CHAPTER 6

Advantages of the Diesel for Aviation

The mechanical advantages which the Diesel aircraft engine has over the gasoline aircraft engine include elimination of electrical ignition trouble and interference with radio communication, freedom from carburetor trouble at sea-level and at various altitudes, lower exhaust gas temperature permitting the use of an exhaust-driven supercharger, and better installation in the airplane. These advantages formerly were offset by the greater specific weight of the Diesel but now that this has been reduced to approximately that of the gasoline engine, full advantage can be taken of them for aviation.

IGNITION FEATURES

The ignition of its fuel by air automatically heated in its cylinders to a high temperature in the Diesel is advantageous in that it eliminates the need for electrical ignition equipment such as magnetos, distributors, spark plugs and shielded wiring. Rain and damp weather no longer are detrimental and delays due to ignition trouble are unknown when the Diesel is used in an airplane. No electrical interference from the ignition system which might affect radio communication is possible with a Diesel. (Fig. 57.)

FUEL FEATURES

Although the fuel injection system on a Diesel aircraft engine requires a number of high-pressure pump units and injectors the functioning of this equipment is comparatively simple and has been standardized to a considerable extent (The American Bosch Corporation manufactures standardized fuel injection equipment suitable for Diesel aircraft engines). The high-speed Diesel is not fuel-sensitive like a gasoline engine and runs satisfactorily on ordinary commercial grade fuel oil. No complicated up-draft or down-draft carburetors with automatic compensating devices are necessary on the Diesel as the latter operates with excess air at low altitudes which benefits it at high altitudes by providing more air and oxygen for combustion and enabling it to maintain its power.

Fig. 57.—*Blohm & Voss Ha 139 Diesel-engined transatlantic mail-plane.*

TEMPERATURES

Relatively low exhaust gas temperatures make it possible to use an exhaust-driven supercharger on a Diesel aircraft engine whereby its power output can be increased considerably without appreciable power absorption from the engine as in the case of a gear-driven supercharger. (The average temperature of the exhaust gases of a Diesel aircraft engine is 1,000° Fahrenheit compared with a temperature of 1,600° Fahrenheit for the exhaust gases of a gasoline aircraft engine.) This low exhaust gas temperature is due to the higher thermal efficiency of the Diesel and the more complete combustion of fuel and conversion of thermal units into mechanical energy. Engine cooling problems also are reduced as there are fewer waste heat units to dissipate and this in turn permits smaller radiators and cooling surfaces and tends to reduce weight.

AERODYNAMIC FEATURES

The non-explosive characteristics of fuel oil make the installation of the Diesel simpler as the fuel tanks can be located close to the passenger cabin in a landplane or in the bottom of the hull of a flying boat. The size of the fuel tanks is less due to the more economical fuel consumption of the Diesel and they can be placed nearer to the center of gravity and the longitudinal axis of the airplane thereby improving its aerodynamic qualities. (Fig. 58.) Installation of the fuel lines is simpler as there are no explosive fumes from fuel oil at ordinary atmospheric temperatures.

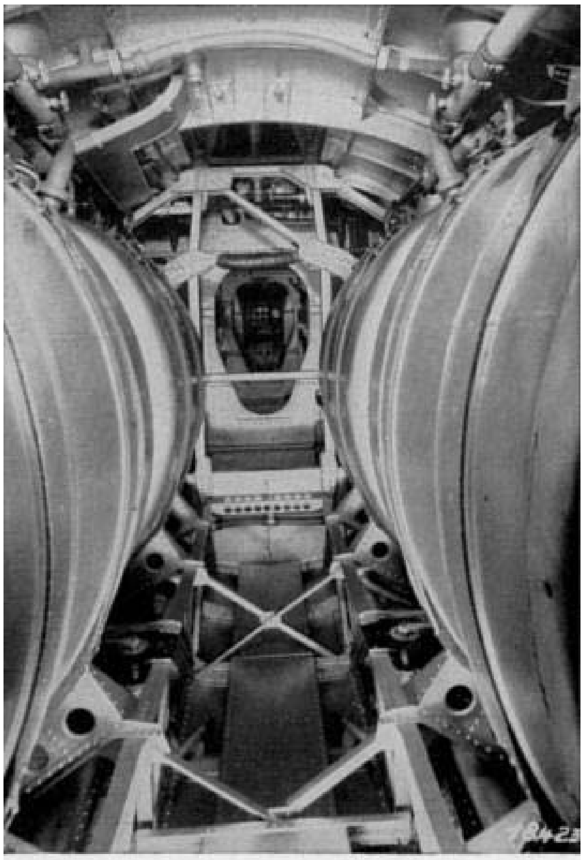

Fig. 58.—*Fuel oil tanks in hull of Dornier Do 18 flying boat.*

As for the weight of the fuel injection equipment required for a Diesel aircraft engine this compares very favorably with the weight of the ignition and carburetion equipment for a gasoline aircraft engine and in fact, it might even be lighter. The cost of the fuel injection equipment for a Diesel probably will be less than that of the corresponding items for a gasoline engine when Diesel production has assumed reasonable quantities. The specific weight of the Diesel aircraft engine now is approximately the same as that of the gasoline aircraft engine, particularly in the case of engines of high power output.

ECONOMIC ADVANTAGES OF THE DIESEL

The economic advantages of the Diesel aircraft engine center around the characteristics of the fuel which it uses to a great extent. Not only does the Diesel use fuel which is much cheaper than aviation gasoline but it also consumes less fuel due to the better utilization of the thermal units contained in it. When these two factors are combined to determine the fuel operating cost it is found that the latter is a great deal less than for a gasoline engine of equal output. Other factors such as ability to carry more payload and/or fly further on the same weight of fuel add to the advantages of the Diesel from the economic viewpoint. (Fig. 59.)

Fig. 59.—*Junkers Ju 86 mailplane—range 3,600 miles—payload 1,000 lb.*

FUEL COST

The fuel oil used in a modern high-speed Diesel aircraft engine is approximately the same as No. 2 furnace oil which is utilized for heating purposes in the United States. It does not contain any dope such as tetra-ethyl-lead which might add to its cost and it is not subject to evaporation losses. It is cheap to buy and costs only 5 cents a gallon (tax extra) compared with 11 cents a gallon (tax extra) for 87-octane gasoline. It is available all over the world and kerosene can be substituted for it in an emergency. Its flash point of 150° Fahrenheit makes it safe in storage and on an airplane as it does not give off inflammable vapor at atmospheric temperature which might be ignited accidentally.

FUEL CONSUMPTION

The fuel consumption of a Diesel aircraft engine such as the Junkers Jumo 205 is approximately 22 per cent less than that of an 87-octane gasoline aircraft engine. The comparison has to be made on a specific weight basis because if it was made on a specific volume basis (or number of gallons of fuel consumed per h.p. per hour) it would not be correct due to the fact that a gallon of fuel oil weighs slightly more than a gallon of gasoline (Fuel oil weighs approximately 7 lb. per gallon and gasoline weighs approximately 6 lb. per gallon). The specific fuel consumption of the Junkers Jumo 205 Diesel aircraft engine is now 0.35 lb. per h.p. per hour compared with a consumption of 0.45 lb. h.p. per hour for an 87-octane gasoline engine, at cruising output. Taking both the lower cost of its fuel and its lower fuel consumption into account it is found that there is a saving of approximately 70 per cent in fuel operating cost in favor of the Diesel aircraft engine. This saving applies to both civil and military aircraft.

The advantage of being able to carry a greater payload and/or fly a longer distance with the same weight of fuel which a Diesel-engined airplane has over a gasoline-engined airplane is due to the lower fuel consumption of the Diesel. Fuel oil also occupies less space than gasoline due to its higher specific gravity and so more room is available for passengers or cargo in the airplane (Fuel oil has an approximate specific gravity of 0.840 and gasoline has an approximate specific gravity of 0.720). Greater payload capacity constitutes a very important advantage for airline operators and can only be obtained by utilizing the Diesel whether it be for short flights over land or long-range flights over land and sea. (Fig. 60.)

Fig. 60.—Two of Deutsche Lufthansa's Junkers Ju 86 airliners at Tempelhof, Berlin.

FIRE HAZARD ELIMINATION

In addition to the saving in fuel operating cost and the increase in payload capacity made possible with the Diesel there is also the advantage of elimination of fire hazard which accrues with the use of this type of power plant. Thousands of valuable lives and many millions of dollars' worth of equipment have been lost in fires involving gasoline. Private fliers and their passenger's have been trapped in their planes and burned alive. Airliners have caught fire in the air or on the ground and have become fiery tombs for their inmates. Army and Navy pilots and their crews have lost their lives in fiery holocausts of a similar nature. Even people on the ground below have not been safe from the fires spread by crashing airplanes and flaming gasoline.

The non-explosive character of fuel oil used in Diesel aircraft engines eliminates practically all danger of fire on airplanes in which these engines are used. True, some fires originate with the lubricating oil but they are of a local nature and can be extinguished quickly provided there is no highly explosive fuel to add to the flames. Thick oil actually will extinguish a rag dipped in gasoline and ignited, so its adoption for aviation where fire now constitutes one of the greatest hazards is justifiable on humanitarian grounds alone.

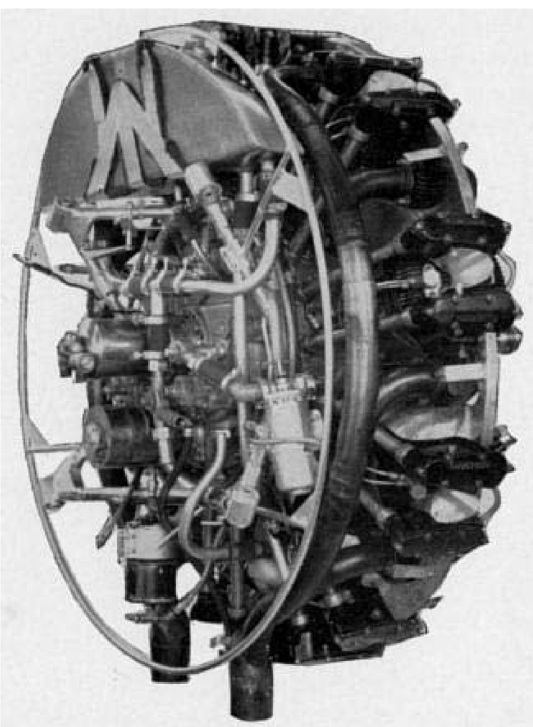

Fig. 61.—Guiberson A-1020 Diesel with accessories and exhaust manifold.

The experience of the Guiberson Diesel Engine Company, developers of the Guiberson A-1020 Diesel aircraft engine, is of particular interest with regard to fire hazard. During an endurance test of one of their nine-cylinder, air-cooled radial Diesels one of the cylinder heads cracked open. The engine continued to run on eight cylinders for several hours before the engineer in charge became aware that anything serious was wrong. He noticed a loss in power but by opening the throttle he obtained the required output from the engine. Apart from the broken cylinder head and the loss of the fuel which the injection pump kept injecting into the cylinder, no damage was done. The point to be emphasized here is that nothing short of a major engine failure such as a broken crankshaft or connecting rod need necessitate shut ting down a Diesel either on the ground or in the air. In a case like this a Diesel-engined airplane could make a forced landing under its own power or fly to the nearest airport without fear of fire. (Fig. 61.)

ADVANTAGES FOR CIVIL AVIATION

The advantages of the Diesel for civil aviation are so overwhelming that when suitable Diesels become available it will not be long before they are used extensively in privately-owned airplanes as well as in large transport planes for passengers and freight. For the private flier there will be the advantage of reduced fire hazard which will safeguard him in forced landings and make the sport even more popular than it is today. The advantages of reduced fuel load and increased payload or flight range also will be noticeable despite the relatively small size of such airplanes. Reduction in fuel operating cost will enable the private flier to spend considerably more hours in the air than he can afford to do at present. (Fig. 62.)

SPECIALIZED DIESEL ADVANTAGES

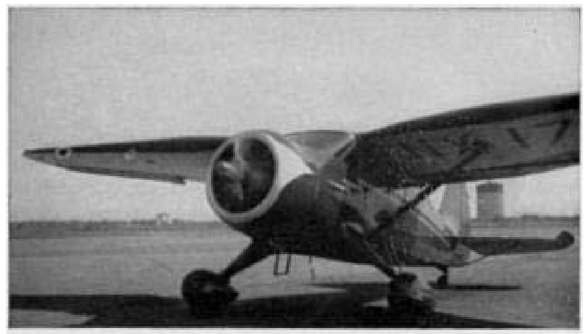

Fig. 62.—*Privately-owned Stinson Reliant powered with Guiberson A-1020 Diesel.*

Owners of airplanes used for special purposes such as exploration in tropical or arctic regions far from ordinary lines of communication will find the Diesel particularly advantageous. In addition to the outstanding advantage of reduced fire hazard the difficulty of transporting fuel to remote out-of-the-way places will be reduced due to the smaller amount of fuel required. The fact that fuel oil does not evaporate at atmospheric temperatures will make fuel storage easier and the ability of the Diesel to run on kerosene in an emergency is an asset which should not be overlooked. Absence of electrical interference from the ignition system of the Diesel is another advantage for expeditions of this kind as it will help to improve radio communication.

COMMERCIAL ADVANTAGES

Airline companies will find the Diesel advantageous for many reasons when reliable engines of this type are available for everyday use. The safety factor of their operations will be increased due to the elimination of fire hazard and the psychological effect on both passengers and crew will be most pronounced. Sleeper planes will become more popular and refueling will not present any hazards. Reduction of fuel loads will enable greater payloads to be carried or schedules to be speeded up by eliminating refueling stops. Fuel operating costs will be cut in half and even insurance rates will be reduced.

For transatlantic airlines the Diesel will prove to be ideal as it will enable larger payloads of passengers and mail to be carried non-stop over considerably greater distances than is now possible with gasoline-engined planes. No longer will intermediate stops have to be made between the United States and Europe which waste time and subject American property to interference by another nation. Passengers will not be forced to wait indefinitely due to the inability of airliners to carry them as well as the mail. Special Diesel-engined mailplanes will be catapulted to ensure that the mail leaves on time regardless of weather conditions. (Fig. 63.) Greater business will result from the use of Diesel-engined airplanes which will save time for the passengers and ensure greater profits for the airlines. All of these highly desirable changes will be brought about by the use of the economical Diesel for aviation in the future after World War II.

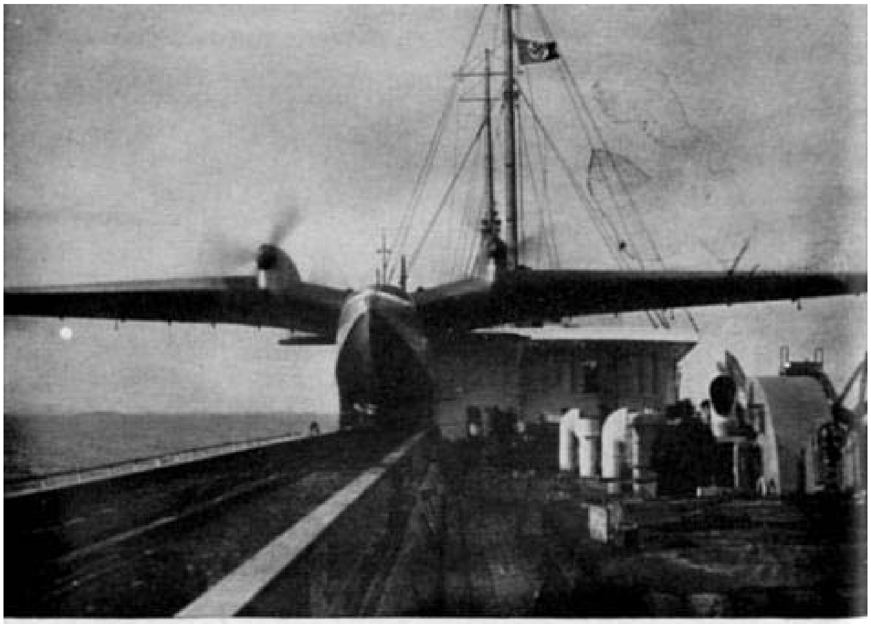

Fig. 63.—Dornier Do 26 transatlantic mailplane ready for catapulting.

ADVANTAGES FOR MILITARY AVIATION

Increased flight range and ability to carry a greater military load are two of the outstanding advantages which the Diesel makes possible for military airplanes. Due to the fuel economy of the Diesel the range of warplanes equipped with this type of power plant can be increased by 25 per cent and their load carrying capacity can be increased by a similar percentage. In this connection it should be mentioned that the German Air Force found that when one hundred Diesel-engined bombers such as the two-engined Junkers Ju 86-K were in flight there was a saving of approximately five tons of fuel each hour compared with the fuel required for one hundred gasoline-engined bombers of similar size and engine power. (Fig. 64.)

Fig. 64.—Germany has many squadrons of Diesel-engined Junkers Ju 86-K bombers.

INCREASE OF RANGE

With regard to our Army warplanes, the Diesel will be advantageous in that the range of our bombers will be increased and their striking power become more effective. Our fighting planes will be able to remain longer in the air and provide better protection for our country. Our observation planes will be able to cooperate with our land forces to greater advantage when they use the same kind of fuel as our mechanized forces which are fast being Dieselized. As for our Navy warplanes, both our long-range patrol flying boats and scout-observation planes will be more useful when powered with Diesels which increase their range and enable them to provide better eyes for the fleet. Our fighters and torpedo planes based on our aircraft carriers likewise will operate more efficiently.

Elimination of fire hazard will prove to be an advantage of great importance for both our Army and Navy air services in times of peace and war. The use of non-explosive fuel oil will reduce fires and loss of life and these services will not lose costly warplanes in gasoline fires as has happened in the past. Danger of explosion of fuel in storage will be eliminated to a great extent and this is a matter of vital importance for the Navy which carries much of its aircraft fuel afloat in aircraft carriers where a fire might result in the destruction of the entire vessel.

After studying the progress made with the Diesel aircraft engine in various countries it is possible to forecast the future trend of its development in the United States. In the case of relatively low-powered engines, that is to say, engines with power outputs of less than 300 h.p., it appears that air-cooled Diesels operating on the four-cycle principle offer the best solution to the problem. Such engines are not difficult to build as they can follow conventional practice. It is not necessary to supercharge them as they give good performance up to an altitude of from 10,000 ft. to 15,000 ft. which is high enough for most small airplanes.
Diesel aircraft engines of medium output, that is to say, of from 300 h.p. to 700 h.p., also can be built with air-cooled cylinders provided they function on the four-cycle principle. Gear-driven superchargers can be used to advantage on these engines whereby their sea-level power is maintained to an altitude of approximately 15,000 ft. A service ceiling of from 25,000 ft. to 30,000 ft. is attainable with this type of engine (The Clerget 14 F-O1 Diesel aircraft engine has been flown to an altitude of 25,114 ft. and the Bristol Phoenix Diesel has been flown to an altitude of 27,453 ft.).

For large Diesel aircraft engines with power outputs in excess of 700 h.p. it appears desirable to use water cooling or ethylene glycol cooling. Such engines should be designed for two-cycle operation so as to obtain the maximum power output per unit of cylinder displacement. (Fig. 65.) A blower is necessary on such engines for scavenging and air loading and it can be geared to run at a higher speed so as to supercharge the engine. On Diesels for military purposes and on high-powered Diesels for civil use it is desirable to use an exhaust-driven supercharger which does not impose a great power drain on the engine. A rated altitude of 25,000 ft. is possible with an exhaust-driven supercharger and a service ceiling of 40,000 ft. should be attainable with an airplane so equipped.

Here in the United States we have made a good start with low-powered air-cooled Diesels such as the Guiberson A-1020 and we also have done considerable research work with high-powered liquid-cooled Diesels such as the Godfrey. Now is the time to put our shoulder to the wheel and see to it that these and other types of Diesel aircraft engines suitable for our needs are developed and placed in production.

Fig. 65.—*The author in Germany with a Diesel-engined Junkers Ju 86 airplane.*