMISTON CORP.,**

Westfield, N. J.  
 PERSONNEL: Linden Stuart, Pres.  
 PRODUCTS: Protective coatings.

**WALKER MANUFACTURING CO. OF WIS-**

CONSIN, Racine, Wisc.  
 PERSONNEL: W. H. Walker, V. Pres.  
 PRODUCTS: Automotive mufflers; Exhaust pipes; Tail pipes.

**WALLACE SUPPLIES MANUFACTURING**

CO., 1310-12 Diversey Parkway, Chicago, Ill.  
 PERSONNEL: E. Metterhausen, Pres.  
 PRODUCTS: Collector rings; Exhaust bends; Ring mufflers.

**WALWORTH CO.,**

60 E. 42nd St., New York, N. Y.  
 PERSONNEL: W. B. Holton, Jr., Pres.  
 PRODUCTS: Valves; Fittings; Pipe; Tools.

**WARD LEONARD ELECTRIC CO.,**

31 South St., Mt. Vernon, N. Y.  
 PERSONNEL: L. Kebler, Pres.  
 PRODUCTS: Electric control devices.

**WARMAN STEEL CASTING CO.,**

6100 S. Boyle Ave., Los Angeles, Calif.  
 PRODUCTS: Alloy and carbon steel castings.

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 PERSONNEL: A. Elliott Merrill, Pres.  
 PRODUCTS: Airplane skis.

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 ington, D. C.  
 PERSONNEL: Col. Sidney F. Mashbir, Pres.; E. L. Reilly, Secy.; M. P. Bradshaw, Treas.  
 PRODUCTS: Phase meters; Radio sondes; Antenna arrays.

**WAYNE CHEMICAL PRODUCTS CO.,**

Detroit, Mich.  
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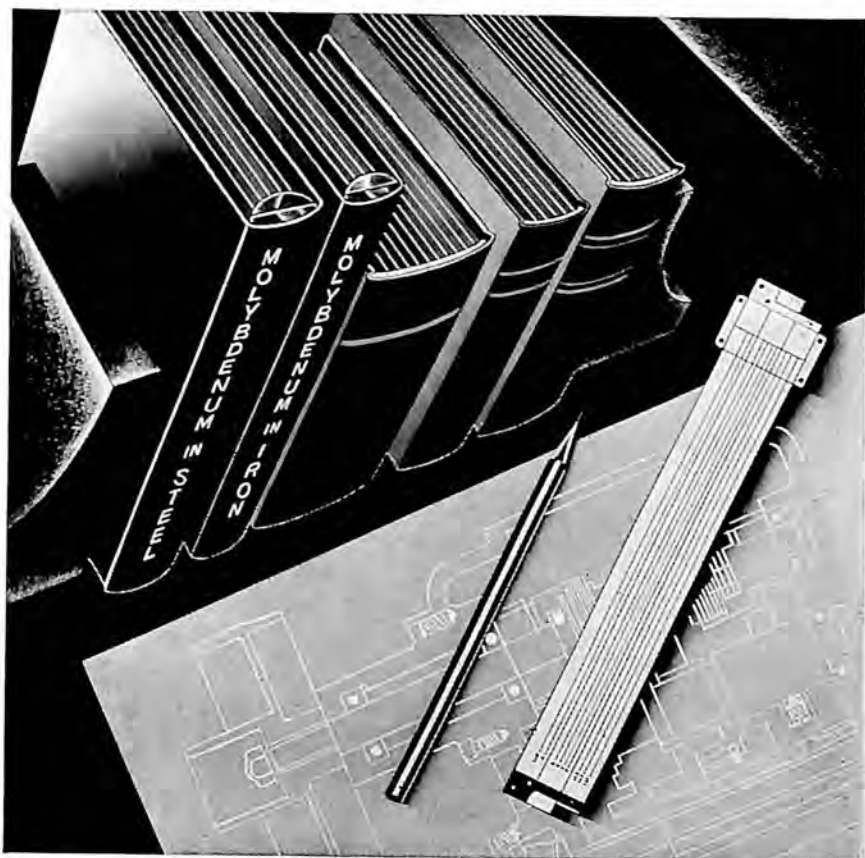
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Standing Committees of the 77th Congress, first session, 1941

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 Southern Airways Sales Company, Inc., Municipal Airport, Birmingham, Ala.  
 Southwest Airways, Inc., Sky Harbor Airport, Phoenix, Ariz.  
 Spartan School of Aeronautics, Box 2649, Tulsa, Okla.  
 Speed's Flying Service, Inc., 33-05 37th Ave., Long Island City, N. Y. In conjunction with New York University, School of Education, 34 Stuyvesant St., New York, N. Y.  
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 St. Louis School of Aeronautics, Inc., Lambert-St. Louis Municipal Airport, Robertson, Mo.  
 Standard Flying School, Hangar #3, Floyd Bennett Field, Brooklyn, N. Y. In conjunction with New York University, School of Education, 34 Stuyvesant St., New York, N. Y.  
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 Stengel, Carl, Flying Service, P. O. Box 352, Gainesville, Fla.  
 Stevens Flying Service, Windsor Mill Road, Woodlawn, Md.  
 Stillwater Flying Service, Box 466, Stillwater, Okla.  
 Strachan Skyways, Inc., Municipal Airport, Savannah, Ga.  
 Swaby School of the Air, Municipal Airport, Columbus, Ga.  
 Teel, D. M., P. O. Box 1646, Odessa, Tex.  
 Tennessee Aero Corporation, Municipal Airport, Nashville, Tenn.  
 Thompson Flying Service, Inc., Municipal Airport, Salt Lake City, Utah.  
 Topeka Flying Service, Municipal Airport, Topeka, Kan.  
 Tred Avon Flying Service, Inc., Easton, Md.  
 Tri-Cities Aviation School, Inc., Tri-Cities Airport, Endicott, N. Y.  
 Turner, Roscoe, Aeronautical Corp., Municipal Airport, Indianapolis, Ind.  
 United Flying School, Hangar #3, Floyd Bennett Field, Brooklyn, N. Y. In conjunction with New York University, School of Education, 34 Stuyvesant St., New York, N. Y.  
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 University of Georgia School of Aviation, Inc., The Municipal Airport, Athens, Ga.  
 Utica Aviation School, Inc., Utica Airport, Utica, N. Y.  
 Vincent Aeronautical, New Orleans Airport, New Orleans, La.  
 Virginia Polytechnic Institute, Blacksburg, Va.  
 Wallace Air Service, 163 South Howard St., Spokane, Wash.  
 Western Air College, 620 East Valley Boulevard, Alhambra, Calif.  
 West Virginia Air Service, Inc., County Airport, Clarksburg, W. Va.  
 Whipp Flying Service, Logan Field, Dundalk, Md.  
 White Flying Service, Caldwell Wright Airport, Caldwell, N. J. In conjunction with Essex County Vocational School, 209 Franklin St., Bloomfield, N. J.  
 Wichita Falls Air Transport Co., Inc., P. O. Box 84, Wichita Falls, Tex.  
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## Flying Facts and Figures

SUBJECT	PAGE
Summary of Air Carrier Operations . . . . .	548
U. S. Domestic Air Line Operations, Accident Statistics	548
U. S. Air Transport Operations . . . . .	550
U. S. Air Transport Routes . . . . .	552-560
Monthly Air Carrier Operations . . . . .	562
U. S. Air Mail Service . . . . .	564-568
U. S. Foreign Air Mail . . . . .	570
U. S. Aeronautical Exports . . . . .	572-580
Non-Military Aircraft in the United States . . . . .	582
Licensed Pilots in the United States . . . . .	584
Airports and Landing Fields . . . . .	586
Aviation Gasoline Tax Summary . . . . .	588-589
Production of U. S. Civil Aircraft . . . . .	590
U. S. Civilian Pilot Training Program . . . . .	592-594

## SUMMARY OF AIR CARRIER OPERATIONS

Air Lines in the United States

Corrected by U. S. Civil Aeronautics Administration  
Calendar Years

Year	Operators	Planes in Service	Miles Flown	Total Passengers Carried	Total Passenger Miles Flown	Express Carried (Pounds)	Mail Pound Miles Flown <sup>1</sup>
1926	11	(2)	4,258,771	5,782	(2)	3,555	(3)
1927	16	128	5,779,863	8,661	(2)	45,850	(3)
1928	31	325	10,400,239	47,840	(2)	210,404	(3)
1929	34	442	22,380,020	159,751	(2)	249,634	(3)
1930	38	497	31,992,634	374,935	84,014,572	359,523	(3)
1931	35	490	42,755,417	409,981	106,442,375	788,059	6,280,409,884
1932	29	456	45,606,354	474,279	127,038,798	1,033,970	5,402,249,740
1933	24	408	48,771,553	493,141	173,492,119	1,510,215	5,135,897,406
1934	22	417	49,955,396	461,743	187,858,620	2,133,191	4,922,822,780
1935	23	356	55,380,353	746,946	313,905,508	3,822,397	8,265,416,188
1936	21	272	63,777,226	1,020,931	435,740,253	6,958,777	11,482,872,622
1937	17	282	66,071,507	1,102,707	476,603,165	7,127,369	13,396,460,117
1938	18	253	69,668,827	1,343,427	557,719,268	7,335,967	14,845,719,671
1939	17	265	82,571,523	1,876,051	749,787,096	9,514,299	17,170,021,595
1940	16	358	108,800,436	2,959,480	1,147,444,948	12,506,176	20,100,000,000 <sup>4</sup>

<sup>1</sup> Mail pound miles flown are for domestic services and Inter-Island Airways which company holds a domestic air mail contract; but does not include American Aviation, Inc. pickup service.

<sup>2</sup> Not available prior to 1930.

<sup>3</sup> Air mail pound-miles have been computed by the Post Office Department commencing with January 1931; and are not available prior to that date.

<sup>4</sup> Last 4 months—estimated.

## U. S. DOMESTIC AIR LINE OPERATIONS

And Accident Statistics for the Calendar Years 1938, 1939 and 1940

	1938	1939	1940
Miles Flown.....	69,668,827	82,571,523	108,800,436
Total Passengers Carried.....	1,343,427	1,876,051	2,959,480
Total Passenger Miles.....	557,719,268	749,787,096	1,147,444,948
Fatal Accidents.....	5	2	3
Fatal Passenger Accidents.....	5	2	3
Passenger Fatalities.....	25	9	35
Crew Fatalities.....	7	2	10
Miles Flown per Fatal Accident.....	13,933,765	41,285,762	36,266,812
Miles Flown per Fatal Passenger Accident.....	13,933,765	41,285,762	36,266,812
Passenger Miles Flown per Passenger Fatality..	22,308,771	83,309,677	32,784,141
Miles Flown per Crew Fatality.....	9,952,690	41,285,762	10,880,044





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## SUMMARY OF UNITED STATES AIR TRANSPORT OPERATIONS

Compiled by U. S. Civil Aeronautics Administration

April 1, 1941

Miles of American-operated air transport routes:	
Domestic .....	41,054
Territorial .....	2,973
International .....	<u>50,052</u>
	94,079
Miles in operation with United States mail:	
Domestic .....	40,461
Territorial .....	1,014
International .....	<u>17,994</u>
	90,360
Miles in operation with passengers:	
Domestic .....	41,054
Territorial .....	2,973
International .....	<u>50,052</u>
	94,079
Miles in operation with express:	
Domestic .....	41,054
Territorial .....	2,973
International .....	<u>50,052</u>
	94,079
Airplane-miles scheduled daily (Average):	
Domestic .....	334,278
Territorial .....	2,430
International .....	<u>43,120</u>
	379,837
With United States Mail:	
Domestic .....	310,325
Territorial .....	1,085
International .....	<u>38,047</u>
	350,357
With passengers:	
Domestic .....	332,828
Territorial .....	2,430
International .....	<u>42,120</u>
	377,387
With express:	
Domestic .....	334,278
Territorial .....	2,430
International .....	<u>43,120</u>
	379,837
Number of Air Transport Services in operation .....	211
Mail .....	165
Passenger .....	210
Express .....	211
Domestic routes .....	164
Mail .....	134
Passenger .....	163
Express .....	164
International routes .....	40
Mail .....	26
Passenger .....	40
Express .....	40
Territorial routes .....	7
Mail .....	5
Passenger .....	7
Express .....	7
Number of scheduled air transport operators <sup>1</sup> .....	20
Domestic .....	16
Territorial .....	2
International .....	6

<sup>1</sup> Three companies operated both domestic and international services, and one company territorial and international services.

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## UNITED STATES AIR TRANSPORT ROUTES

Compiled by U. S. Civil Aeronautics Administration

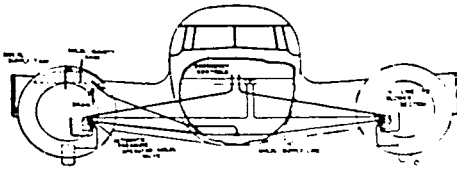
April 1, 1941

Routes	Airway miles <sup>1</sup>	Schedule (round trips)	Daily mileage <sup>2</sup>	Operator
DOMESTIC				
New York-Boston (direct).....	186	11 times daily..	4,092	American Airlines,
New York-Boston via Hartford....	186	3 times daily...	1,116	Inc.
New York-Boston via Providence .	204	7 times daily...	2,856	"
New York-Boston via Hartford and Providence.....	204	2 times daily...	816	"
New York-Boston via Hartford and Springfield....	208	2 times daily...	832	"
New York-Springfield, Mass.....	120	1 time daily...	240	"
New York-Chicago (direct).....	725	3 times daily...	4,350	"
New York-Chicago via Buffalo & Detroit.....	763	5 times daily...	7,630	"
New York-Chicago via Buffalo, Detroit & South Bend.....	763	1 time daily...	1,526	"
New York-Chicago via Buffalo, Detroit & Battle Creek.....	763	1 time daily...	1,526	"
New York-Chicago via Syracuse, Buffalo & Detroit.....	832	1 time daily...	1,664	"
New York-Detroit.....	513	1 time daily...	1,026	"
New York-Buffalo via Syracuse...	361	1 time daily...	722	"
New York-Syracuse.....	234	2 times daily...	936	"
Detroit-Chicago.....	250	2 times daily...	1,000	"
Detroit-Chicago via South Bend..	250	1 time daily...	500	"
New York-Albany.....	136	1 time daily...	272	"
Boston-Cleveland via Buffalo.....	599	1 time daily...	1,198	"
Syracuse-Buffalo.....	127	1 time daily...	254	"
New York-Washington.....	214	10 times daily..	2,140	"
New York-Los Angeles via Wash- ington, Nashville & Dallas....	2,758	3 times daily...	16,548	"
New York-Los Angeles via Nash- ville & Fort Worth.....	2,758	1 time daily...	5,516	"
New York-Fort Worth via Wash- ington & Memphis.....	1,458	1 time daily...	2,916	"
New York-Memphis via Wash- ington.....	1,003	1 time daily...	2,006	"
Washington-Chicago via Cincinnati	700	3 times daily...	4,200	"
Washington-Cincinnati.....	431	1 time daily...	862	"
Washington-Cincinnati via Elkins & Charleston, W. Va.....	431	1 time daily...	862	"
Chicago-Fort Worth via St. Louis & Oklahoma City.....	926	3 times daily...	5,556	"
Cleveland-Nashville via Cincinnati	461	2 times daily...	1,844	"
Cincinnati-Nashville.....	247	1 time daily...	494	"
Cincinnati-Louisville.....	91	1 time daily...	182	"
Chicago-Dallas via Kansas City & Wichita.....	923	3 times daily...	5,538	Braniff Airways, Inc.
Dallas-Brownsville.....	519	2 times daily...	2,076	"
Oklahoma City-Amarillo.....	243	2 times daily...	972	"
Amarillo-Galveston.....	605	2 times daily...	2,420	"
Dallas-San Antonio.....	265	1 time daily...	530	"
Dallas-Houston via Waco.....	265	1 time daily...	530	"
Dallas-Houston.....	241	1 time daily...	482	"
Dallas-Corpus Christi via San Antonio.....	390	1 time daily...	780	"
Houston-San Antonio.....	193	2 times daily...	772	"
Houston-Corpus Christi.....	185	2 times daily...	740	"
Wilmington-Avalon.....	31	3 times daily...	186	Catalina Air Trans- port
Chicago-New Orleans.....	859	3 times daily...	5,154	Chicago & Southern Airlines, Inc.

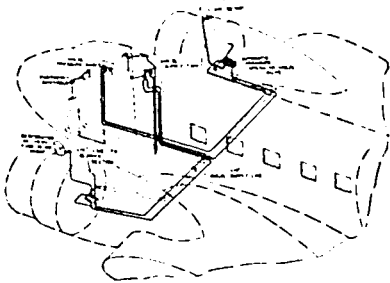


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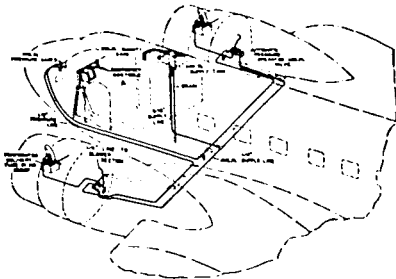
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Routes	Airway miles <sup>1</sup>	Schedule (round trips)	Daily mileage <sup>2</sup>	Operator
Memphis-Houston.....	441	1 time daily ...	882	Chicago & Southern Airlines, Inc.
Denver-El Paso.....	579	1 time daily ...	1,158	Continental Airlines, Inc.
Denver-El Paso via Roswell & Hobbs.....	812	1 time daily ...	1,624	"
Denver-Wichita via Pueblo.....	509	1 time daily ...	1,018	"
Charleston-Fort Worth via Atlanta.....	1,084	2 times daily ...	4,336	Delta Air Corporation
Atlanta-Fort Worth.....	783	1 time daily ...	1,566	"
Atlanta-Birmingham.....	134	2 times daily ...	536	"
Atlanta-Cincinnati via Knoxville.....	383	2 times daily ...	1,532	"
New York-Washington.....	214	12 times daily ...	5,136	Eastern Air Lines, Inc.
New York-Miami.....	1,204	4 times daily ...	9,032	"
New York-Miami via Orlando.....	1,213	3 times daily ...	7,278	"
Jacksonville-Miami via Daytona Beach & Orlando.....	355	1 time daily ...	710	"
Chicago-Miami via Louisville, Nashville & Atlanta.....	1,258	3 times daily ...	7,548	"
Chicago-Birmingham via Louisville & Nashville.....	631	1 time daily ...	1,262	"
St. Louis-Miami via Evansville and Nashville.....	1,134	1 time daily ...	2,268	"
New York-Atlanta.....	795	7 times daily ...	11,130	"
Atlanta-Brownsville.....	1,055	1 time daily ...	2,110	"
Atlanta-San Antonio.....	934	2 times daily ...	3,736	"
Atlanta-Houston.....	741	1 time daily ...	1,482	"
Atlanta-Tampa via Tallahassee.....	432	2 times daily ...	1,728	"
Memphis-Tampa via Birmingham & Tallahassee.....	706	1 time daily ...	1,412	"
Cheyenne-Great Falls.....	573	2 times daily ...	2,292	Inland Air Lines, Inc.
Cheyenne-Huron, South Dakota.....	559	1 time daily ...	1,118	"
Minneapolis-Huron, South Dakota.....	257	2 times daily ...	1,028	Mid-Continent Airlines, Inc.
Huron-Minot, North Dakota.....	324	1 time daily ...	648	"
Minneapolis-St. Louis via Des Moines.....	519	1 time daily ...	1,038	"
Minneapolis-Kansas City via Sioux City.....	481	1 time daily ...	962	"
Huron-Kansas City.....	423	1 time daily ...	846	"
Des Moines-Tulsa.....	389	1 time daily ...	778	"
Omaha-Tulsa.....	382	1 time daily ...	764	"
Jacksonville-St. Petersburg via Daytona Beach & Orlando.....	239	2 times daily ...	956	National Airlines, Inc.
Jacksonville-St. Petersburg via Daytona Beach & Orlando.....	239	1 time daily ...	478	"
St. Petersburg-Miami via Fort Meyers.....	200	3 times daily ...	1,200	"
Jacksonville-New Orleans.....	510	2 times daily ...	2,040	"
Boston-Bangor.....	217	3 times daily ...	1,302	Northeast Airlines, Inc.
Boston-Portland.....	96	1 time daily ...	192	"
Bangor-Caribou.....	166	1 time daily ...	332	"
Boston-Burlington, Vt.....	184	2 times daily ...	736	"
Chicago-Seattle via Milwaukee & Helena.....	1,856	1 time daily ...	3,712	Northwest Airlines, Inc.
Chicago-Seattle via Milwaukee & Butte.....	1,870	1 time daily ...	3,740	"
Chicago-Seattle via Minneapolis & Butte.....	1,832	1 time daily ...	3,664	"
Chicago-Minneapolis via Milwaukee & Rochester.....	395	1 time daily ...	790	"
Chicago-Minneapolis (direct).....	357	2 times daily ...	1,428	"
Spokane-Portland via Yakima.....	296	2 times daily ...	1,184	"
Minneapolis-Duluth.....	145	2 times daily ...	580	"
Washington-Detroit via Pittsburgh.....	402	6 times daily ...	4,824	Pennsylvania-Central Airlines
Washington-Detroit.....	402	2 times daily ...	1,608	"



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United States Air Transport Routes (April 1, 1941)—Continued

Routes	Airway miles <sup>1</sup>	Schedule (round trips)	Daily mileage <sup>2</sup>	Operator
Detroit-Milwaukee via Muskegon	260	3 times daily...	1,560	Pennsylvania-Central Airlines
Grand Rapids-Chicago	132	2 times daily...	528	
Detroit-Chicago via Grand Rapids & Flint	287	1 time daily...	574	"
Pittsburgh-Buffalo	215	2 times daily...	860	"
Washington-Buffalo	329	1 time daily...	658	"
Detroit-Sault Ste. Marie	347	1 time daily...	694	"
Cleveland-Detroit	91	1 time daily...	182	"
Knoxville-Norfolk via Raleigh	473	1 time daily...	946	"
Norfolk-Birmingham via Raleigh & Knoxville	711	1 time daily...	1,422	"
Pittsburgh-Birmingham via Knoxville	653	2 times daily...	2,612	"
Knoxville-Pittsburgh via Charleston, W. Va.	415	1 time daily...	830	"
Washington-Norfolk	145	3 times daily...	870	"
Pittsburgh-Detroit	217	1 time daily...	434	"
Washington-Pittsburgh via Baltimore	235	1 time daily...	470	"
New York-Los Angeles via Pittsburgh, St. Louis & Kansas City	2,550	2 times daily...	10,200	Transcontinental & Western Air
New York-Los Angeles via Chicago & Kansas City	2,557	1 time daily...	5,114	"
New York-Los Angeles via Pittsburgh, Kansas City & Boulder City	2,586	1 time daily...	5,172	"
New York-Kansas City via Philadelphia, Pittsburgh & Chicago	1,173	2 times daily...	4,692	"
New York-Kansas City via Pittsburgh & St. Louis	1,123	2 times daily...	4,492	"
New York-Kansas City via Chicago	1,130	2 times daily...	4,520	"
New York-Chicago via Philadelphia & Pittsburgh	768	1 time daily...	1,536	"
New York-Chicago via Philadelphia, Pittsburgh & Fort Wayne	819	2 times daily...	3,276	"
New York-Chicago via Pittsburgh	744	1 time daily...	1,488	"
New York-Chicago via Pittsburgh & Fort Wayne	795	1 time daily...	1,590	"
New York-Pittsburgh via Philadelphia	348	1 time daily...	696	"
New York-Pittsburgh (direct)	324	1 time daily...	648	"
Phoenix-San Francisco via Las Vegas and Fresno	689	1 time daily...	378	"
New York-Cincinnati via Pittsburgh and Dayton	610	2 times daily...	2,440	"
New York-Chicago via Pittsburgh	744	1 time daily...	1,488	"
Pittsburgh-Chicago (direct)	420	1 time daily...	840	"
Pittsburgh-Cincinnati via Dayton	286	1 time daily...	572	"
Detroit-St. Louis via Cincinnati	562	1 time daily...	1,124	"
Detroit-Cincinnati via Dayton	241	3 times daily...	1,446	"
Chicago-Kansas City (direct)	405	1 time daily...	810	"
New York-Oakland via Chicago & Denver	2,632	2 times daily...	10,528	United Air Lines Transport Corp.
New York-Oakland via Chicago & Cheyenne	2,609	2 times daily...	10,436	"
New York-Salt Lake via Chicago & Cheyenne	1,996	1 time daily...	3,992	"
New York-Omaha via Philadelphia & Chicago	1,235	1 time daily...	2,470	"
New York-Chicago via Cleveland	725	3 times daily...	4,350	"
New York-Chicago via Philadelphia & Allentown	806	1 time daily...	1,612	"
Chicago-Lincoln via Omaha	484	1 time daily...	968	"



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## United States Air Transport Routes (April 1, 1941) --Continued

Routes	Airway miles <sup>1</sup>	Schedule (round trips)	Daily mileage <sup>2</sup>	Operator
Denver-Salt Lake	380	1 time daily	760	United Air Lines
New York-Cleveland	418	1 time daily	836	Transport Corp.
Philadelphia-Cleveland	404	1 time daily	808	"
New York-Chicago (direct)	725	1 time daily	1,450	"
Chicago-Salt Lake via Cheyenne	1,271	1 time daily	2,542	"
Denver-Cheyenne	96	4 times daily	768	"
Salt Lake City-Seattle via Portland	814	2 times daily	3,256	"
Pendleton-Portland	168	1 time daily	376	"
Pendleton-Spokane	158	2 times daily	632	"
San Diego-Seattle via Fresno & Bakersfield & Sacramento	1,161	1 time daily	2,322	"
Los Angeles-Seattle via San Francisco (direct)	1,020	1 time daily	2,040	"
Los Angeles-Seattle via San Francisco & Sacramento	1,013	1 time daily	2,026	"
Los Angeles-Oakland via Monterey	394	2 times daily	1,556	"
Los Angeles-Oakland via Fresno	342	2 times daily	1,368	"
Los Angeles-Oakland (direct)	327	4 times daily	2,616	"
San Diego-Los Angeles	123	3 times daily	738	"
Los Angeles-Seattle via Sacramento	1,043	1 time daily	2,086	"
San Francisco-Sacramento	79	1 time daily	158	"
San Diego-Salt Lake	713	2 times daily	2,852	Western Air Express Corporation
Los Angeles-Salt Lake	590	2 times daily	2,360	"
Salt Lake-Great Falls	484	2 times daily	1,936	"
San Diego-Los Angeles	123	2 times daily	492	"
Total Domestic Routes <sup>3</sup>	41,054		334,278	
INTERNATIONAL				
New York-Montreal	320	1 time daily	658	Canadian Colonial Airways, Inc.
New York-Montreal via Burlington	333	2 times daily	1,332	"
New York-Montreal via Albany & Burlington	333	1 time daily	666	"
Bangor-Moncton, B. C.	217	2 times daily	868	Northeast Airlines
Burlington-Montreal	74	2 times daily	296	"
Fargo-Winnipeg	208	2 times daily	832	Northwest Airlines
Miami-Havana	226	1 time daily	452	Pan American Airways, Inc.
Miami-Barranquilla via Cienfuegos & Kingston	1,125	2 times weekly	643	"
Cristobal-Port of Spain	1,340	1 time daily	2,680	"
Miami-Buenos Aires via Port of Spain & Barreiras	5,690	2 times weekly	3,251	"
Miami-Buenos Aires via Antilla, San Juan, Barreiras & Asuncion	6,083	1 time weekly	1,738	"
Miami-San Juan via Antilla & Port au Prince	1,137	2 times weekly	650	"
Miami-Rio de Janeiro via Port au Prince, San Juan, St. Johns, Port of Spain, Georgetown, Cayenne, Belem and Natal	5,633	1 time weekly	1,609	"
Miami-Nassau	188	1 time daily	376	"
Brownsville-Mexico City	463	1 time daily	926	"
Brownsville-Cristobal, Canal Zone via Mexico City and Guatemala	2,142	1 time daily	4,284	"
Miami-Cristobal (direct)	1,170	3 times weekly	1,003	"
Paramaribo-Buenos Aires via Natal & Porto Alegre	4,454	2 times weekly	2,545	"
Paramaribo-Buenos Aires via Belem, Rio de Janeiro & Asuncion	4,688	1 time weekly	1,339	"
Baltimore-Bermuda	816	2 times weekly	466	"
New York-Lisbon, Portugal via Bermuda	3,896	2 times weekly	2,226	"



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## United States Air Transport Routes (April 1, 1941)—Continued

Routes	Airway miles <sup>1</sup>	Schedule (round trips)	Daily mileage <sup>2</sup>	Operator
San Francisco-Auckland, New Zealand via Los Angeles & Honolulu	7,966	2 times monthly	2,124	Pan American-Grace Airways, Inc.
Rio de Janeiro-Buenos Aires via Porto Alegre.....	1,276	1 time weekly..	364	"
Port au Prince-San Juan.....	415	2 times weekly..	237	"
Port au Prince-Maracaibo.....	543	1 time daily...	1,086	"
Miami-Havana.....	226	1 time daily...	452	"
Miami-Merida.....	748	3 times weekly..	641	"
Kingston-Port au Prince via Santiago.....	455	1 time weekly..	130	"
Cristobal-Balboa.....	35	1 time daily...	70	Panama Airways, Inc.
Cristobal-Medellin via Balboa & Turbo.....	416	3 times weekly..	357	Uraba, Medellin & Central Airways
San Francisco-Hong Kong.....	8,746	1 time weekly..	2,499	Pan American Airways, Inc.
Cristobal, Canal Zone-Buenos Aires via Santiago, Chile.....	4,418	3 times weekly..	3,787	Pan American-Grace Airways, Inc.
Cristobal-Loja via Quito & Esmeraldas.....	1,446	1 time weekly..	413	"
Arequipa-Buenos Aires via Arica La Paz & Cordoba.....	1,817	2 times weekly..	1,038	"
Quito-Guayaquil.....	166	1 time weekly..	71	"
Quito-Loja via Guayaquil.....	326	1 time weekly..	140	"
Quito-Guayaquil via Esmeraldas & Salinas.....	428	1 time weekly..	122	"
Santiago-Buenos Aires.....	871	1 time weekly..	240	"
Seattle-Vancouver, B. C.....	122	2 times daily...	488	United Air Lines Transport Corp.
Total International Routes <sup>3</sup> ..	50,052		43,120	
TERRITORIAL				
Honolulu-Hilo.....	229	1 time daily...	458	Inter-Island Airways, Ltd.
Honolulu-Lihue.....	102	1 time daily...	204	"
Honolulu-Port Allen.....	120	1 time daily...	240	"
Seattle-Juneau, Alaska.....	905	2 times weekly..	517	Pan American Airways (Pacific Alaska Airways)
Juneau-Fairbanks via Whitehorse.	660	3 times weekly..	566	"
Fairbanks-Nome via Ruby.....	528	2 times weekly..	302	"
Fairbanks-Bethel via McGrath & Flat.....	531	1 time weekly..	152	"
Total Territorial Routes <sup>3</sup> ....	2,973		2,439	
GRAND TOTAL <sup>3</sup> .....	94,079		379,837	

<sup>1</sup> Airways miles here given are airport to airport.<sup>2</sup> Plane miles scheduled to be flown, averaged on a daily basis.<sup>3</sup> Airways miles total corrected for duplications when airways are used for two or more services.

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## MONTHLY AIR CARRIER OPERATIONS

Domestic Air Lines in the U. S.

Compiled by Civil Aeronautics Administration

<i>1938</i>	<i>Miles Flown</i>	<i>Passengers</i>	<i>Passenger Miles</i>	<i>Mail<sup>1</sup> Pound-Miles</i>	<i>Express Pounds</i>
January . . . . .	4,995,333	60,435	32,461,176	1,107,694,270	456,303
February . . . . .	4,560,887	73,563	34,387,606	1,057,451,924	421,326
March . . . . .	5,540,409	94,112	43,548,986	1,278,502,116	558,113
April . . . . .	5,621,818	104,661	44,412,815	1,155,775,372	497,225
May . . . . .	6,278,025	110,293	48,812,927	1,302,524,805	499,980
June . . . . .	6,136,757	115,255	47,514,979	1,254,606,501	558,710
July . . . . .	6,270,990	127,590	59,859,047	1,199,495,168	541,346
August . . . . .	6,360,401	143,488	59,404,599	1,272,873,777	623,770
September . . . . .	6,151,147	139,297	54,805,506	1,235,017,708	777,564
October . . . . .	6,302,438	143,993	56,828,286	1,299,263,414	855,151
November . . . . .	5,776,499	113,621	46,089,543	1,251,886,341	685,389
December . . . . .	5,665,063	99,119	41,593,798	1,430,568,176	761,090
<b>Total . . . . .</b>	<b>69,668,827</b>	<b>1,343,427</b>	<b>557,719,268</b>	<b>14,845,719,671</b>	<b>7,335,967</b>
<i>1939</i>					
January . . . . .	5,453,093	89,002	38,402,960	1,243,868,119	577,982
February . . . . .	5,031,767	81,131	35,002,226	1,220,711,135	564,028
March . . . . .	6,125,164	117,971	49,445,372	1,447,382,546	685,274
April . . . . .	6,267,595	133,460	53,482,725	1,355,973,784	663,884
May . . . . .	7,122,347	162,682	63,361,491	1,434,236,026	725,061
June . . . . .	7,182,963	179,955	70,199,181	1,426,340,778	824,630
July . . . . .	7,541,305	185,643	72,917,924	1,384,713,526	725,922
August . . . . .	7,638,796	194,418	75,145,452	1,485,144,967	933,965
September . . . . .	7,441,600	192,544	75,800,149	1,420,683,215	981,461
October . . . . .	7,625,880	194,216	77,468,144	1,508,595,443	948,501
November . . . . .	7,407,864	171,557	67,031,434	1,471,926,931	844,413
December . . . . .	7,733,059	175,263	71,530,038	1,770,535,125	1,038,278
<b>Total . . . . .</b>	<b>82,571,523</b>	<b>1,876,051</b>	<b>749,787,096</b>	<b>17,170,021,595</b>	<b>9,514,299</b>
<i>1940</i>					
January . . . . .	7,271,154	150,102	61,355,485	1,534,408,814	817,633
February . . . . .	6,672,914	139,816	58,937,141	1,499,673,303	697,385
March . . . . .	7,930,038	195,062	80,686,124	1,680,965,576	894,581
April . . . . .	8,331,759	224,852	88,061,683	1,627,442,686	871,317
May . . . . .	9,266,687	258,451	100,044,047	1,682,136,183	941,810
June . . . . .	9,549,109	286,272	110,839,615	1,597,006,626	981,884
July . . . . .	10,120,569	296,539	112,376,882	1,633,813,933	1,056,599
August . . . . .	10,223,149	320,990	121,002,029	1,718,622,237	1,201,999
September . . . . .	10,084,445	310,293	118,533,626	1,680,450,000 <sup>2</sup>	1,184,249
October . . . . .	10,635,210	334,386	125,924,103	1,790,000,000 <sup>2</sup>	1,329,843
November . . . . .	9,573,378	239,858	99,097,083	1,630,000,000 <sup>2</sup>	1,205,261
December . . . . .	9,142,024	202,859	78,387,130	1,985,000,000 <sup>2</sup>	1,323,615
<b>Total . . . . .</b>	<b>108,800,436</b>	<b>2,959,480</b>	<b>1,147,444,948</b>	<b>20,059,519,358</b>	<b>12,506,176</b>

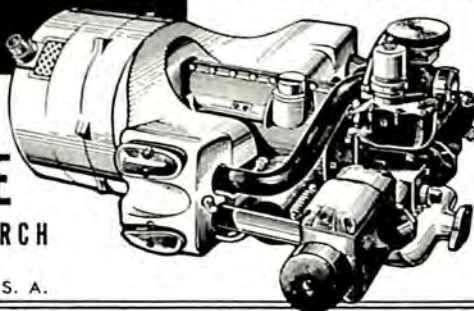
<sup>1</sup> Includes Inter Island Airways Ltd.<sup>2</sup> Estimated.

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## U. S. AIR MAIL SERVICE

From report of the Postmaster General for fiscal year 1940

Mileage and cost of service on Government-operated and private-carrier-operated domestic air mail routes and amount of annual appropriation, for the fiscal years 1918 to 1940, inclusive

<i>Fiscal Year</i>	<i>Revenue Miles Flown</i>	<i>Cost of Service</i>	<i>Average Cost per Mile</i>	<i>Appropriation</i>
Government operation:				
1918.....	16,000	\$13,604.00	\$0.850	\$100,000
1919.....	160,066	717,177.00	4.481	100,000
1920.....	549,244	1,264,495.00	2.302	850,000
1921.....	1,554,985	2,653,882.00	1.707	1,375,000
1922.....	1,537,927	1,418,146.00	.922	1,425,000
1923.....	1,590,637	1,807,151.00	1.193	1,000,000
1924.....	1,522,703	1,498,674.00	.984	1,500,000
1925.....	2,076,764	2,743,750.00	1.321	2,750,000
1926.....	2,256,137	2,782,422.00	1.233	2,885,000
1927.....	2,329,553	2,255,919.00	.968	2,650,000
1928.....	173,987	160,314.00	.956	2,150,000
Operation by private carriers:				
1926.....	396,345	89,753.71	.226	500,000
1927.....	2,805,781	1,363,227.82	.486	2,000,000
1928.....	5,585,224	4,042,777.16	.724	4,500,000
1929.....	10,212,511	11,169,015.13	1.094	12,430,000
1930.....	14,939,468	14,618,231.50	.978	15,000,000
1931.....	21,381,852	16,943,605.56	.792	18,000,000
1932.....	32,202,170	19,938,122.61	.619	20,000,000
1933.....	35,909,811	19,400,264.81	.540	19,460,000
1934.....	29,111,474	<sup>1</sup> 12,129,959.64	.417	15,000,000
1935.....	31,148,693	8,834,732.43	.284	<sup>2</sup> 12,003,291
1936.....	38,700,643	12,177,682.47	.315	12,247,500
1937.....	39,958,771	13,165,574.73	.329	13,239,000
1938.....	46,166,192	14,741,249.42	.319	14,831,403
1939.....	52,048,627	<sup>1</sup> 16,767,934.50	.322	17,240,000
1940.....	59,190,838	<sup>1</sup> 18,678,921.01	.316	19,168,200

<sup>1</sup> Subject to final adjustment.<sup>2</sup> \$3,291 of this amount was a special appropriation for the purpose of salary restoration.

Statistical report showing the total mileage of domestic air mail routes, the miles of service scheduled and actually flown, and the cost of air mail service for the fiscal years 1926-40

<i>Fiscal Year</i>	<i>Miles of Route</i>	<i>Miles of Service</i>		<i>Percentage of Performance</i>	<i>Cost of Service</i>
		<i>Scheduled</i>	<i>Actually Flown</i>		
1926.....	3,597	411,070	396,345	96.42	\$89,753.71
1927.....	5,551	3,092,016	2,805,781	90.74	1,363,227.82
1928.....	10,932	5,999,948	5,585,224	93.09	4,042,777.16
1929.....	14,406	11,032,508	10,212,511	92.57	11,169,015.13
1930.....	14,907	16,228,453	14,939,468	92.06	14,618,231.50
1931.....	23,488	22,907,169	21,381,852	93.34	16,943,605.56
1932.....	20,745	34,509,483	32,202,170	93.31	19,938,122.61
1933.....	27,679	38,114,425	35,909,811	94.22	19,400,264.81
1934.....	28,820	31,223,641	29,111,474	93.24	<sup>1</sup> 12,129,959.64
1935.....	28,884	33,770,909	31,148,693	92.24	8,834,732.43
1936.....	29,198	40,802,141	38,700,643	94.85	12,177,682.47
1937.....	29,622	42,051,957	39,958,771	95.02	13,165,574.73
1938.....	33,655	48,735,120	46,166,192	94.73	14,741,249.42
1939.....	37,080	54,150,037	52,048,627	96.12	<sup>1</sup> 16,767,934.50
1940.....	37,943	60,826,262	59,190,838	97.31	<sup>1</sup> 18,678,921.01

<sup>1</sup> Subject to final adjustment.





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Both products have been fully approved and are functioning satisfactorily on major aircraft in daily flight where they are important contributions to safety and efficiency. That Acrotorque will offer further advances and improved products in the field of Hydraulics for Aviation is assured, since its organization is constantly delving into the numerous possibilities of Hydraulic activating mechanisms. Its extensive engineering and research organization is desirous to serve and share in the progress of the aircraft industry and to render every cooperation to the program of National Defense.



★ The Acrotorque Fast Feathering Control Valve

Correspondence is invited with those who are interested in its present products as well as those desirous of making use of its extensive Hydraulic engineering and research experience.

<p>THE ACROTORQUE COMPANY          4833 Lexington Avenue Cleveland, Ohio, U. S. A.          West Coast Sales and Service Offices, 3658 Wilshire Blvd., Los Angeles, Cal. Ed. Zuehlhoff, Sales Mgr.</p>							
<p><b>ACROTORQUE</b> <i>for</i> <b>SAFETY</b></p>							
<p><b>NOW SUPPLYING</b></p> <table border="0"> <tr> <td>★ U. S. Air Corps</td> <td>★ Royal Air Force</td> </tr> <tr> <td>★ American Airlines</td> <td>★ Martin Aircraft Corp.</td> </tr> <tr> <td>★ Pan American Airways</td> <td>★ T. W. A.</td> </tr> </table>		★ U. S. Air Corps	★ Royal Air Force	★ American Airlines	★ Martin Aircraft Corp.	★ Pan American Airways	★ T. W. A.
★ U. S. Air Corps	★ Royal Air Force						
★ American Airlines	★ Martin Aircraft Corp.						
★ Pan American Airways	★ T. W. A.						

## U. S. AIR MAIL SERVICE

From report of the Postmaster General for fiscal year 1940

Statistical report showing by routes the miles of service scheduled and actually flown, pound-miles performed, and the amount paid air mail contractors for service by airplanes for the fiscal year ended June 30, 1940

Route	Present Carrier	Termini	Revenue Mail Miles Flown	Pound-Miles Performed		Payments to Carriers <sup>1</sup>	
				Total	Percent of Whole	Total	Percent of Whole
1	United Air Lines Transport Corporation..	New York-Oakland.....	6,720,208	4,681,144,134	25.07	\$2,689,567.88	14.40
11		Seattle-San Diego.....	1,965,276	692,608,281	3.71	590,304.47	3.16
12		Salt Lake City-Seattle.....	1,220,653	214,223,655	1.15	406,862.32	2.18
17		Cheyenne-Denver.....	196,106	9,434,950	.05	56,893.84	.30
		Total.....	10,102,423	5,597,411,020	29.98	3,743,628.51	20.04
2	Transcontinental & Western Air, Inc.....	New York-Los Angeles.....	6,341,361	3,074,200,266	16.47	2,415,567.25	12.933
36		Dayton-Chicago.....	171,024	36,383,648	.20	150.47	.001
37		Winslow-San Francisco.....	301,226	13,809,448	.07	268.23	.002
38		Phoenix-Las Vegas.....	184,747	2,718,898	.01	57,273.37	.307
44		Kansas City-Pittsburgh-New York.....	552,557	231,548,126	1.24	<sup>2</sup> 141,280.57	.757
		Total.....	7,550,915	3,358,759,386	17.99	2,614,539.89	14.00
3	Northwest Airlines, Inc.....	Fargo-Seattle.....	3,103,023	718,900,495	3.852	1,150,471.44	6.16
16		Chicago-Winnipeg.....	1,910,912	515,377,874	2.757	568,884.38	3.04
45		St. Paul/Minneapolis-Duluth/ Superior.....	14,790	248,675	.001	<sup>3</sup> 5,472.30	.03
		Total.....	5,028,725	1,234,527,044	6.61	1,724,828.12	9.23
4	American Airlines, Inc.....	Fort Worth-Los Angeles.....	2,887,444	1,319,452,334	7.07	865,168.11	4.63
7		New York-Chicago.....	1,996,571	1,088,339,955	5.83	783,479.69	4.20
18		Boston-New York.....	434,495	138,780,575	.74	154,984.70	.83
21		Boston-Cleveland.....	495,775	17,471,662	.09	165,249.33	.89
22		Cleveland-Nashville.....	686,910	49,791,835	.27	221,863.15	1.19
23		Albany-Fort Worth.....	4,144,359	1,397,187,752	7.00	988,692.98	5.20
25		Washington-Chicago.....	1,157,822	130,580,036	.70	332,809.14	1.78
30		Chicago-Fort Worth.....	1,189,235	299,781,790	1.61	331,274.19	1.77
			Total.....	12,992,521	4,351,385,939	23.31	3,843,521.20

**U. S. AIR MAIL SERVICE (Cont.)**

5	Eastern Air Lines, Inc.	New York-New Orleans	1,848,478	650,991,437	3.543	\$505,922.30	2.71
6	"	New York-Miami	2,470,009	1,178,573,628	6.311	665,424.13	3.56
10	"	Chicago-Jacksonville	1,341,265	323,734,068	1.732	364,281.81	1.95
20	"	New Orleans-Houston	441,548	83,772,866	.447	130,784.44	.70
40	"	Tampa-Atlanta-Memphis	504,336	39,491,240	.210	101,001.12	.54
42	"	Houston-San Antonio-Brownsville	368,287	27,482,641	.145	0	0
2001	"	Philadelphia-Camden Airport	15,432	516,144	.002	59,567.52	.32
	<b>Total</b>		<b>7,079,355</b>	<b>2,313,472,030</b>	<b>12.39</b>	<b>1,826,981.32</b>	<b>9.78</b>
9	Braniff Airways, Inc.	Chicago-Dallas	1,307,944	335,667,603	1.80	366,494.87	1.96
15	"	Amarillo-Brownsville	1,817,198	184,239,701	.90	453,066.17	2.43
	<b>Total</b>		<b>3,125,142</b>	<b>519,907,304</b>	<b>2.70</b>	<b>819,561.04</b>	<b>4.39</b>
13	Western Air Express Corporation	Salt Lake City-San Diego	1,428,272	384,144,252	2.06	529,832.54	2.84
19	"	Great Falls-Salt Lake City	700,597	49,409,330	.20	283,831.80	1.52
	<b>Total</b>		<b>2,137,869</b>	<b>433,553,582</b>	<b>2.32</b>	<b>813,664.34</b>	<b>4.36</b>
14	Pennsylvania-Central Airlines Corporation	Norfolk-Detroit	1,724,304	220,683,388	1.18	291,828.28	1.56
32	"	Detroit-Milwaukee	512,001	19,554,101	.11	144,026.11	.77
34	"	Washington-Buffalo	201,057	4,759,091	.03	51,940.96	.28
41	"	Detroit-Sault Ste. Marie	240,384	4,247,753	.02	84,273.99	.45
	<b>Total</b>		<b>2,678,346</b>	<b>249,244,303</b>	<b>1.34</b>	<b>571,169.34</b>	<b>3.06</b>
28	Inland Air Lines, Inc.	Great Falls-Cheyenne	673,946	15,364,518	.08	233,056.09	1.24
35	"	Huron-Cheyenne	344,310	13,457,277	.07	113,592.30	.61
	<b>Total</b>		<b>1,018,256</b>	<b>28,821,795</b>	<b>.15</b>	<b>346,648.39</b>	<b>1.85</b>
29	Continental Air Lines, Inc.	Denver-El Paso	905,346	38,979,171	.21	286,798.54	1.54
43	"	Wichita-Pueblo	277,153	17,439,175	.09	92,378.32	.49
	<b>Total</b>		<b>1,182,499</b>	<b>56,418,346</b>	<b>.30</b>	<b>379,176.86</b>	<b>2.03</b>
31	National Airlines Incorporated	Jacksonville-Miami	462,598	25,265,266	.13	129,491.44	.69
39	"	Jacksonville-New Orleans	371,588	27,215,607	.15	103,981.64	.56
	<b>Total</b>		<b>834,186</b>	<b>52,480,963</b>	<b>.28</b>	<b>233,473.08</b>	<b>1.25</b>

U. S. AIR MAIL SERVICE (Cont.)

Route	Present Carrier	Termini	Revenue Mail Miles Flown	Pound-Miles Performed		Payments to Carriers <sup>1</sup>	
				Total	Percent of Whole	Total	Percent of Whole
8	Chicago & Southern Air Lines, Inc.....	Chicago-New Orleans.....	1,243,652	228,217,296	1.22	\$402,861.59	2.16
24	Delta Air Corporation.....	Charleston-Fort Worth.....	1,627,491	150,003,482	.86	424,436.51	2.27
26	Mid-Continent Airlines, Inc.....	Minneapolis-Tulsa.....	1,334,932	70,802,766	.38	507,250.16	2.71
27	Boston-Maine Airways, Inc.....	Boston-Caribou-Montreal....	696,412	13,700,605	.07	245,822.90	1.32
33	Inter-Island Airways, Ltd.....	Honolulu-Hilo-Port Allen.....	179,904	4,522,022	.03	44,976.00	.24
	Total.....		5,082,391	467,486,171	2.50	1,625,347.25	8.70
1001	All American Aviation, Inc.....	Philadelphia-Pittsburgh.....	238,742	4,192,198	.02	76,397.44	.41
1002	..... "	Pittsburgh-Clarksburg- Huntington.....	139,498	3,708,259	.02	59,084.14	.32
	Total.....		378,240	7,900,457	.04	136,381.58	.73
	Grand total.....		59,190,838	18,671,367,440	100.00	18,678,921.01	100.00

<sup>1</sup> Subject to final adjustment.  
<sup>2</sup> Computed at a rate prescribed in Civil Aeronautics Board order of Sept. 19, 1940.  
<sup>3</sup> Estimated. No rate has been prescribed by the Civil Aeronautics Board.

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## U. S. FOREIGN AIR MAIL

From annual report of the Postmaster General  
For Fiscal Year 1940

Air mail service to foreign countries during fiscal year, 1940

Route	Service Scheduled	Service Performed	Compensation	Percentage of Performance
	Miles	Miles		
1. New York to Montreal <sup>1</sup> .....	450,093.0	420,823.0	\$257,890.80	95.31
5. Miami to Cristobal (via Kingston direct) .....	133,114.0	133,114.0	229,525.72	100.00
Miami to Barranquilla .....	260,437.1	260,437.1	520,874.20	100.00
Miami to Habana .....	117,936.5	117,936.5	235,873.00	100.00
Barranquilla to Cristobal .....	40,237.6	40,237.6	72,427.68	100.00
San Salvador to Cristobal .....	185,577.0	185,073.0	333,032.60	99.73
Port of Spain to Paramaribo .....	110,236.0	110,236.0	208,760.24	100.00
Barranquilla to Port of Spain .....	198,008.4	198,008.4	356,606.88	100.00
6. Miami to San Juan .....	471,404.0	470,787.0	825,612.45	99.85
San Juan to Port of Spain .....	209,903.0	200,903.0	293,800.10	100.00
7. Miami to Nassau <sup>2</sup> .....	25,944.0	25,944.0	32,430.00	100.00
8. Brownsville to Mexico City .....	339,208.8	339,208.8	610,575.84	100.00
Mexico City to San Salvador .....	166,217.7	166,214.4	299,026.20	99.99
9. Cristobal to Buenos Aires .....	1,025,844.8	1,025,498.7	1,537,846.11	99.07
10. Paramaribo to Buenos Aires .....	951,338.1	951,300.6	1,622,385.24	99.99
14. San Francisco to Hong Kong .....	869,336.8	815,283.5	2,856,020.82	93.78
15. Juneau to Whitehorse .....	17,650.5	17,593.2	27,260.42	99.68
16. Fairbanks to Whitehorse .....	51,628.5	51,593.4	41,274.72	99.93
17. New York to Hamilton, Bermuda <sup>2 3</sup> .....	81,534.0	57,610.0	125,800.00	70.66
18. New York to Marseilles/London <sup>2 4</sup> .....	392,350.0	294,568.0	1,936,780.67	75.08
20. Seattle to Juneau <sup>5</sup> .....	.....	.....	.....	.....
Total .....	<sup>a</sup> 6,107,991.6	<sup>b</sup> 5,909,372.0	<sup>c</sup> 12,424,721.69	<sup>d</sup> 96.75

<sup>1</sup> Southbound service authorized Apr. 1, 1939.

<sup>2</sup> 1 way.

<sup>3</sup> New Civil Aeronautics Board rate of pay effective Nov. 19, 1938.

<sup>4</sup> Third weekly trip effective June 18, 1940.

<sup>5</sup> Service commenced June 20, 1940—no rate of pay as yet established by Civil Aeronautics Board.

<sup>a</sup> Subject to final adjustment.

Mileage and cost of service on United States foreign air mail routes and amount of annual appropriation, for the fiscal years 1928 to 1940, inclusive

Fiscal Year	Miles Flown	Cost of Service	Average Cost per Mile	Appropriation
1928 .....	99,530.0	\$147,950.00	\$1.49	\$150,000
1929 .....	738,712.0	1,150,711.96	1.56	2,050,000
1930 .....	2,503,595.0	4,300,000.00	1.72	4,300,000
1931 .....	3,535,864.0	6,564,858.17	1.86	6,600,000
1932 .....	3,778,729.0	6,962,984.28	1.84	7,000,000
1933 .....	3,775,454.5	6,948,188.77	1.84	7,000,000
1934 .....	3,797,102.0	6,942,375.29	1.84	7,000,000
1935 .....	3,682,621.0	6,828,178.06	1.85	7,000,000
1936 .....	3,754,537.3	6,610,271.15	1.76	8,000,000
1937 .....	4,448,608.3	7,880,001.17	1.77	8,230,000
1938 .....	4,994,557.6	8,579,524.57	1.72	9,905,860
1939 .....	5,357,405.1	9,313,216.48	1.74	10,352,275
1940 .....	5,909,372.0	12,424,721.69	2.10	12,649,520

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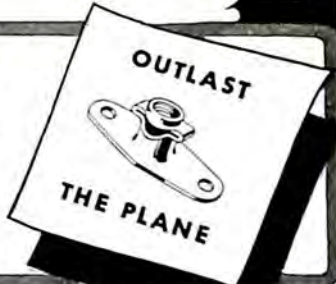
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PIONEER INSTRUMENT  
 DIVISION OF BENDIX AVIATION CORP.  
 BENDIX NEW JERSEY

## U. S. AERONAUTICAL EXPORTS

Compiled by Automotive-Aeronautics Trade Division  
U. S. Bureau of Foreign and Domestic Commerce

## Total Value for Calendar Years

<i>Country of Destination</i>	<i>1939 Value</i>	<i>1950 Value</i>
Aden.....	\$ .....	\$ 34,700
Algeria.....	99,479	4,116
Argentina.....	2,186,630	1,179,609
Australia.....	2,265,152	15,887,718
Azores & Madeira.....	18,208	23,415
Barbados.....	1,779	.....
Belgium.....	279,883	1,150,083
Belgian Congo.....	1,653	155
Bermuda.....	5,340	21,004
Bolivia.....	68,337	120,510
Brazil.....	1,924,649	3,013,606
British East Africa.....	2,300	177,784
British Guiana.....	5,389	8,274
British Honduras.....	57	.....
British India.....	77,861	272,235
British Malaya.....	56	100
British Oceania.....	3,454	.....
Bulgaria.....	9,652	.....
Burma.....	83,461	258,087
Canada.....	3,275,132	33,994,473
Ceylon.....	75	.....
Chile.....	26,396	118,627
China.....	1,071,782	11,087,467
Colombia.....	592,971	321,355
Costa Rica.....	83,579	219,204
Cuba.....	28,001	50,466
Czechoslovakia.....	135,839	.....
Denmark.....	29,403	43
Dominican Republic.....	22,662	2,968
Ecuador.....	41,038	7,062
Egypt.....	1,904	350,654
Estonia.....	44,396	.....
Finland.....	462,551	4,303,299
France.....	12,484,742	75,463,921
French Guiana.....	48	247
French Indochina.....	5,413	15
French Oceania.....	14,359	672
French West Indies.....	404	241
Germany.....	90,780	.....
Gold Coast.....	.....	57
Greece.....	180,212	48,402
Guatemala.....	20,855	31,172
Haiti, Republic of.....	449	1,575
Honduras.....	204,821	158,004
Hong Kong.....	404,003	518,185
Hungary.....	8,100	8,381
Iceland.....	4,348	9,960
Iran.....	6,699	125,253
Iraq.....	43,324	902,544
Ireland.....	245,008	161,804
Italy.....	81,286	6,712
Jamaica.....	1,265	3,164
Japan.....	2,580,565	932,809
Latvia.....	9,431	14,371
Lithuania.....	1,669	.....
Mexico.....	3,239,953	762,831
Morocco.....	.....	3,400
Mozambique.....	35,252	445,165
Netherlands.....	4,353,366	724,064
Netherlands Indies.....	6,248,675	6,128,729
Netherlands West Indies.....	37,275	331,714
Newfoundland & Labrador.....	23,264	2,384
New Zealand.....	78,627	34,305
Nicaragua.....	21,669	52,255
Norway.....	56,344	1,468,591
Other Asia.....	144	300
Other British South Africa.....	2,603	294,454
Other British West Africa.....	.....	718
Other British West Indies.....	713	882
Other French Africa.....	13,516	3,261
Other Portuguese Africa.....	8,277	6,639





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## FLYING FACTS AND FIGURES

<i>Country of Destination</i>	<i>1939 Value</i>	<i>1940 Value</i>
Palestine.....	4,463	936
Panama.....	11,578	26,105
Panama, Canal Zone.....	70,035	123,872
Paraguay.....	135	2,215
Peru.....	1,311,243	684,939
Philippine Islands.....	542,430	165,926
Poland & Danzig.....	427,760	.....
Portugal.....	75,677	962,305
Rumania.....	86,542	367,230
Salvador.....	5,020	25,054
Spain.....	59,160	1,291
Surinam.....	145	1,433
Sweden.....	477,285	5,231,384
Switzerland.....	244,943	21,259
Syria.....	.....	.....
Thailand (Siam).....	624,742	844,397
Trinidad & Tobago.....	20,869	26,858
Tunisia.....	30	.....
Turkey.....	1,176,732	2,458,860
Union of South Africa.....	171,330	4,033,849
United Kingdom.....	34,794,800	134,543,037
Uruguay.....	2,140	59,150
U. S. S. R. (Russia).....	2,904,866	270,685
Venezuela.....	445,947	504,603
Yugoslavia.....	266,812	147,743
Totals.....	\$117,081,212	\$311,757,326

## Airplanes, Seaplanes, Amphibions and Lighter-than-air Craft

<i>Country of Destination</i>	<i>No.</i>	<i>1939 Value</i>	<i>No.</i>	<i>1940 Value</i>
Algeria.....	1	\$ 93,168	.....	.....
Argentina.....	16	600,431	14	49,949
Australia.....	22	1,600,700	92	8,154,426
Barbados.....	1	1,640	.....	.....
Belgium.....	.....	.....	18	994,845
Belgian Congo.....	1	1,249	.....	.....
Bermuda.....	.....	.....	2	8,000
Bolivia.....	2	9,948	2	19,000
Brazil.....	92	1,270,147	80	1,942,800
British East Africa.....	1	2,300	.....	.....
British India.....	5	27,083	13	228,308
Canada.....	68	2,149,259	539	18,320,239
Chile.....	2	5,209	2	7,840
China.....	6	152,502	110	4,423,405
Colombia.....	8	258,436	5	26,790
Costa Rica.....	4	37,880	2	80,000
Cuba.....	.....	.....	2	6,217
Czechoslovakia.....	1	115,500	.....	.....
Ecuador.....	1	16,000	.....	.....
Egypt.....	1	1,600	1	17,419
Finland.....	3	14,550	46	2,571,776
France.....	444	29,370,567	750	53,400,797
Guatemala.....	.....	.....	1	21,500
Honduras.....	4	175,000	3	130,000
Hong Kong.....	1	120,000	6	305,530
Iceland.....	.....	.....	1	8,653
Iran (Persia).....	.....	.....	25	108,395
Iraq.....	1	40,000	15	868,704
Ireland.....	2	210,434	1	116,823
Japan.....	1	32,000	.....	.....
Mexico.....	66	2,253,050	62	616,873
Mozambique.....	.....	.....	4	283,400
Netherlands.....	26	1,919,332	.....	.....
Netherlands Indies.....	66	4,753,010	101	3,928,205
Netherlands West Indies.....	.....	.....	4	213,695
New Zealand.....	3	4,500	.....	.....
Nicaragua.....	2	21,086	1	40,888
Norway.....	1	.....	24	1,299,321
Other British South Africa.....	1	1,900	.....	.....
Other Portuguese Africa.....	4	5,391	1	3,200
Palestine.....	2	3,052	.....	.....
Panama.....	1	4,100	1	17,448
Panama, Canal Zone.....	.....	.....	2	2,744
Peru.....	22	989,065	8	387,481
Philippine Islands.....	23	406,954	1	55,600

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Country of Destination	1930		1940	
	No.	Value	No.	Value
Poland & Danzig.....	4	365,705	...	...
Portugal.....	6	8,810	13	816,183
Salvador.....	...	...	3	19,900
Sweden.....	2	5,992	67	3,667,988
Switzerland.....	2	120,500	1	8,350
Thailand (Siam).....	1	5,500	21	535,381
Turkey.....	7	168,495	49	1,234,494
Union of South Africa.....	30	58,713	34	3,009,658
United Kingdom.....	241	16,572,570	1,376	88,020,839
Uruguay.....	...	...	13	57,767
U. S. S. R. (Russia).....	13	1,959,449	...	...
Venezuela.....	7	272,053	15	257,741
Yugoslavia.....	3	182,036	1	63,743
Totals.....	1,220	\$66,386,866	3,532	\$196,352,315

## Aircraft Engines

Country of Destination	1930		1940	
	No.	Value	No.	Value
Argentina.....	31	\$ 332,352	37	\$ 290,695
Australia.....	18	155,406	205	2,791,122
Azores & Madeira Islands.....	...	...	1	14,000
Belgium.....	8	86,400	13	82,496
Bermuda.....	1	3,000	...	...
Bolivia.....	4	27,200	7	50,641
Brazil.....	76	191,873	90	327,413
British Guiana.....	2	5,000	1	2,500
British India.....	2	3,516	1	1,318
Burma.....	...	...	28	33,350
Canada.....	83	194,616	1,042	5,339,813
Chile.....	2	12,000	17	60,616
China.....	55	567,175	254	2,991,352
Colombia.....	28	89,165	15	35,873
Costa Rica.....	34	26,440	17	25,490
Cuba.....	1	1,000	2	2,000
Czechoslovakia.....	2	12,840	...	...
Denmark.....	9	5,500	...	...
Dominican Republic.....	2	11,100	...	...
Ecuador.....	1	1,950	...	...
Egypt.....	...	...	9	16,470
Finland.....	34	216,089	109	1,148,144
France.....	563	5,734,572	1,136	11,918,944
French Oceania.....	1	14,000	...	...
Germany.....	5	17,567	...	...
Greece.....	4	2,200	...	...
Guatemala.....	2	7,564	...	...
Honduras.....	1	2,500	...	...
Hong Kong.....	...	...	5	42,560
Iceland.....	1	3,670	...	...
Ireland.....	2	29,298	2	25,000
Italy.....	1	13,900	...	...
Latvia.....	...	...	8	14,371
Mexico.....	73	557,386	44	39,960
Mozambique.....	2	13,670	6	55,710
Netherlands.....	161	1,213,657	34	256,462
Netherlands Indies.....	28	262,307	43	345,080
Netherlands West Indies.....	3	19,726	10	56,000
Newfoundland & Labrador.....	1	14,500	...	...
New Zealand.....	2	19,300	2	16,540
Nicaragua.....	...	...	1	870
Norway.....	9	18,400	10	51,919
Other Portuguese Africa.....	1	1,471	...	...
Palestine.....	1	404	1	412
Panama.....	3	3,400	2	1,380
Panama, Canal Zone.....	5	12,000	6	34,182
Peru.....	9	66,459	7	78,959
Philippine Islands.....	3	18,684	5	23,264
Portugal.....	2	14,475	5	33,125
Rumania.....	2	13,050	...	...
Salvador.....	1	850	...	...
Sweden.....	14	32,220	32	250,973
Switzerland.....	2	20,200	...	...
Thailand (Siam).....	47	346,200	30	193,120
Trinidad & Tobago.....	8	11,500	4	6,000
Turkey.....	...	...	12	70,344
Union of South Africa.....	1	3,600	29	333,355
United Kingdom.....	491	3,432,345	1,659	22,450,206



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<i>Country of Destination</i>	No.	1930 Value	No.	1940 Value
Uruguay.....			1	413
U. S. S. R. (Russia).....	19	176,536	16	230,628
Venezuela.....	19	79,802	23	99,673
Yugoslavia.....			5	31,080
Totals.....	1,880	\$14,120,035	4,986	\$49,873,823

## Parachutes and Parts

<i>Country of Destination</i>	1930 Value	1940 Value
Argentina.....	\$ 75,260	\$ 40,164
Australia.....		50,000
Azores & Madeira Islands.....	50	
Belgium.....	62,650	50,000
Bolivia.....	180	
Brazil.....	36,725	26,239
British India.....		220
Canada.....	6,993	396,606
Colombia.....		999
Cuba.....		100
Denmark.....	3,853	
France.....		740
Greece.....	161,237	8,785
Guatemala.....	3,050	
Mexico.....	41,860	275
Netherlands.....	5,095	89,035
Netherlands Indies.....	55,061	142,307
Netherlands West Indies.....		1,012
Norway.....	13,233	25,705
Palestine.....	120	
Peru.....	225	30,350
Philippine Islands.....	1,393	6,208
Portugal.....		23,800
Rumania.....	21,702	16,576
Salvador.....		19
Spain.....	59,160	
Sweden.....	27,087	115,417
Thailand (Siam).....	191	170
Trinidad & Tobago.....	215	
Turkey.....	191,535	43,750
United Kingdom.....	4,739	302
Venezuela.....	3,775	
Totals.....	\$775,389	\$1,068,779

## Aircraft Parts, Instruments and Accessories (Except Tires)

<i>Country of Destination</i>	Total 1930 Value	Total 1940 Value	Engine Parts, Propellers and Parts, Accessories	Instruments and Parts	Parts and Accessories N. E. S.
Aden.....	\$ .....	\$ 34,700	\$ .....	\$ .....	\$ 34,700
Algeria.....	6,311	4,116	2,153	1,325	638
Argentina.....	1,178,587	798,801	304,728	70,551	423,522
Australia.....	509,046	4,892,170	3,562,670	440,565	888,935
Azores and Madeira Islands.....	18,158	9,415	6,284	1,432	1,699
Barbados.....	139				
Belgium.....	130,833	22,742	9,006	5,522	8,214
Belgian Congo.....	404	155	155		
Bermuda.....	2,340	13,004	3,903	445	8,656
Bolivia.....	31,009	50,869	36,228		14,641
Brazil.....	425,904	717,154	227,775	73,283	416,096
British East Africa.....		177,784	58,800		118,984
British Guiana.....	389	5,774	246		5,528
British Honduras.....	57				
British India.....	47,262	42,389	22,124	9,790	10,475
British Malaya.....	56	100	100		
British Oceania.....	3,454				
Bulgaria.....	9,652				
Burma.....	83,461	224,737	70,834	47,502	106,401
Canada.....	924,264	9,937,815	3,604,650	1,840,380	4,492,785
Ceylon.....	75				
Chile.....	9,187	50,171	31,591	2,530	16,050
China.....	352,105	3,672,710	1,375,603	266,408	2,030,699
Colombia.....	245,370	257,693	164,032	31,148	62,513
Costa Rica.....	19,259	113,714	52,240	220	61,254

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<i>Country of Destination</i>	<i>Total 1930 Value</i>	<i>Total 1930 Value</i>	<i>Engine Parts, Propellers and Parts, Accessories</i>	<i>Instruments and Parts</i>	<i>Parts and Accessories N. E. S.</i>
Cuba.....	27,001	42,149	14,447	201	27,501
Czechoslovakia.....	7,499	.....	.....	.....	.....
Denmark.....	20,050	43	43	.....	.....
Dominican Republic.....	11,562	2,968	646	64	2,258
Ecuador.....	23,088	7,062	3,466	25	3,571
Egypt.....	304	316,765	119,514	.....	197,251
Estonia.....	44,396	.....	.....	.....	.....
Finland.....	231,912	583,379	264,863	48,002	270,514
France.....	7,379,603	10,143,440	6,013,065	547,343	3,583,032
French Guiana.....	48	247	247	.....	.....
French Indochina.....	5,413	15	15	.....	.....
French Oceania.....	359	672	157	.....	515
French West Indies.....	404	241	224	15	2
Germany.....	73,213	.....	.....	.....	.....
Greece.....	16,775	39,617	1,554	.....	38,063
Gold Coast.....	.....	57	.....	.....	57
Guatemala.....	10,241	9,672	7,021	50	2,601
Haiti, Republic of.....	449	1,575	695	250	630
Honduras.....	27,321	28,004	15,887	812	11,305
Hong Kong.....	284,003	170,095	12,191	1,061	156,843
Hungary.....	8,100	8,381	.....	8,381	.....
Iceland.....	678	1,307	710	193	404
Iran.....	6,699	16,858	14,868	168	1,822
Iraq.....	3,324	33,840	2,700	25,590	5,550
Ireland.....	5,276	19,981	3,373	638	15,970
Italy.....	67,386	6,712	6,167	445	100
Jamaica.....	1,265	3,164	164	95	2,905
Japan.....	2,548,565	932,809	320,523	188,939	423,347
Latvia.....	9,431	.....	.....	.....	.....
Lithuania.....	1,669	.....	.....	.....	.....
Mexico.....	387,657	105,723	44,907	21,450	39,366
Morocco.....	.....	3,400	.....	.....	3,400
Mozambique.....	21,582	106,055	68,787	1,560	35,708
Netherlands.....	1,215,282	378,567	269,365	42,958	66,244
Netherlands Indies.....	1,178,297	1,713,137	782,999	170,962	759,176
Netherlands West Indies.....	17,549	61,007	39,842	3,557	17,608
Newfoundland and Labrador.....	8,764	2,384	280	.....	2,104
New Zealand.....	54,827	17,765	9,640	648	7,477
Nicaragua.....	583	10,497	4,430	.....	6,067
Norway.....	24,711	91,646	40,173	9,876	41,597
Other Asia.....	144	300	300	.....	.....
Other British South Africa.....	703	294,454	34,493	14,974	244,987
Other British West Africa.....	.....	718	.....	.....	718
Other British West Indies.....	713	882	551	20	311
Other French Africa.....	13,516	3,261	78	.....	3,183
Other Portuguese Africa.....	1,415	3,439	2,071	148	1,220
Palestine.....	887	524	279	.....	245
Panama.....	4,078	7,277	5,637	107	1,533
Panama, Canal Zone.....	58,035	86,946	30,899	11,345	44,702
Paraguay.....	135	2,215	.....	.....	2,215
Peru.....	255,494	188,149	129,016	9,121	50,012
Philippine Islands.....	115,399	80,854	54,952	3,177	22,725
Poland and Danzig.....	62,055	.....	.....	.....	.....
Portugal.....	52,392	89,197	36,319	3,904	48,974
Rumania.....	51,790	350,654	6,961	1,722	341,971
Salvador.....	4,170	5,135	3,599	60	1,476
Spain.....	.....	1,291	495	149	647
Surinam.....	145	1,433	224	.....	1,209
Sweden.....	411,986	1,197,006	493,073	101,185	602,748
Switzerland.....	104,243	12,909	11,940	36	933
Syria.....	.....	.....	.....	.....	.....
Thailand (Siam).....	272,851	115,726	41,876	815	73,035
Trinidad and Tobago.....	9,154	20,858	6,774	613	13,471
Tunisia.....	30	.....	.....	.....	.....
Turkey.....	816,702	1,110,272	304,819	53,816	751,637
Union of South Africa.....	109,017	690,836	442,202	120,099	128,535
United Kingdom.....	14,785,146	24,071,690	10,382,209	3,085,352	10,604,129
Uruguay.....	2,140	970	644	.....	326
U. S. S. R. (Russia).....	768,881	40,057	16,958	21,781	1,318
Venezuela.....	90,317	147,189	69,468	1,085	76,636
Yugoslavia.....	84,776	52,920	19,707	9,493	23,720
Totals.....	\$35,798,922	\$64,462,409	\$29,691,629	\$7,303,386	\$27,467,394





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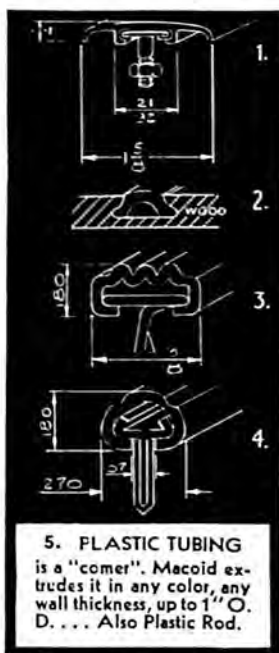
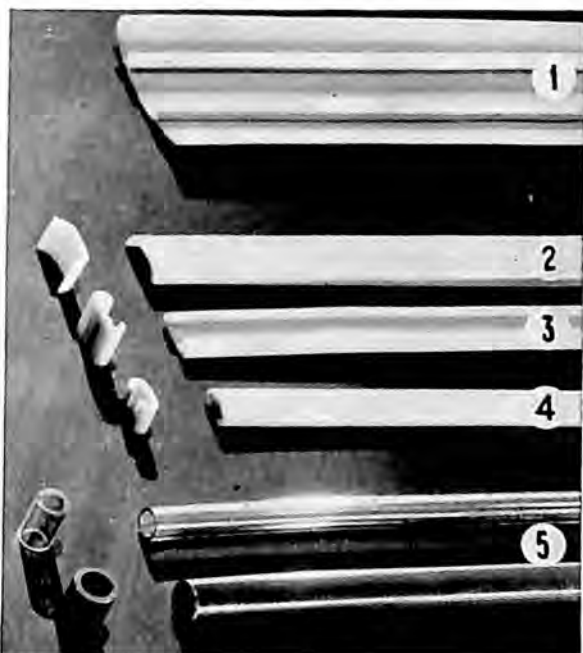
## NON-MILITARY AIRCRAFT IN THE UNITED STATES

January 1, 1941

Compiled by Civil Aeronautics Administration

State	Certificated Aircraft				
	Jan. 1, 1941	Jan. 1, 1940	Percent In- crease	Jan. 1, 1939	Jan. 1, 1938
Alabama.....	119	88	35.2	60	61
Arizona.....	103	79	30.4	64	56
Arkansas.....	149	75	98.7	47	47
California.....	1,753	1,431	22.5	1,107	1,110
Colorado.....	169	136	24.3	92	72
Connecticut.....	198	158	25.3	149	153
Delaware.....	89	62	43.5	54	38
District of Columbia.....	214	149	43.6	117	97
Florida.....	389	293	32.8	234	196
Georgia.....	241	155	55.5	136	98
Idaho.....	92	63	46.0	51	52
Illinois.....	992	874	13.5	663	604
Indiana.....	519	410	26.6	314	257
Iowa.....	381	245	55.5	184	160
Kansas.....	382	205	86.3	164	145
Kentucky.....	118	89	32.6	63	63
Louisiana.....	208	134	55.2	109	92
Maine.....	134	113	18.6	98	83
Maryland.....	230	157	46.5	122	110
Massachusetts.....	406	322	26.1	264	221
Michigan.....	723	559	29.3	428	433
Minnesota.....	401	275	45.8	194	180
Mississippi.....	116	111	4.5	94	97
Missouri.....	505	331	52.6	239	206
Montana.....	130	76	71.1	55	54
Nebraska.....	166	152	9.2	119	105
Nevada.....	50	28	78.6	30	26
New Hampshire.....	58	48	20.8	39	36
New Jersey.....	496	388	27.8	273	268
New Mexico.....	76	37	105.4	31	30
New York.....	1,323	1,091	21.3	932	921
North Carolina.....	352	231	52.4	166	125
North Dakota.....	102	68	50.0	48	46
Ohio.....	899	748	20.2	556	544
Oklahoma.....	362	243	49.0	198	185
Oregon.....	210	149	40.9	111	116
Pennsylvania.....	1,438	958	50.1	732	622
Rhode Island.....	135	97	39.2	64	56
South Carolina.....	160	102	56.9	68	47
South Dakota.....	87	71	22.5	62	66
Tennessee.....	226	157	43.9	126	101
Texas.....	980	612	60.1	504	422
Utah.....	81	44	84.1	36	31
Vermont.....	59	39	51.3	34	33
Virginia.....	269	181	48.6	116	112
Washington.....	296	221	33.9	184	166
West Virginia.....	146	130	12.3	86	76
Wisconsin.....	347	256	35.5	204	166
Wyoming.....	64	46	39.1	36	32
Alaska.....	149	94	58.5	96	97
Canada <sup>1</sup> .....	1	1	—	1	1
Canal Zone.....	0	1	—	0	0
Hawaiian Islands.....	31	24	29.2	24	24
Mexico <sup>1</sup> .....	1	0	—	0	0
Philippine Islands <sup>2</sup> .....	0	0	—	2	0
Puerto Rico.....	21	17	23.5	6	9
Foreign, Miscellaneous.....	5	5	—	14	4
Totals.....	17,351	12,829	35.2	10,000	9,152

<sup>1</sup> Figures for these countries are for aircraft and pilots registered by the United States.<sup>2</sup> Civil aircraft in the Philippine Islands are now registered with the local Government.



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## LICENSED PILOTS IN THE UNITED STATES

January 1, 1941

Compiled by Civil Aeronautics Administration

State	Certificated Pilots				
	Jan. 1, 1941	Jan. 1, 1940	Percent In- crease	Jan. 1, 1930	Jan. 1, 1938
Alabama	661	210	214.8	160	121
Arizona	451	183	146.4	125	95
Arkansas	603	124	386.3	110	88
California	8,285	5,193	59.5	4,207	3,373
Colorado	960	355	170.4	222	130
Connecticut	592	417	42.0	350	268
Delaware	205	82	150.0	64	44
District of Columbia	560	362	54.7	308	243
Florida	1,462	748	95.6	580	508
Georgia	1,072	435	146.4	215	181
Idaho	523	185	182.7	128	70
Illinois	3,033	1,817	66.9	1,353	1,071
Indiana	1,416	909	55.8	585	433
Iowa	1,261	598	110.9	384	217
Kansas	1,326	430	208.4	281	196
Kentucky	375	181	107.2	117	99
Louisiana	1,000	321	211.5	253	195
Maine	330	184	79.3	125	95
Maryland	758	408	85.8	280	189
Massachusetts	1,728	1,062	62.7	781	474
Michigan	2,208	1,203	83.5	935	761
Minnesota	1,053	544	93.6	353	266
Mississippi	468	141	231.9	107	86
Missouri	2,075	738	181.2	525	411
Montana	544	159	242.1	114	100
Nebraska	879	294	199.0	176	140
Nevada	174	57	205.3	34	28
New Hampshire	280	129	117.1	85	55
New Jersey	1,630	976	67.0	762	638
New Mexico	364	69	427.5	66	42
New York	4,863	2,636	84.5	2,091	1,661
North Carolina	757	518	46.1	222	139
North Dakota	385	103	273.8	72	55
Ohio	2,654	1,471	80.4	1,128	893
Oklahoma	1,448	429	237.5	290	248
Oregon	921	409	125.2	259	206
Pennsylvania	3,452	1,882	83.4	1,335	968
Rhode Island	209	109	91.7	71	46
South Carolina	627	208	201.4	103	72
South Dakota	442	136	225.0	106	72
Tennessee	1,086	417	160.4	285	224
Texas	3,918	1,384	183.1	1,002	827
Utah	545	152	258.6	126	77
Vermont	207	92	125.0	75	45
Virginia	1,018	552	84.4	412	280
Washington	1,709	875	95.3	525	413
West Virginia	721	271	166.1	183	125
Wisconsin	929	467	98.9	334	242
Wyoming	238	113	110.6	90	72
Alaska	184	125	47.2	95	85
Canada	44	35	25.7	29	27
Canal Zone	37	37	—	51	39
Hawaiian Islands	254	157	61.8	146	102
Mexico	8	6	33.3	6	4
Philippine Islands	21	21	—	24	25
Puerto Rico	45	16	181.3	126	11
Foreign, Miscellaneous	115	129	-10.9	12	106
Totals	63,113 <sup>1</sup>	31,264 <sup>2</sup>	101.9	22,983	17,681

<sup>1</sup> Includes 2,145 women pilots divided as follows: 113 commercial, 27 limited commercial, 1,803 private, and 202 solo.

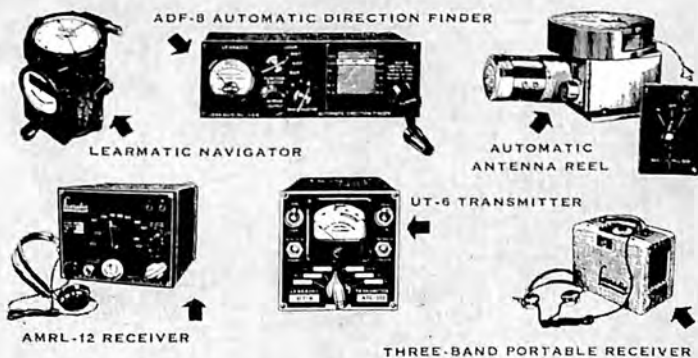
<sup>2</sup> Includes 902 women pilots divided as follows: 86 commercial, 30 limited commercial, 476 private, and 311 solo.



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## AIRPORTS AND LANDING FIELDS

January 1, 1941

Compiled by Civil Aeronautics Administration

State	Municipal	Commercial	Intermediate	Auxiliary	Navy	Army	Private	Miscellaneous Government (USFS & CG)	Totals	Partially or Fully Lighted
Alabama.....	11	2	6	8	0	3	4	0	34	13
Alaska.....	1	8	0	118	0	0	2	0	120	2
Arizona.....	9	7	11	16	0	1	0	0	44	17
Arkansas.....	10	3	4	5	0	0	3	0	25	8
California.....	49	40	17	26	4	6	20	3	174	62
Colorado.....	28	2	3	0	0	1	2	0	36	9
Connecticut.....	8	5	1	3	0	0	0	0	17	8
Delaware.....	1	4	0	0	0	1	1	0	7	3
District of Columbia..	0	1	0	0	1	1	0	0	3	3
Florida.....	44	11	7	52	3	3	2	0	122	35
Georgia.....	22	6	11	14	0	2	0	0	55	22
Idaho.....	16	0	7	13	0	0	3	7	46	12
Illinois.....	15	33	6	2	0	3	7	0	66	28
Indiana.....	14	21	6	5	0	2	3	0	51	18
Iowa.....	20	9	3	0	0	0	2	0	34	11
Kansas.....	22	7	4	0	0	2	1	0	36	14
Kentucky.....	6	1	3	5	0	1	3	0	19	4
Louisiana.....	14	2	4	2	0	1	3	0	26	12
Maine.....	13	3	0	2	0	0	0	0	18	5
Maryland.....	2	12	1	1	0	2	2	0	20	10
Massachusetts.....	6	26	1	4	1	1	1	0	40	12
Michigan.....	61	10	0	28	1	3	10	3	116	21
Minnesota.....	16	5	3	2	0	1	1	0	28	12
Mississippi.....	16	1	7	7	0	0	1	0	32	15
Missouri.....	12	7	12	0	1	1	4	0	37	19
Montana.....	20	1	15	24	0	0	2	8	70	22
Nebraska.....	31	1	5	0	0	3	3	0	43	16
Nevada.....	2	3	8	8	0	0	0	0	21	12
New Hampshire.....	8	3	0	1	0	0	0	0	12	4
New Jersey.....	5	15	0	1	2	1	3	1	28	7
New Mexico.....	8	6	13	7	0	0	3	0	37	18
New York.....	25	39	6	4	0	5	13	0	92	30
North Carolina.....	16	11	2	2	0	1	1	1	34	11
North Dakota.....	8	4	9	13	0	0	0	0	34	11
Ohio.....	27	41	11	13	0	3	9	1	105	27
Oklahoma.....	18	5	7	8	0	1	2	0	41	20
Oregon.....	12	3	6	7	0	0	2	0	30	14
Pennsylvania.....	31	56	6	8	1	1	4	0	107	35
Rhode Island.....	1	3	0	1	0	0	0	0	5	1
South Carolina.....	12	2	4	7	2	0	2	0	29	9
South Dakota.....	15	2	1	3	0	0	1	0	22	4
Tennessee.....	8	1	8	4	0	0	0	0	21	13
Texas.....	45	16	31	38	0	10	6	0	146	56
Utah.....	2	1	11	7	0	0	0	0	21	15
Vermont.....	6	3	0	1	0	1	0	0	11	1
Virginia.....	14	15	7	4	4	2	3	0	49	17
Washington.....	17	4	6	15	1	4	1	3	51	17
West Virginia.....	11	7	2	5	0	1	1	0	27	7
Wisconsin.....	18	18	3	6	0	1	1	0	47	18
Wyoming.....	12	1	11	7	0	0	2	0	33	16
Totals.....	788	496	289	507	21	69	134	27	2,331	776



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*Tipp City, Ohio*

## AVIATION GASOLINE TAX SUMMARY

April 1, 1941

Compiled by American Petroleum Institute

States	State Taxes		Refunds		Exemption on Aircraft Fuel	Disposition of Fund
	Tax Per Gal. on Motor Fuel	Tax Per Gal. on Fuel Used for Aviation	State Laws Providing for Refund in Certain Cases	Refunds Applying to Aircraft Fuel		
Alabama.....	6	6				Highway purposes
Arizona.....	5		x			*
Arkansas.....	6½				x	
California.....	3		x			
Colorado.....	4		x	x		
Connecticut.....	3		x			
Delaware.....	4		x	x		
District of Columbia.....	2		x	x		
Florida.....	7				x	*
Georgia.....	6	6				2/3 State Highway 1/6 County Rds. 1/6 Education For Aeronautics Fund*
Idaho.....	5	2½				
Illinois.....	3		x	x		
Indiana.....	4		x	x		
Iowa.....	3		x	x		
Kansas.....	3				x	*
Kentucky.....	5	5				Highway purposes
Louisiana.....	7	7				Highway purposes
Maine.....	4	1		3		*
Maryland.....	4		x	x	x	
Massachusetts.....	3		x			
Michigan.....	3	1½		1¼		For Aeronautics Fund*
Minnesota.....	4		x			
Mississippi.....	6	1	5	x	5	The 1 cent is used for highways*
Missouri.....	2		x			
Montana.....	5		x	x		
Nebraska.....	5	5				20% to State Asst. Fund, 80% to Aviation Fund*
Nevada.....	4		x			
New Hampshire.....	4		x			
New Jersey.....	3		x	x		
New Mexico.....	5		x	x		*
New York.....	4		x			
North Carolina.....	6		x	x	x	*
North Dakota.....	4		x	x		
Ohio.....	4	1	x	3		*
Oklahoma.....	4				x	
Oregon.....	5	1	x	4		For State Board of Aeronautics*
Pennsylvania.....	4	4				*
Rhode Island.....	3		x			
South Carolina.....	6	6				For State Aviation Funds*
South Dakota.....	4					*
Tennessee.....	7	7				*
Texas.....	4		x	x		*
Utah.....	4	4				For State Aeronautics Fund*
Vermont.....	4	4				*
Virginia.....	5	3	x	2		*
Washington.....	5		x			
West Virginia.....	5		x	x		*
Wisconsin.....	4		x	x		
Wyoming.....	4	2	x	2		*

\* See following notes accompanying name of State.



## NOTES ON GASOLINE TAX SUMMARY

- ARKANSAS—Aircraft fuel having a rating of not less than 80 octane is not taxed. Regular gasoline when used in airplanes is taxed 6½ cents per gallon and the funds are used for highway purposes.
- FLORIDA—Aviation fuel testing 78 octane or higher is not taxed.
- IDAHO—Airplane or air transport carriers importing gasoline into State for use in its airplane were not within statute taxing use of such fuels. For purposes of State Aeronautics Funds. L. 1933, C. 40, Sec. 12.
- KANSAS—Exemption on aircraft fuel applies on purchase of forty gallons or more.
- MAINE—¾ used for highway purposes. If consumer fails to apply for the ¾ allowable refund within 9 months, then the ¾ of the tax shall be added to the aeronautical fund. ¼ of the 1¢ tax for aeronautical purposes shall be allocated to aeronautical fund. L. 1931, C 283.
- MICHIGAN—A refund of 1½¢ per gallon is made to air line operators operating interstate on schedule operations. All money received from aviation gasoline taxes paid into State Treasury and credited to Aeronautics Fund.
- MISSISSIPPI—¾ used for highway purposes. Licensed airports selling gasoline to crafts engaged in interstate flights entitled to exemption of 5¢ per gallon of the tax paid by licensed airport operator.
- NEBRASKA—For aviation purposes. Available information indicates that all the motor fuel sold for aircraft is used for aviation purpose. Tax on aircraft fuel used by flying schools refunded.
- NEW MEXICO—Refund where amount purchased at one time is at least 50 gallons.
- NORTH CAROLINA—Aviation gasoline is sold tax free. If ordinary gasoline is used in aircraft a refund of 5¢ per gallon will be made if purchase is in quantities of 10 gallons or more at one time. The 1¢ is used for highway purposes.
- OHIO—Refund of 3¢; 1¢ not refundable but used to defray expenses of administering the provisions of Sec. 5542-1 to 5542-18c both incl. of the General Code.
- OREGON—Refund ¼; remaining ¼ for use of State Board of Aeronautics.
- PENNSYLVANIA—No special appropriation of gasoline tax for aircraft. No money appropriated for aeronautics since 1931. Board of Property in the Dept. of Internal Affairs takes care of airports.
- SOUTH CAROLINA—All taxes on aviation fuel credited to State Aviation Fund for development, advancement, upkeep and promotion of aviation as Aeronautics Commission directs. Apportionment allocated to each airport is in an amount as nearly the same as possible as tax collections at each airport.
- SOUTH DAKOTA—No refund on gasoline used for aircraft but such tax is allocated each month to State Aeronautics Fund. From time to time State Aeronautics Commission allocates to each airport its proportionate share for maintenance.
- TENNESSEE—The 7¢ used exclusively for aviation purposes; ½ to Bureau of Aeronautics and ½ to development of airports. Law of 1939, Ch. 105 provides that any money allocated to the Bureau of Aeronautics out of the proceeds of gasoline tax in excess of any appropriations made to Dept. of Highways and Public Works shall be covered into the general fund.
- TEXAS—Law 1939 Texas Statute 7065 provides for entire refund but still charges \$1.00 filing fee for refund claims as expense for furnishing forms.
- UTAH—Ch. 66 Laws 1939 provides that ¾ shall be expended on the airport where gasoline is sold; ¼ to be spent for maintenance, etc. as commission may determine.
- VERMONT—Law 1939 Appropriation No. 125 p. 156 provides that \$2,000 is appropriated annually for aeronautical purposes.
- VIRGINIA—1. Intrastate operators—Tax of 3¢ per gallon imposed by reduction from refunds.  
2. Interstate operators—Tax of 3¢ per gallon on gasoline purchased for use and used by interstate operators in intrastate operations and within the borders of the state, the amount of tax to be based on the flight logs of each trip and average consumption of gasoline per hour per month.
- WEST VIRGINIA—Ch. 125 Laws 1939—Refunds on quantities of 25 gallons or more when used in aircraft.
- WYOMING—2¢ per gallon refund on purchases in excess of 10,000 gallons per month, Law of 1935. Funds paid to city, town or county where air field is located (and from which tax was collected) for maintenance of such air field.

## PRODUCTION OF U. S. CIVIL AIRCRAFT

(Calendar Years)

Compiled by U. S. Civil Aeronautics Administration

## Production by Types

	1940	1939	Percent of Increase or Decrease
Landplanes:			
1-2 place:			
Single engine.....	5542	3114	+77.97
Multi-engine.....	2	4	-50.00
3-5 place:			
Single engine.....	978	456	+114.47
Multi-engine.....	16	9	+77.78
6-17 place:			
Multi-engine.....	29	21	+38.09
21 place and over:			
Multi-engine.....	118	55	+114.55
Seaplanes:			
Single engine.....	17	43	-60.47
Multi-engine.....	0	8	-100.00
Amphibians:			
Single engine.....	1	0	—
Multi-engine.....	1	5	-80.00
Total single engine.....	6538	3613	+80.96
Total multi-engine.....	166	102	+62.75
Unclassified.....	44	0	—
Grand Total.....	6748	3715	+81.64

## Production by Engine Horsepower

50 H.P. and under:			
Single engine.....	335	1684	-80.11
Multi-engine.....	1	2	-50.00
51-70 H.P.			
Single engine.....	4569	1349	+238.70
Multi-engine.....	0	0	—
71-100 H.P.			
Single engine.....	1043	311	+235.37
Multi-engine.....	0	0	—
101-165 H.P.			
Single engine.....	180	119	+51.26
Multi-engine.....	0	1	-100.00
166-225 H.P.			
Single engine.....	313	8	+3812.50
Multi-engine.....	15	1	+1400.00
226-300 H.P.			
Single engine.....	36	82	-56.10
Multi-engine.....	0	4	-100.00
301-600 H.P.			
Single engine.....	61	54	+12.96
Multi-engine.....	14	22	-36.36
601-1800 H.P.			
Single engine.....	1	6	-83.33
Multi-engine.....	136	72	+88.89
Total single engine.....	6538	3613	+80.96
Total multi-engine.....	166	102	+62.75
Unclassified.....	44	0	—
Grand Total.....	6748	3715	+81.64

## Production by Weight and Engine Classification

Class I (not more than 1,300 lbs.).....	4455	3029	+47.08
Class IIS (1,300-4,000 lbs. single engine).....	2017	526	+283.46
Class IIM (1,300-4,000 lbs. multi-engine).....	2	3	-33.33
Class IIIS (4,000-10,000 lbs. single engine).....	66	56	+17.86
Class IIIM (4,000-10,000 lbs. multi-engine).....	28	26	+7.69
Class IVS (10,000-25,000 lbs. single engine).....	0	2	-100.00
Class IVM (10,000-25,000 lbs. multi-engine).....	126	61	+106.56
Class V (gross weight in excess of 25,000 lbs.).....	10	12	-16.67
Unclassified.....	44	0	—
Grand Total.....	6748	3715	+81.64

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## U. S. CIVILIAN PILOT TRAINING PROGRAM

Cumulative totals in the U. S. Civil Aeronautics Administration's Civilian Pilot Training Program from inception in February, 1939, to June, 1941.

States	Number of Trainees	
	Primary	Secondary
Alabama.....	938	150
Arizona.....	430	60
Arkansas.....	815	100
California.....	6,065	990
Colorado.....	1,040	270
Connecticut.....	350	20
Delaware.....	160	30
District of Columbia.....	325	40
Florida.....	982	130
Georgia.....	894	90
Idaho.....	600	90
Illinois.....	2,165	250
Indiana.....	1,507	180
Iowa.....	1,505	220
Kansas.....	1,777	300
Kentucky.....	330	20
Louisiana.....	1,055	190
Maine.....	475	80
Maryland.....	524	120
Massachusetts.....	1,280	200
Michigan.....	2,326	260
Minnesota.....	1,117	180
Mississippi.....	714	20
Missouri.....	2,004	440
Montana.....	627	150
Nebraska.....	945	140
Nevada.....	201	20
New Hampshire.....	309	20
New Jersey.....	925	110
New Mexico.....	511	70
New York.....	2,912	385
North Carolina.....	1,002	80
North Dakota.....	602	40
Ohio.....	2,627	240
Oklahoma.....	1,780	210
Oregon.....	959	150
Pennsylvania.....	2,375	180
Rhode Island.....	324	70
South Carolina.....	1,014	140
South Dakota.....	505	40
Tennessee.....	1,267	190
Texas.....	3,916	700
Utah.....	689	70
Vermont.....	299	—
Virginia.....	861	110
Washington.....	1,451	200
West Virginia.....	790	120
Wisconsin.....	720	110
Wyoming.....	204	50
State Totals.....	57,193	8,025
Territories		
Alaska.....	55	—
Hawaii.....	40	—
Puerto Rico.....	20	—
Territory Totals.....	115	—
Grand Total.....	57,308	8,025

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## FLYING FACTS AND FIGURES

## U. S. CIVILIAN PILOT TRAINING PROGRAM

Statistics on flights training in the U. S. Civil Aeronautics Administration's  
Civilian Pilot Training Program.

## Flight Training from February, 1939 to January, 1941.

Private Pilots.....	Feb.-June, 1939.....	313
Private Pilots.....	Nov., 1939-June, 1940.....	9,243
Private Pilots.....	July, 1940-Jan., 1941.....	27,721
Secondary Pilots.....	July, 1940-Jan., 1941.....	3,911
Totals.....	41,188 flight courses, 37,277 pilots	
	(Secondary pilots are chosen from preliminary graduates)	

Training Centers..... 707 College, 200 Non-College

## Instructor Refresher Courses

	<i>Centers</i>	<i>Quota</i>	<i>Completions to date</i>
<i>Primary Instructor Refresher</i> (20-25 hours flight training, 20 hours ground training)	139	4,600	1,482
<i>Advanced Instructor Refresher</i> (25-30 hours flight training)	91	2,123	581

## Commercial Refresher Course

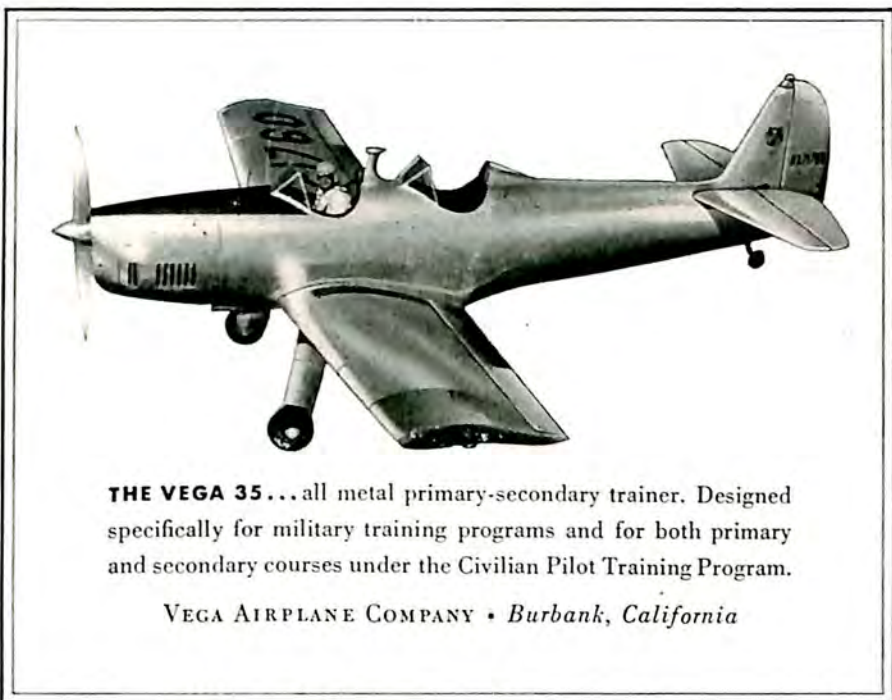
(20-25 hours flight training)

<i>No. of Centers</i>	<i>Quota</i>	<i>In Training</i>	<i>Completions to date</i>
131	1,430	472	131

## Student Instructors

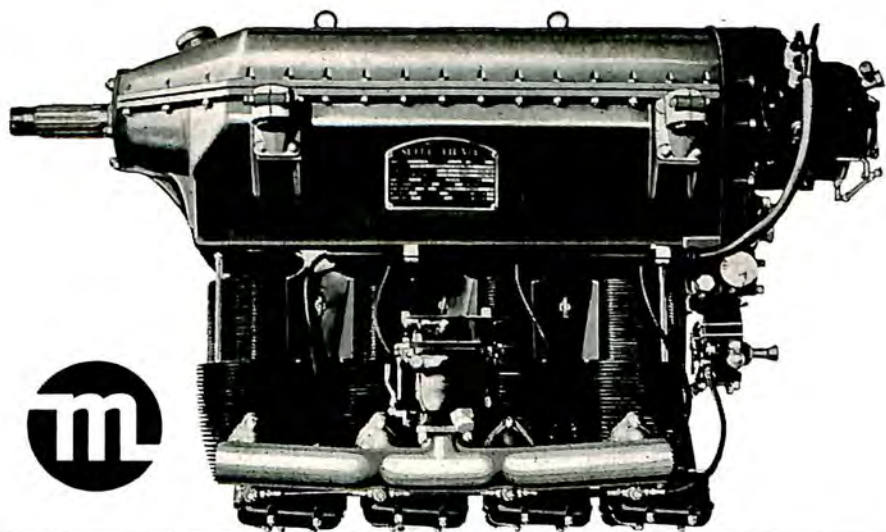
(35 hours ground training—30 hours flight training)

<i>No. of Centers</i>	<i>Quota</i>	<i>In Training</i>	<i>Completions to date</i>
78	780	183	31



**THE VEGA 35**... all metal primary-secondary trainer. Designed specifically for military training programs and for both primary and secondary courses under the Civilian Pilot Training Program.

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## INDEX OF ADVERTISERS

- Academy of Aeronautics, 561  
 Acrotorque Co., 565  
 Adel Precision Products Corp., 431  
 Aero Digest magazine, 544  
 Aero Instrument Co., 519  
 Aero Supply Mfg. Co., Inc., 521  
 Aeromarine Instrument Co., 581  
 Aircraft Accessories Corp., 432  
 Aircraft Hardware Mfg. Co., Inc., 519  
 Aircraft Year Book, 513, 533  
 Allison Division of General Motors Corp., 435  
 Allmendinger, Edwin D., Co., 507  
 Aluminum Company of America, 591  
 American Bosch Corp., 557  
 American Eastern Corp., 575  
 American Screw Co., 546  
 American Tube Bending Co., Inc., 535  
 Apex Machine & Tool Co., 515  
 Arch Roof Construction Co., 563  
 Aro Equipment Corp., 529  
 Aviation Equipment & Export, Inc., 579  
 Aviation Institute of Technology, 531  
 Aviation magazine, 579
- B. G. Corp., 437  
 B. H. Aircraft Co., 531  
 Babb, Charles H., Co., 559  
 Barr Shipping Corp., 581  
 Beech Aircraft Corp., 439  
 Bell Aircraft Corp., 441  
 Bendix Aviation Corp., Export Division, 573  
 Bendix Products Division of Bendix Aviation Corp., 527  
 Boeing Aircraft Co., 443  
 Boots Aircraft Nut Corp., 571  
 Breeze Corporations, Inc., 515  
 Brewster Aeronautical Corp., 521
- Cambridge Instrument Co., 515  
 Champion Spark Plug Co., 519  
 Chandler-Evans Corp., 522  
 Cleveland Pneumatic Tool Co., 593  
 Climax Molybdenum Co., 511
- Consolidated Aircraft Corp., 445  
 Continental Motors Corp., 591  
 Curtiss-Wright Corp., 447  
 Curtiss-Wright Technical Institute, 543
- Detroit Macoid Corp., 583  
 Diebold Safe & Lock Co., 449  
 Douglas Aircraft Co., Inc., 451  
 Dow Chemical Co., 513  
 Dowty Equipment Corp., 523  
 Dzus Fastener Co., Inc., 453
- Eastman Kodak Co., 535  
 Eclipse Aviation Division of Bendix Aviation Corp., 513  
 Edo Aircraft Corp., 521  
 Eisemann Magneto Corp., 518  
 Engineering & Research Corp., 522
- Fairchild Aerial Camera Corp., 575  
 Fairchild Engine & Airplane Corp., 455  
 Farnham Manufacturing Co., 519  
 Federal Products Corp., 527  
 Finch-Telecommunications, Inc., 531  
 Fleetwings, Inc., 457  
 Flying & Popular Aviation magazine, 537  
 Formica Insulation Co., 527  
 Fuel Development Corp., 553
- Gaertner Scientific Corp., 534  
 General Aircraft Equipment, Inc., 459  
 General Electric Co., 529  
 Gillies Aviation Corp., 461  
 Goodrich, The B. F., Co., 569  
 Grimes Manufacturing Co., 551  
 Grumman Aircraft Engineering Corp., 460  
 Gulf Oil Corp., 555
- Hamilton Standard Propellers Division, 495  
 Hartzell Propeller Co., 591  
 Harvill Aircraft Die-Casting Co., 463



- Intercontinent Corp., 577  
 International Flare-Signal Division, 587  
 J. V. W. Corp., 561  
 Jacobs Aircraft Engine Co., 465  
 Jones, Casey, School of Aeronautics, 561  
 Kinner Motors, Inc., 593  
 Knu-Vise, Inc., 533  
 Kollsman Instrument Co., 467  
 Lawrance Engineering & Research Corp., 563  
 Lear Avia, Inc., 585  
 Leece-Neville Co., 469  
 Lenz Electric Manufacturing Co., 471  
 Liberty Aircraft Products Corp., 529  
 Liquidometer Corp., 557  
 Littelfuse, Inc., 591  
 Lockheed Aircraft Corp., 473  
 Luscombe Airplane Corp., 539  
 Luscombe School of Aeronautics, 522  
 Lycoming Division of Aviation Manufacturing Corp., 577  
 McArthur, Warren, Corp., 476  
 McDonnell Aircraft Corp., 475  
 Macwhlyte Co., 529  
 Martin, The Glenn L., Co., 477  
 Menasco Manufacturing Co., 595  
 Moore-Eastwood & Co., 533  
 Norma-Hoffmann Bearings Corp., 515  
 North American Aviation, Inc., 479  
 Northrop Aircraft, Inc., 480  
 Northwest Airlines, Inc., 551  
 Pacific Aviation, Inc., 481  
 Parks Air College, Inc., 551  
 Pioneer Instrument Division of Bendix Aviation Corp., 571  
 Pioneer Parachute Co., Inc., 535  
 Pratt & Whitney Aircraft Division, 495  
 R E F Aircraft Corp., 518  
 Ranger Aircraft Engines, 455  
 Republic Aviation Corp., 483  
 Revista Aerea magazine, 544  
 Rochester Ropes, Inc., 534  
 Roebing's, John A., Sons Co., 485  
 Roosevelt Aviation School, 541  
 Ryan Aeronautical Co., 487  
 S K F Industries, Inc., 535  
 Safair, Inc., 593  
 St. Louis Aircraft Corp., 505  
 Schrader's, A., Son, 525  
 Sensenich Brothers, 539  
 Sheffield Gage Corp., 489  
 Shell Oil Co., Inc., 563  
 Siebenthaler Division of Aircraft Accessories Corp., 433  
 Sinclair Refining Co., 557  
 Socony-Vacuum Oil Co., Inc., 575  
 Solar Aircraft Co., 525  
 Spartan Aircraft Co., 527  
 Sperry Gyroscope Co., Inc., 491  
 Sportsman Pilot magazine, 544  
 Spriesch Tool & Manufacturing Co., Inc., 518  
 Standard Oil Company of California, 591  
 Stearman Aircraft Division, 443  
 Stewart Technical School, 521  
 Stinson Aircraft Division, 497  
 Summerill Tubing Co., 493  
 Suncook Mills, 579  
 Superior Tube Co., 546  
 Taylorcraft Aviation Corp., 593  
 Texas Co., 551  
 Thompson Products, Inc., 534  
 Timmerman Products, Inc., 523  
 Titeflex Metal Hose Co., 525  
 Transcontinental & Western Air, Inc., 549  
 Uniloy Accessories Corp., 513  
 United Aircraft Corp., 495  
 United Aircraft Products, Inc., 505  
 United States Gauge Co., 461  
 Vega Airplane Co., 595  
 Vickers, Inc., 496  
 Vought-Sikorsky Aircraft Division, 495  
 Vultee Aircraft, Inc., 497  
 Waco Aircraft Co., 591  
 Weatherhead Co., 499  
 Wellington Sears Co., 501  
 Western Electric Co., 534  
 Westinghouse Electric & Manufacturing Co., 503  
 White, S. S., Dental Manufacturing Co., 522  
 Whitney, O. J., Inc., 571  
 Wilcox-Rich Division of Eaton Manufacturing Co., 533  
 Wittek Manufacturing Co., 546  
 Wright Aeronautical Corp., 447

## INDEX

### A

- Abbot, C. G., 520  
Academy of Aeronautics, 117-118  
Accessories, manufacturers, 332-400, 438-506  
Accidents, 548  
Acrotorque Co., 332-333  
Adel Precision Products, 333-334  
Advertisers, index of, 596-597  
Aerial warfare, 11-16  
Aero Club of Iran, 262  
Aero Digest magazine, 545  
Aero Instrument Co., 334  
Aero Insurance Underwriters, 400  
Aero Medical Research Laboratory, 42  
Aero Supply Mfg. Co., 334  
Aerodynamics, 72-75  
Aeromarine Instrument Co., 334  
Aeronautical Board, 53  
Aeronautical Chamber of Commerce of America, 23, 61, 62, 156, 508-509; work of, 161-166  
Aeronautical Review, 545  
Aeronautical University, 108  
Aeronca Aircraft Corp., 159, 189  
Aeroproducts Division of General Motors Corp., 334  
Aherne, B., 159  
Air Associates, 334-335  
Air Corps, U. S. Army, 23, 31-44, 53, 59, 264, 330, 331, 333; expansion, 33-35, 38; personnel, 39, 514; procurement, 32-33, 190, 195-196, 198, 204, 212-214, 216, 219-220, 225-227, 232, 233, 234, 238, 240, 247-248, 250, 254, 262, 263, 265, 267, 268, 271, 272, 284, 288, 317; training, 34, 40-41, 97-99, 102, 103, 105; *see also* Education, aeronautical  
Air Law Review, 545  
Air Line Mechanic magazine, 545  
Air Line Pilot magazine, 545  
Air mail, 564-568; foreign routes, 570  
Air power, 11-16  
Air Safety Board, 62  
Air Trails magazine, 545  
Air transport, 129-150; international routes, 133-140; operations, 550, 562; routes, 552-560; safety, 548; summary, 548  
Air Transport Association of America, 61, 166-168, 509  
Aircooled Motors Corp., 289-290  
Aircraft Accessories Corp., 335-336  
Aircraft Hardware Manufacturing Co., 336  
Aircraft Owners and Pilots Association, 168-170, 510  
Aircraft manufacturing industry, 17-30, 187-400; bottlenecks, 28-29; deliveries, 201, 213, 219, 220, 225, 287-288, 315-316, 317; development, 27; personnel expansion, 22, 190, 197, 209, 212, 216, 219, 234, 235-236, 239, 240-241, 245, 250-252, 254, 256, 257, 262, 266, 272, 278, 287, 293, 309, 324, 326-327, 346, 363; production, 35, 189-400; production capacity, 18; production methods, 19, 219, 220, 235, 243, 266-267, 274-275; research, 27; subcontracting, 22, 29, 198, 204, 207, 209, 222, 233, 239, 243-244, 245, 254, 283; technical development, 187-189; technical superiority, 25; training, 27, 103-104, 216, 222, 234, 240-241, 252-253, 310-312; *see also* Education, aeronautical  
Aircraft Radio Corp., 336  
Aircraft Tools, Inc., 336

Aircraft Year Book, 545  
 Airplanes, deliveries, 22; designs, 190-288; for Britain, 15-16; manufacturers, 189-289, 430-436; number licensed, 152, 582; procurement of, 22-23; production, 152, 590; specifications, 401-406  
 Airports, 179-184, 586  
 Airports and Airways, 179-186  
 Airways, 184-186  
 Ajax Metal Co., 336  
 Alabama Institute of Aeronautics, 120-121  
 Aldrin, E. E., 512  
 All American Aviation, 141-142  
 Allison Division of General Motors Corp., 290-295  
 Allmendinger, Edwin D., 399  
 Aluminum Company of America, 336-338  
 American Airlines, 142, 329, 333  
 American Aviation Daily, 545  
 American Aviation Directory, 545  
 American Aviation magazine, 545  
 American Bosch Corp., 338  
 American Eastern Corp., 399  
 American Export Airlines, 139-140  
 American School of Aircraft Instruments, 108  
 American Screw Co., 338  
 American Society of Mechanical Engineers, 512  
 American Tube Bending Co., 338  
 Ames Aeronautical Laboratory, 71  
 Anderson, J. W., 44  
 Antioch College, 307  
 Apex Machine & Tool Co., 338  
 Arch Roof Construction Co., 338  
 Arnold, H. H., 33-38, 520  
 Aro Equipment Corp., 338  
 Associated Aviation Underwriters, 400  
 Aviation Capital, Inc., 400  
 Aviation Equipment & Export, 399  
 Aviation Institute of Technology, 109  
 Aviation magazine, 545  
 Aviation Writers Association, 545  
 Ayers, F. W., 514

## B

B. G. Corp., 338-339  
 B. H. Aircraft Co., 339  
 Babb, Charles H., Co., 399  
 Babcock Aircraft Corp., 189  
 Baker, G. P., 524  
 Ball, R. S., 545  
 Bard, R., 516  
 Barker, F. W., 509  
 Barnaby, R. S., 512  
 Barr Shipping Corp., 400  
 Batt, W. L., 514  
 Bauer, L. H., 172  
 Beaverbrook, 249  
 Beck, T. H., 510  
 Beech, W. H., 194, 508  
 Beech Aircraft Corp., 190-195  
 Belgium, 11, 20, 207, 237  
 Bell Aircraft Corp., 195-197, 233  
 Bell Telephone Laboratories, 396, 397  
 Bellanca Aircraft Corp., 197-198  
 Bendix Aviation Corp., 339-342  
 Bendix Aviation, Ltd., 341, 342  
 Bendix Export Division of Bendix Aviation Corp., 341, 399  
 Bendix Products Division of Bendix Aviation Corp., 341  
 Bendix Radio Corp., 341  
 Bendix-Westinghouse Automotive Air Brake Co., 342  
 Biggers, J. D., 85, 514  
 Black, S. A., 514  
 Boeing Aircraft Co., 198-204  
 Boeing Aircraft of Canada, 201  
 Boeing School of Aeronautics, 109-110, 226  
 Boettcher, C., II, 510  
 Boots Aircraft Nut Corp., 342-343  
 Border Patrol, 234  
 Bourne, T. B., 524  
 Bowersock, J. D., 545  
 Boyer, H. R., 514  
 Bradley, S. S., 509  
 Branch, H., 173, 524  
 Brand, H., Jr., 508, 509  
 Braniff, T. E., 509  
 Braniff Airways, 329

Breeze Corporations, 343-344  
 Brett, G. H., 173, 514, 520  
 Brewer, G., 171-172, 173  
 Brewster Aeronautical Corp., 204-207, 233  
 Briggs, L. J., 520  
 Briggs Manufacturing Co., 344  
 Brinckerhoff, W. W., 508, 510  
 Britain, *see* Great Britain  
 British Commonwealth Air Training Plan, 299  
 Brukner, C. J., 508, 509  
 Budd, R., 84  
 Buick Division of General Motors Corp., 309-310  
 Bullard, E. C., 44  
 Burden, W. A. M., 510  
 Bureau of Aeronautics, U. S. Navy, 23, 45-60, 105-106; appropriations, 50-51; personnel, 516-517; procurement, 46-47, 190, 204, 207, 214, 217, 219, 228-229, 231-232, 240, 241, 248, 269, 271, 272, 280, 283, 317, 351; research, 49, 51-52; standardization, 52-53; training, 49, 59, 99-100, 102  
 Bureau of Foreign and Domestic Commerce, 61-62, 520  
 Bureau of Ordnance, 54  
 Burton, A. T., 508  
 Bush, V., 520

## C

Cadillac Division of General Motors Corp., 293  
 Cal-Aero Academy, 110  
 Caldwell, F. W., 510  
 Calkins, S., 545  
 Cambridge Instrument Co., 344  
 Canada, 23, 249, 288, 299  
 Canadian Airways, 193  
 Canadian Colonial Airways, 142-143  
 Candee, R. C., 514  
 Case, N. S., 514  
 Catalina Air Transport, 143  
 Cattarius, A., 43  
 Central Aircraft Corp., 207  
 Cessna Aircraft Co., 207-209  
 Chamberlin, E. H., 520  
 Chambers, R. M., 508  
 Champion Aviation Co., 344  
 Champion Spark Plug Co., 344  
 Chandler-Evans Corp., 345  
 Chanute, Octave, Award, 172  
 Charles, J. S., 512  
 Chatfield, C. H., 509  
 Cheney Award, 41  
 Chicago and Southern Airlines, 329  
 Chilton, A., 173  
 China Airmotive Co., 399  
 Churchill, W., 13-14  
 Civil Aeronautics Administration, 62-64, 70, 77, 93, 94, 96, 156, 172, 179, 226, 329, 330, 351, 524  
 Civil Aeronautics Board, 62-63, 64-65, 524  
 Civilian Pilot Training Program, 153, 156, 233, 258, 306, 592-594; *see also* Education, aeronautical  
 Clapp, E. H., 530  
 Clark, J. M., 512  
 Cleveland Pneumatic Tool Co., 345  
 Climax-Molybdenum Co., 345  
 Coast Guard, 96, 213, 231  
 Cobey, E. A., 516  
 Coffey, H. K., 510  
 Cole, J. W., 517  
 Colgate-Larsen Aircraft Co., 209-211  
 Columbian Trophy, 44  
 Colvin, C. H., 173, 510  
 Colwell, A. T., 512  
 Compton, L., 45  
 Congressional Committees, 526-530  
 Connolly, D. H., 520, 524  
 Consolidated Aircraft Corp., 211-213, 233, 254  
 Continental Motors Corp., 296  
 Cousins, R. P., 514  
 Cox & Stevens Aircraft Corp., 400  
 Craven, T. A. M., 514  
 Crawford, F. C., 510  
 Cross-license agreement, 173-176  
 Culbert, A., 167  
 Culver Aircraft Corp., 213  
 Cunningham-Hall Aircraft Corp., 213  
 Curtiss-Wright Corp., 233

Curtiss-Wright Corp., Curtiss Air-  
plane Division, 213-218  
Curtiss-Wright Corp., Curtiss Pro-  
peller Division, 345-346  
Curtiss-Wright Corp., Exports Divi-  
sion, 400  
Curtiss-Wright Technical Institute,  
111-112

## D

Dallas Aviation School and Air Col-  
lege, 113  
Damon, R. S., 510  
Dargue, H. A., 514  
Daughters of the American Revolu-  
tion Trophy, 60  
Davis, C., 84  
de Florez, L., 510  
DeFrance, S. J., 173, 520  
Dealers, 506  
Decker, C. J., 512  
Delta Air Corporation, 168  
Denmark, 20  
Depew, R. H., Jr., 508  
Detroit Macoid Corp., 347  
Diebold Safe and Lock Co., 346-347  
Diplomatic Service to the United  
States, 532  
Directory of Manufacturers, 429-506  
Distinguished Flying Cross, 42, 43, 60  
Distributors, 506  
Division of Controls, 67-68  
Division of International Communi-  
cations, 68-69  
Doherty, R. E., 520  
Dolan, C. H., 512  
Douglas Aircraft Co., 172, 218-222  
Dow Chemical Co., 347-348  
Dowty Equipment Corp., 348  
Dryden, H. L., 172  
Dudley, A. S., 510  
Duncan, A. N., 514  
Dunkirk, evacuation of, 12, 237  
Dzus Fastener Co., 348

## E

Early, T. G., 524  
Eastern Air Lines, 143-144, 329

Eastman Kodak Co., 348  
Eaton Manufacturing Co., 348-349  
Echols, O. P., 514  
Eclipse Aviation Division of Bendix  
Aviation Corp., 341, 349-351  
Eclipse Machine Division of Bendix  
Aviation Corp., 341  
Edgerton, J., 545  
Edo Aircraft Corp., 351-352  
Education, aeronautical, 97-128; Civil-  
ian Pilot Training Program, 100-  
103  
Edwards Flying Service, 115  
Eisemann Magneto Corp., 352  
Electronic Specialty Co., 352-353  
Elliott, H., 84  
Elwell, R. E., 524  
Emmons, D. C., 173, 514  
Employees, *see* Aircraft manufactur-  
ing industry, personnel  
Engineering and Research Corp., 159,  
222-224  
Engines, designs, 298-332; manufactur-  
ers, 289-332, 436-438; specifica-  
tions, 407-428  
England, *see* Great Britain  
Eoff, J. H., 60  
Evans, F. E., 510  
Expansion, *see* Aircraft manufactur-  
ing industry  
Export Control Act, 67, 68  
Exporters, 506  
Exports, 572-580  
Express, 130-133

## F

Fairchild Aviation Corp., 353-354  
Fairchild Engine and Airplane Corp.,  
Fairchild Aircraft Division, 158-  
159, 224-226  
Farnham Manufacturing Co., 354-355  
Federal Communications Commission,  
69-71, 514  
Federal Metal Hose Corp., 355  
Federal Products Corp., 355  
Ferson, O. S., 514  
Finch Telecommunications, 356-357  
Finland, 204

Firestone Tire and Rubber Co., 357  
 Fleetwings, Inc., 226-227  
 Fleischman, M. C., 510  
 Fly, J. L., 514  
 Flying & Popular Aviation magazine,  
 545  
 Flying Facts and Figures, 547-595  
 Flying schools, 536-540; *see also*,  
 Education, aeronautical  
 Forbes, W. A., 508  
 Ford, V., 509  
 Ford Motor Co., 204, 309  
 Foreign Commerce Weekly, 61-62  
 Forest Service, 85-88, 530  
 Formica Insulation Co., 357-358  
 Forrestal, J. V., 516  
 France, 11, 12, 219, 237; procurement,  
 19, 20, 241, 280, 283  
 Francis, D., 545  
 Freeman, R. S., 43  
 Friez, Julian P., Division, Bendix  
 Aviation Corp., 341  
 Froelich, M., 545  
 Frye, J., 509  
 Frye Aircraft Co., 115  
 Fuel Development Corp., 358  
 Fuller, F. W., Jr., 510

## G

Gaertner Scientific Corp., 358-359  
 Gagg, R. F., 512  
 Gardner, L. D., 510  
 Gasoline Taxes, 588-589  
 General Aircraft Corp., 227-228, 400  
 General Aircraft Equipment Corp.,  
 359  
 General Electric Co., 359-360  
 General Motors Corp., 245, 293  
 Germany, 11-16, 21, 236; military air-  
 planes, 25  
 Gillies Aviation Corp., 159-160, 400  
 Globe Aircraft Corp., 228  
 Goldsmith, R., 508, 510  
 Goodrich, B. F., Co., 360-362  
 Goodyear Tire and Rubber Co., 362  
 Gordon, M. B., 508  
 Gorrell, E. S., 509, 510  
 Gott, E. N., 509

Gough, M. N., 173  
 Government Activities, 61-96  
 Graham Aviation, 115  
 Gray, J. S., Jr., 60  
 Gray, J. T., 509  
 Grayson, G. H., 517  
 Great Britain, 11-16, 25, 27; aid to,  
 17-18, 26-27; procurement, 19, 20,  
 22, 23, 195-196, 204, 207, 213, 219,  
 232, 236, 238, 240, 241, 249, 250, 254,  
 280, 283  
 Grimes Manufacturing Co., 362-363  
 Gross, R. E., 509  
 Grumman, L. R., 508, 510  
 Grumman Aircraft Engineering  
 Corp., 228-232  
 Guggenheim, H. F., 510  
 Guggenheim, Daniel, Medal, 172  
 Guggenheim Fund, 66  
 Gulf Oil Corp., 157, 363  
 Guthrie, W. D., 508

## H

Haddaway, G. E., 545  
 Hall-Aluminum Aircraft Corp., 212  
 Hamilton Standard Propellers Divi-  
 sion of United Aircraft Corp., 363-  
 365  
 Harlow Aircraft Co., 232-233  
 Harris, S. R., 42  
 Hartranft, J. B., Jr., 510  
 Hartson, J. T., 508, 509  
 Hartzell Propeller Co., 365-366  
 Harvey Machine Co., 366  
 Harvill Die-Casting Corp., 366-367  
 Haskell, R., 510  
 Hatfield, V. O., 60  
 Hawks, Frank M., Memorial Award,  
 370  
 Hayes Industries, 367  
 Haynes, C. V., 43  
 Heidt, W. J., 43  
 Helicopter, 280-283  
 Henderson, L., 84  
 Hepburn Board, 47  
 Heron, S. D., 173  
 Hewlett, P. W., 508  
 Hibbard, H. L., 510

Hillman, S., 84, 514  
 Hinckley, R. H., 181-182, 520, 524  
 Hine, T., 43  
 Hine, V., 43  
 Hines, H. L., 43  
 Hinton, C., 510  
 Hirsch, Lilienthal & Co., 400  
 Hoernes Collection, 66  
 Holland, H., 20  
 Hopper, R. E., 60  
 Houghton, G. H., 173  
 Howard Aircraft Corp., 233  
 Hudnell, W. T., Jr., 42  
 Hughes, A. D., 545  
 Hughes, H., 172  
 Hunsaker, J. C., 520  
 Huntington, G., 160

## I

Institute of the Aeronautical Sciences,  
 170-173, 510  
 Intercontinent Corp., 400  
 International Flare Signal Division  
 of Kilgore Manufacturing Co., 367-  
 368  
 International Technical Committee of  
 Aerial Legal Experts, 69  
 Interstate Aircraft and Engineering  
 Corp., 233  
 Iran, 262  
 Italy, 16, 236

## J

J. V. W. Corp., 400  
 Jacobs Aircraft Engine Co., 297  
 Jeffries, John, Award, 172  
 Johansen, W. F., 60  
 Johnson, D., 514  
 Johnson, E. F., 514  
 Johnson, L., 31-33  
 Johnson, P. G., 510  
 Jones, C. S., 508  
 Jones, J. H., 520, 524  
 Jones, Casey, School of Aeronautics,  
 116-118

Jouett, J. H., 23-29, 508, 509, 510  
 Journal of Air Law, 545  
 Journal of the Aeronautical Sciences,  
 545  
 Junior, R. E., 43-44

## K

Kellett, W. W., 508, 510  
 Kellett Autogiro Corp., 233-234  
 Kemmer, P. H., 173  
 Kennedy, F. M., 514  
 Kerber, L. V., 508  
 Kidde, Walter & Co., 368-369  
 Kindelberger, J. H., 249, 509  
 King, H., 510  
 Kinner Motors, 298-299  
 Kirschbaum, D., 545  
 Knox, F., 84, 516  
 Knu-Vise, Inc., 369  
 Knudsen, W. S., 29, 84, 514  
 Knudsen Plan, 23, 29-30, 243  
 Koch, A. S., 524  
 Kollsman, P., 170, 173  
 Kollsman Instrument Division of  
 Square D Co., 369-370  
 Kraus, S. M., 516, 520

## L

La Guardia Field, 184  
 Labor, *see* Aircraft manufacturing in-  
 dustry; personnel  
 Lafferty, J. C., 60  
 Lake, H. W., 508  
 Lakeland School of Aeronautics, 118  
 Lamiell, J. E., 517  
 Lane, F. K., Jr., 510  
 Langley Aeronautic Library, 66  
 Langley Laboratory, 71  
 Larner, G. de F., 510  
 Lawrance, C. L., 508  
 Lawrance Engineering and Research  
 Corp., 370  
 Lawver, L., 510  
 Lazarus, W. W., 42  
 Lear, W. P., 370  
 Lear Avia, 370-372

Lederer, J., 524  
 Leece-Neville Co., 372  
 Lees, R. E., 514  
 Leighton, B. G., 510  
 Lenz Electric Manufacturing Co., 372  
 Lewis, G. W., 173, 512, 520  
 Lewis School of Aeronautics, 118-119  
 Liberty Aircraft Products Corp., 372-373  
 Library of Congress, 66  
 Lichty, L. C., 512  
 Link Aviation Devices, 373  
 Liquidometer Corp., 373-374  
 Littelfuse, Inc., 374  
 Lockheed Aircraft Corp., 234-238  
 Lodwick, A. I., 508, 510  
 Loening, G., 510  
 Loening Intercollegiate Trophy, 177  
 Lombard, A. E., Jr., 514  
 Loomis, Suffern & Fernald, 400  
 Losey, Robert M., Award, 173  
 Lubrication Corp., 342  
 Ludington, C. T., 510  
 Luscombe Airplane Corp., 159, 238-239  
 Luscombe, Don A., Co., 400  
 Luscombe School of Aeronautics, 110  
 Lycoming Division of Aviation Manufacturing Corp., 300-306  
 Lyman, L. D., 508  
 Lyon, A. L., 514

## M

McArthur, Warren, Corp., 374-375  
 McDonnell Aircraft Corp., 239  
 McKay, D. D., 60  
 McMullen, A. B., 524  
 McQuiston, I. M., 516  
 MacCart, R. D., 510  
 MacLane, B., 159  
 Macfadden cross country race, 194-195  
 Mackay Army Award, 43  
 Macwhyte Co., 375-376  
 Magazines, aeronautical, 545  
 Maggs Brothers Collection, 66  
 Magin, F. W., 170

Manufacturers Aircraft Association, 173-176, 509  
 Marcus, C., 508, 510  
 Marine Corps, 219  
 Marine Division, Bendix Aviation Corp., 341  
 Marmon Motor Co., 346  
 Marshall-Eclipse Division, Bendix Aviation Corp., 341  
 Martin, G. L., 172, 508  
 Martin, Glenn L., Co., 172, 233, 239-244  
 Mason, G. G., Jr., 524  
 Mattix, P. R., 520  
 Mead, G. J., 520  
 Mechanics schools, 542; *see also* Education, aeronautical  
 Meigs, M. C., 85, 510, 514  
 Menasco Manufacturing Co., 306-308  
 Messaggero, 16  
 Meteorology, 91-96  
 Miami Air Maneuvers, 157  
 Mid-Continent Airlines, 144  
 Mingos, H., 508, 509  
 Minshall, R. J., 171  
 Miranda Brothers, 400  
 Missouri Aviation Institute, 119  
 Mitscher, M. A., 516  
 Model Airplane News, 545  
 Moffett Memorial Trophy, 60  
 Monocoupe Aeroplane & Engine Corp., 244  
 Monro, C. B., 509  
 Moore-Eastwood & Co., 376  
 Morgan, T. A., 508  
 Mountain States Aviation, 119  
 Murray, J. P., 508, 509  
 Musick Memorial Trophy, 171

## N

Naiden, E. L., 514  
 National Advisory Committee for Aeronautics, 71-78, 210, 256, 520  
 National Aeronautic Association, 176-177, 510  
 National Aeronautics magazine, 545  
 National Aviation Insurance Agency, 400



National Bureau of Standards, 78-83,  
172  
National Credit Office, 400  
National Defense Advisory Commis-  
sion, 83-84  
National Defense Council, 59  
National Glider Association, 178  
National Intercollegiate Flying Club,  
177  
National Park Service, 234  
National Youth Administration, 179,  
351  
Naval Aeronautical Organization,  
48-49  
Naval Aircraft Factory, 51, 57  
Naval Expansion Act, 48  
Navy, *see* Bureau of Aeronautics  
Near, A. H., 510  
Neely, F. R., 508  
Neely, H. L., 41-42  
Nelson, D. M., 85  
Neutrality Act, 67, 68  
New England Aircraft School, 119  
Newhouse & Sayre, 400  
Norma-Hoffmann Bearings Corp.,  
376  
North American Aviation, 244-253  
Northrop Aircraft, 253-256  
Northwest Air Service, 376, 400  
Northwest Airlines, 144  
Norway, 20, 236, 254  
Nutt, A., 510  
Nyden, C. N., 514

## O

Oakland Municipal Airport, 184  
Office of Education, 106-107  
Office of Emergency Management,  
83-84  
Office of Indian Affairs, 96  
Office of Production Management,  
29, 83-85, 106, 514  
Official Aviation Guide, 545  
Old, W. D., 43  
Olds, R., 514  
O'Malley, T. F., 42-43  
Oswald, W. B., 172

## P

Pacific Aviation, 376-377  
Page, G. A., Jr., 173  
Palmer, R. E., 514  
Pan American Airways, 133-139, 203-  
204, 329, 333  
Parker, L., 168  
Parker & Co., 400  
Parker Appliance Co., 377  
Parks Air College, 119-120  
Patents, 173-176  
Patterson, W. A., 509  
Payne, G. H., 514  
Peabody, H., 514  
Pennsylvania-Central Airlines, 144-  
146, 329  
Periodicals, aeronautical, 545  
Perkins, K., 514  
Permanent American Aeronautical  
Commission, 69  
Petras, T. A., 195  
Petterssen, S., 171  
Phelps, O. R., 60  
Phillips Aviation Co., 307-308  
Pierrot, A. O., 514  
Pilot magazine, 545  
Pilots, number licensed, 151, 584  
Pioneer Instrument Division, Bendix  
Aviation Corp., 341, 377-379  
Pioneer Parachute Co., 379-381  
Piper, W. T., 154-155  
Piper Aircraft Co., 158, 256-260  
Pitcairn-Larsen Autogiro Co., 260  
Pogue, L. W., 524  
Poland, 20  
Porterfield Aircraft Corp., 159, 261-  
262  
Post Office Department, Air Mail  
Service, 517  
Powers, E. M., 514  
Pratt & Whitney Aircraft Division of  
United Aircraft Corp., 308-317;  
customers school, 311-312  
Price, G. E., 42  
Private Flyers Association, 155  
Private Flying, 151-159

- Procurement, *see* Air Corps, U. S. Army; Bureau of Aeronautics, U. S. Navy; Great Britain  
 Production, growth of, 17-30; program, 19-20, 23; *see also* Aircraft manufacturing industry  
 Public Health Service, 88-91  
 Purdue University Flying Club, 177  
 Purdum, S. W., 517
- R
- RCA Manufacturing Co., 381  
 R E F Aircraft Corp., 381  
 Ramsey, D. C., 516  
 Ranger Aircraft Engines Division of Fairchild Engine and Airplane Corp., 317-323  
 Rankin, H. C., 194  
 Rearwin Aircraft and Engine Co., 262, 323  
 Redding, W. P., 510  
 Reed, Sylvanus Albert, Award, 172  
 Reichelderfer, F. W., 173, 520  
 Reid, H. J. E., 520  
 Republic Aviation Corp., 233, 262-265  
 Reynolds, T. W., 60  
 Reynolds Metals Co., 381-382  
 Rich, N. B., Airplane Co., 265  
 Richardson, H. C., 516  
 Rickenbacker, E. V., 509  
 Rising Sun School of Aeronautics, 121  
 Robertson Aircraft Corp., 121  
 Rochester Ropes, Inc., 382  
 Roddy, M., 545  
 Roebing's, John A., Sons Co., 382  
 Rogers, C., 159  
 Rogers, J. M., 508, 509  
 Roosevelt, F. D., 83, 84  
 Roosevelt Aviation School, 121-122  
 Rosendahl, C. E., 516  
 Royal Air Force, 12-16, 195, 207, 236-237, 238, 249, 250, 256, 317, 333  
 Royal Australian Air Force, 238  
 Royal Dutch Airlines, 329  
 Royal Swedish Air Force, 264  
 Ruckstell Burkhardt Engineering Co., 382-383
- Russell, C. W., 514  
 Russell, F. H., 509  
 Russia, *see* U. S. S. R.  
 Ryan, O., 524  
 Ryan, T. F., III, 510  
 Ryan Aeronautical Corp., 265-267  
 Ryan School of Aeronautics, 122-125
- S
- SKF Industries, 383  
 Safair Flying School, 125-127  
 St. Louis Aircraft Corp., 267  
 Samford, J. A., 43  
 Sanborn, J. A., 509  
 Sands, J. E., 44  
 Schrader's, A., Son, Division of Scovill Manufacturing Co., 383-384  
 Scintilla Magneto Division of Bendix Aviation Corp., 341, 384  
 Seifert, F. W., 43  
 Sensenich Brothers, 384  
 Shaffer, H. A., 514  
 Sharples, L. P., 510  
 Sharples, P. T., 510  
 Sheffield Gage Corp., 384-385  
 Shell Oil Co., 385  
 Short, M., 512  
 Siebenthaler, Thomas L., Manufacturing Co., 385  
 Sikorsky, I. I., 173, 282  
 Silberer Collection, 66  
 Simmonds Aerocessories, 385-386  
 Sinclair, C. E., 510  
 Sinclair Refining Co., 386-387  
 Six, R. F., 509  
 Skelly, W. G., 510  
 Slowie, T. J., 514  
 Smith, C. R., 509  
 Smith, J. A. B., 508  
 Smith, J. S., 508  
 Smith, Barney & Co., 400  
 Smithsonian Institution, 66  
 Snodgrass, H., 169  
 Soaring magazine, 545  
 Soaring Society of America, 178, 512  
 Society of Automotive Engineers, 177-178, 512  
 Socony-Vacuum Oil Co., 387

- Solar Aircraft Co., 387-388  
 Soldier's Medal, 44  
 Southec, E. R., 512  
 Southern Aircraft Corp., 267-269  
 Southern Flight magazine, 545  
 Spaatz, C. A., 514  
 Spartan Aircraft Co., 269-270  
 Spartan School of Aeronautics, 127  
 Sperry, E. A., Jr., 510  
 Sperry Gyroscope Co., 388-390  
 Sperry, Lawrence, Award, 172  
 Sperry Products, Inc., 390  
 Spicer, D. L., 43  
 Sportsman Pilot magazine, 545  
 Spriessch Tool & Manufacturing Co., 390  
 Standard Oil Company of California, 390-391  
 Standard Oil Company of New Jersey, 391  
 Standard Statistics Co., 400  
 Stanley, R., 512  
 Stanton, C. I., 524  
 Stearman Aircraft Division of Boeing Airplane Co., 201, 271-275  
 Steel Products Engineering Co., 392  
 Stengel Flying Service, 127  
 Stettinius, E. R., Jr., 84, 85  
 Stewart Technical School, 127  
 Stimson, H. L., 31, 84, 514  
 Stinson Aircraft Division of Vultee Aircraft, 275-276  
 Stockburger, A. E., 524  
 Stough, R. W., 524  
 Stovall, W. R., 524  
 Stratmeyer, G. E., 514  
 Stryker, C. E., 514  
 Subcontracting, *see* Aircraft manufacturing industry  
 Summerill Tubing Co., 392  
 Suncook Mills, 392  
 Superior Tube Co., 392  
 Swallow Airplane Co., 276  
 Sweet, F., 512
- T
- Talman, E. L., 167  
 Taxes, gasoline, 588-589
- Taylor, E. S., 514  
 Taylor, I. H., 508, 509  
 Taylor, L. R., 509  
 Taylor, R., 159  
 Taylor, W. C., 520, 524  
 Taylor-Winfield Corp., 392-393  
 Taylorcraft Aviation Corp., 276-278  
 Texas Co., 393  
 Thompson, F. I., 514  
 Thompson Products, 393-394  
 Tichenor, F., 508, 510  
 Tillinghast, T. E., 508  
 Timken Roller Bearing Co., 394  
 Timm Aircraft Corp., 278  
 Tinnerman Products, 394  
 Tissandier Collection, 66  
 Titanine, Inc., 394  
 Titeflex Metal Hose Co., 394-395  
 Towers, J. H., 46-60, 516, 520  
 Training, *see* Education, aeronautical  
 Transatlantic air lines, *see* Air transport, international routes  
 Transcontinental & Western Air, 146-147, 203, 329, 333  
 Transpacific air lines, *see* Air transport, international routes  
 Tri-American Aircraft Corp., 400
- U
- U. S. S. R., 204  
 U. S. Air Services magazine, 545  
 U. S. Aviation Underwriters, 400  
 U. S. Gauge Co., 395  
 Uniloy Accessories Corp., 395  
 United Air Lines, 109, 147-149  
 United Aircraft Export Division of United Aircraft Corp., 400  
 United Aircraft Products, 395  
 United States Chamber of Commerce, 23  
 University of Georgia School of Aviation, 127-128  
 University of New Mexico, 169
- V
- Valk, W. E., 509  
 Vega Airplane Co., 234, 235, 278  
 Venezuela, 250

Versailles Treaty, 21  
 Vickers, Inc., 395  
 Victory, J. F., 520  
 Vinson-Trammell Act, 33  
 Vollandt, W. F., 514  
 Voorhes, S. W., 509  
 Vought-Sikorsky Aircraft Division of  
 United Aircraft Corp., 278-284  
 Vultee Aircraft, Inc., 284-289

## W

Waco Aircraft Co., 289  
 Waldorf, H., 545  
 Walker, F. C., 517  
 Walker, P. A., 514  
 Walsh, F. J., 508  
 Walsh, R., 514  
 Walz, E. J., 160  
 War, European, 11-16  
 Ward, J. C., Jr., 508  
 Warner, E., 520, 524  
 Warner, J. A. C., 512  
 Warner Aircraft Corp., 323-324  
 Washington National Airport, 183-  
 184  
 Wayne Division of Bendix Aviation  
 Corp., 341  
 Weather Bureau, 91-96  
 Weatherhead Co., 395-396  
 Webb, J. E., 510  
 Webster, G., 524  
 Webster, W. W., 516  
 Wehmiller, H. E., 508  
 Wellington Sears Co., 396  
 Western Air College, 128  
 Western Air Express, 149  
 Western Air Lines, 149-150  
 Western Electric Co., 396-397  
 Western Flying magazine, 545

Westinghouse Air Brake Co., 342  
 Westinghouse Electric & Manufac-  
 turing Co., 397-398  
 White, S. S., Dental Manufacturing  
 Co., 398-399  
 Whitman, R. P., 509  
 Whitney, R. U., 42  
 Whitney, O. J., Inc., 400  
 Whyatt, E. I., 167  
 Wickard, C. R., 530  
 Wiggins, E. W., Airways, 128  
 Wilcox-Rich Division of Eaton  
 Manufacturing Co., 349, 399  
 Wild, A. W., 508  
 Wilson, C., 520  
 Wilson, D., 514  
 Wilson, E. E., 509  
 Wilson, F. H., 44  
 Wilson, G. R., 510  
 Wittek Manufacturing Co., 399  
 Wold, T. G., 43  
 Wolf, A. L., 510  
 Wolfe, F. C., 42  
 Woodward Governor Co., 399  
 Woolman, C. E., 509  
 Works Project Administration, 181  
 Wright, O., 520  
 Wright, R., 524  
 Wright, T. P., 85, 514  
 Wright Aeronautical Corp., 233, 324-  
 332  
 Wright Brothers Lecture, 171

## Y

Younger, J. E., 512

## Z

Zenith Carburetor Division of Bendix  
 Aviation Corp., 341

