CHAPTER IX

AIRCRAFT ENGINE ACCESSORIES

Aircraft engine accessories can be divided into three general groups; (1) those essential for operation of the engine, (2) those essential for operation of the airplane and simply use the engine as a driving source, and (3) those instruments used for indicating the operating condition of the engine.

It is the policy of the Wright Aeronautical Corporation to investigate all accessories that come within the first and second groups to insure that they will properly fit the mounting provision on the engine and that they will have no detrimental effect upon the life or operation of the engine. This investigation and the subsequent release, however, does not make the Wright Aeronautical Corporation responsible for the durability of the accessory, nor for the operation of the accessory except in so far as it affects the operation of the engine. The Field Engineering Division of the Wright Aeronautical Corporation will at any time, furnish information regarding the status of any accessory which has completed or is undergoing investigation.

The release of an accessory is based on its adaptability to a particular drive, taking into consideration the power required and the strength of the drive, the inclusion of a proper shear member in the accessory to protect the engine drive from damage in event the accessory fails, the lubrication requirements of the accessory, and the provision of proper seals at the drive shaft. When selecting an accessory, it is therefore necessary to determine the drive or drives it is released for.

Propellers

All Wright engines are supplied with a splined propeller shaft end, patterned after the SAE standard and suitable for receiving propellers with metal hubs. Since it is often desirable on certain type aircraft to use wooden propellers, splined hubs are available for these with certain SAE shaft sizes. Table V lists the SAE shaft sizes as supplied on current Wright engines, and Table VI lists the wooden propellers available for certain of these shafts.

When ordering propellers from the manufacturer, the engine number, model, propeller gear ratio, and propeller shaft dimensions, i.e. SAE shaft size, thread length, and information regarding the hydraulic adapter for hydraulic propellers, should be given. While Wright Aeronautical Corporation keeps a complete record of propeller shaft sizes on engines as shipped from the factory, since replacement parts are installed by operators in the field, propeller manufacturers should have shaft dimensions verified by the operator in each instance prior to furnishing the propeller.

TABLE V

Series	Model	SAE Propeller Spline Standard	SAE Propeller Spline Optional
Whirlwind	R-760-ET	20	30
	E1	20	30
	E2	20	30
	R-975-E1	30	
	E3	30	
Cyclone	R-1820-F50	40	
	GR-1820-F50	50	
	R-1820-G	40	
	GR-1820-G and G100	50	

TABLE VI

Hubs for wooden propellers
available for SAE propeller splines

SAE Propeller Spline	WAC Part No.
30	48869
40	47195

The Wright Aeronautical Corporation in conjunction with the propeller manufacturers have conducted very extensive investigations on various combinations of propellers and engines to determine the blade stresses under all conditions of operation. As a result it has been found necessary to put a definite release on only those propeller-engine combinations showing no undesirable resonant vibration stresses. For this reason, when ordering a propeller, it is necessary to inform the propeller manufacturer the number of the engine and its model and the propeller gear ratio for which the propeller is intended.

The principal propeller shaft designations are the spline size, the length of thread for the propeller nut and, in the case of hydraulic propellers, type of oil transfer connection. The S.A.E. #50 propeller shaft has short and long type threads. The short thread is nominally 5/8" long, the long thread end is increased 7/16", or is nominally 1-1/16" long. Propeller nuts supplied for the long thread shafts are also suitable for the short thread shafts but a nut designed for the short thread shaft will fit that shaft only. There is but one type thread for S.A.E. #40 spline, which is essentially the short thread type and has threads nominally 3/4" long. No changes have been made on the #40 spline end or the S.A.E. #30 or #20 end which would affect interchangeability.

All engines of the Cyclone series are fitted with a hydraulic propeller oil transfer connection suitable for any kind of hydraulic propeller. By removal of the plug in the end of the adapter illustrated in Figure 85, the arrangement is suitable for a two-position or constant speed propeller. By removal of the complete adapter and insertion of suitable propeller parts, the arrangement is suitable for a hydromatic propeller. For any propeller not using oil for operation, the adapter should be left intact. When using a hydraulic propeller, the propeller manufacturer should be advised of the distance between the face of the propeller shaft and the face of the oil transfer connection less end plug.

The foregoing also applies to engines of the Whirlwind series with the exception of the remarks pertaining to installation of hydromatic propellers, as the Whirlwind series is not equipped for this type of installation.

When Curtiss electic propellers are installed it is necessary to fit an adapter on the nose of the engine. A ring 3/8" thick is supplied on all Cyclone engines which is removed for installation of the Curtiss brush housing. This installation is illustrated in Figure 86.

All Wright engines are supplied with a constant speed propeller governor drive and mounting pad on the nose section. It is possible to drive the Curtiss electric propeller governor remotely from one of the accessory or tachometer drives on the rear of the engine. Detailed instructions regarding installation and control of

FEATURES OF PROPELLER SHAFT PERTINENT TO PROPELLER INSTALLATION

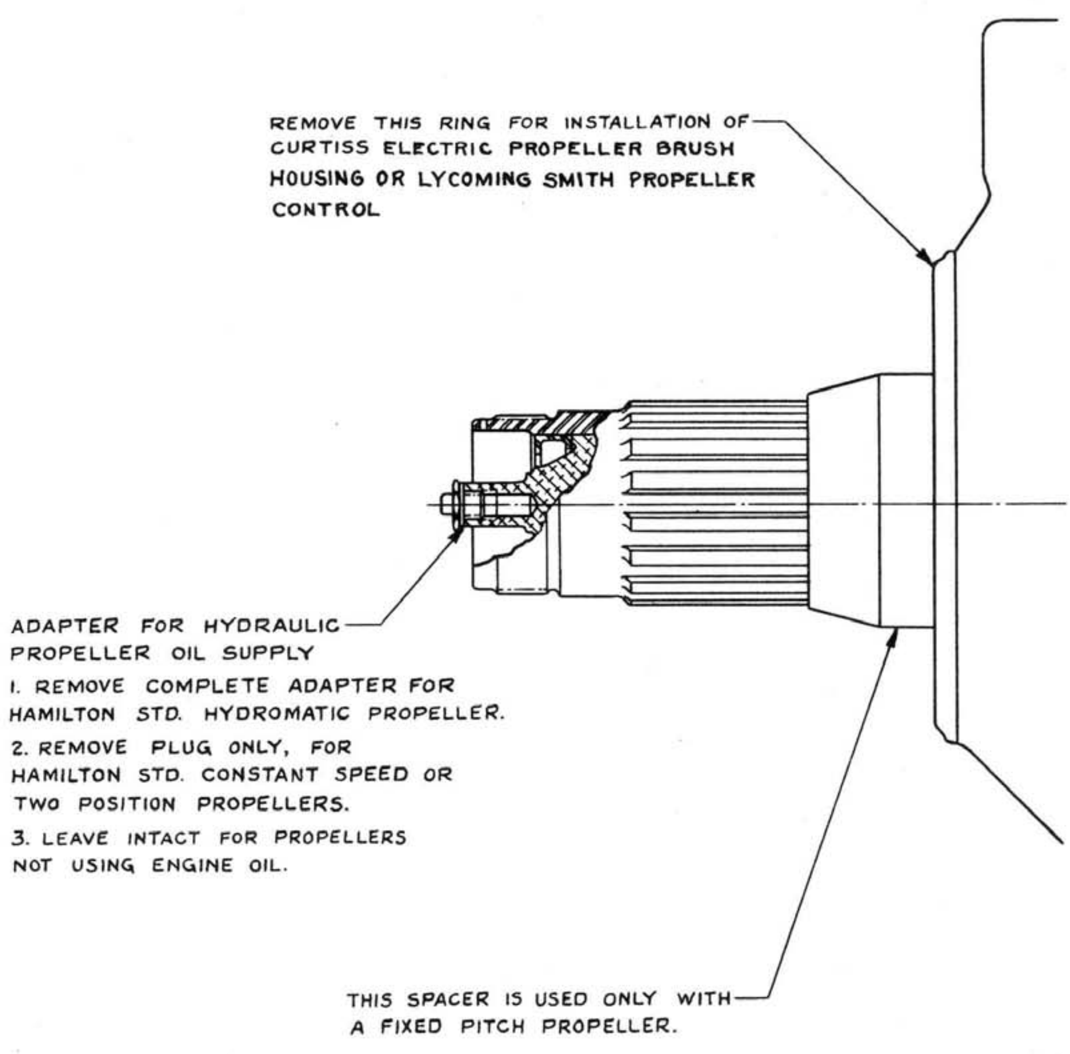


Figure 85

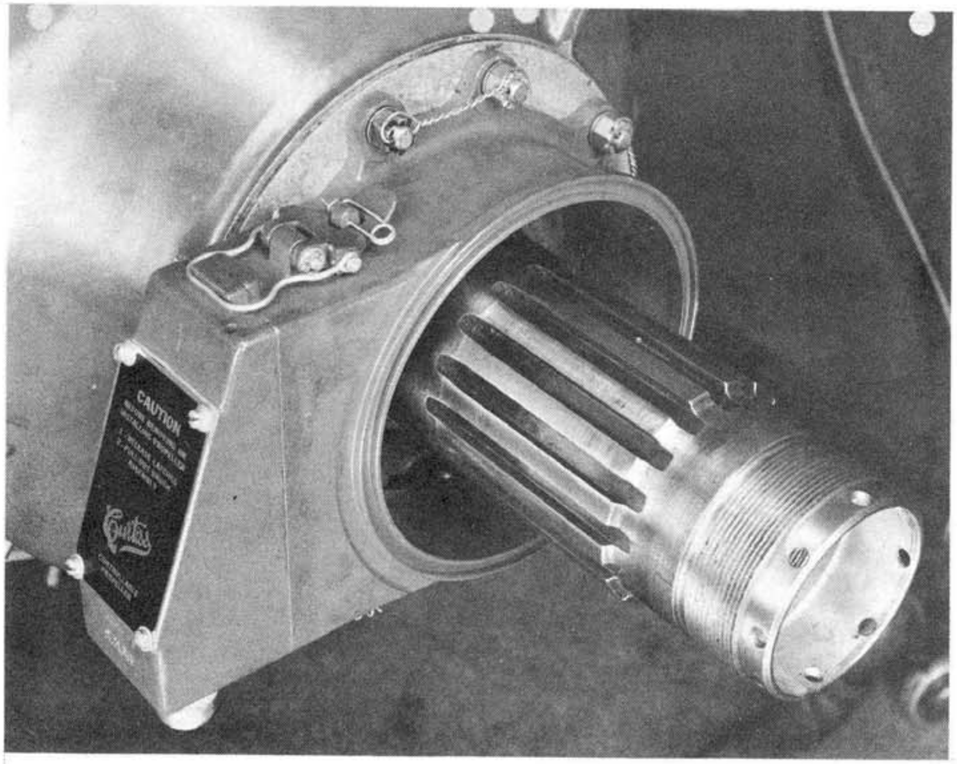


Figure 86

Courtesy
Curtiss Propeller
Corp.

constant speed propeller governors can best be obtained from the manufacturer of the governor in question. Any constant speed governor drive on the engine nose section can be easily converted to a control for a two position hydraulic propeller by the installation of suitable parts. Figure 87 illustrates a constant speed propeller drive as supplied on engines of the Cyclone series.

For the feathering operation of Hamilton-Standard Hydromatic propellers it is necessary to install an auxiliary high pressure oil system. The two systems in current use for feathering this propeller are as follows:

(1) A system using engine oil from the supply tank pumped to the propeller by an auxiliary pump, independently or engine driven.

(2) A system using low viscosity oil from an independent supply, pumped to the propeller by an auxiliary pump, independently or engine driven.

The choice of the feathering system is determined by the type of airplane to which it is being applied. Either system meets with the approval of the Wright Aeronautical Corporation when the feathering operation is conducted in accordance with their detailed instructions.

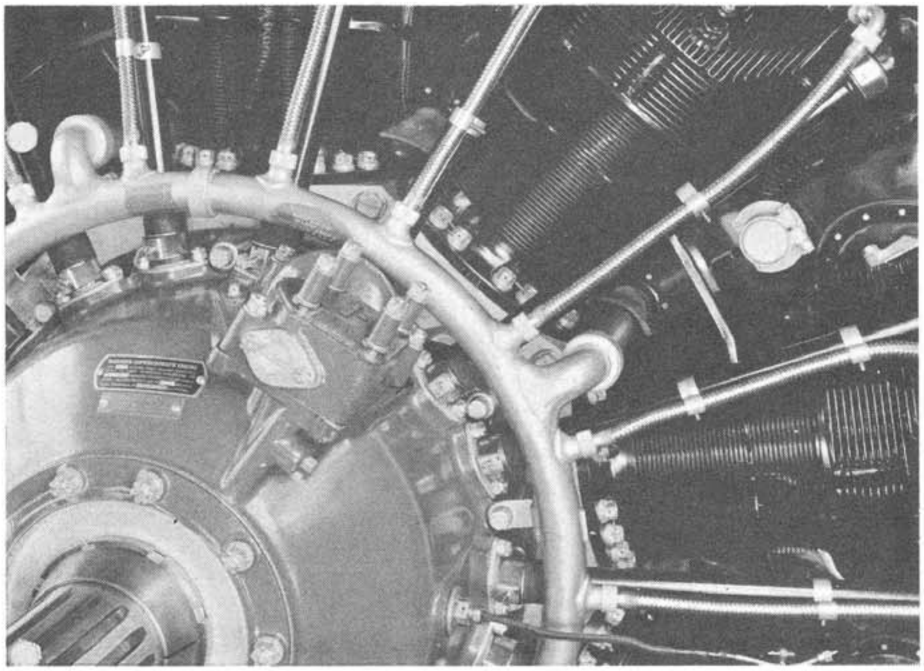


Figure 87

Because of the wide variety of airplanes to which feathering propellers can be applied, definite recommendations for their installation cannot be made. However, the following points should be given consideration when designing the feathering installation on any airplane.

(1) It must be possible to feather the propeller with the engine stopped. Therefore, on single engine airplanes the high pressure feathering pump must be driven independently of the engine. Multi-engine airplanes, using the hydraulic system for feathering, can satisfy this requirement if hydraulic pumps are installed on each engine.

(2) Where feathering is to be conducted as a normal flight procedure, such as in the case of a long range flying boat, the use of engine oil is recommended. The restrictions applying to engine power output subsequent to unfeathering when using low viscosity oil precludes its use for such procedure.

(3) Where feathering is to be conducted only for emergency purposes or under controlled flight conditions, such as pilot training, etc., the use of either system is satisfactory.

All feathering procedure must be conducted in accordance with instructions from the Wright Aeronautical Corporation.

Fuel Pumps

The standard fuel pump drive on a Cyclone engine is on the right hand side of the rear crankcase over the dual tachometer drive housing. Figure 88 shows this position as well as alternate locations with the corresponding (installation drawing supplement) SU part numbers. All fuel pumps are provided with a drain for the fuel that leaks past the shaft seal. A 1/4" O.D. drain line should be connected to this drain and it should be piped outboard, clear of all parts on the airplane.

The standard fuel pump drive on a Whirlwind engine is at the lower right hand corner of the rear cover, as illustrated in Figure 89. An alternate location is possible when the engine is equipped with a spur gear accessory drive box. This location is also shown in Figure 89. The fuel pump drainage requirement, as mentioned above, applies to pumps on the Whirlwind series as well as on the Cyclone series.

A list of tested and released fuel pumps for use on Wright engines is given in Table VII in the Appendix. Information on pumps not given in this table will be furnished upon request to the Field Engineering Division of the Wright Aeronautical Corporation.

Starters

All Wright engines are equipped for the installation of a starter on the rear cover. The starter for the Cyclone engine connects directly to the tailshaft and consequently it must turn clockwise, as viewed from the rear. The Whirlwind starter must turn counter-clockwise, as viewed from the rear, because it connects to a jack-shaft which is geared to the crankshaft. A list of tested and released starters for use on Wright engines is given in Table VIII in the Appendix. There are two styles of starter drives; the 3-jaw type and the 12-jaw type. When ordering an engine, the style starter drive should be specified.

There are three types of starters generally used, they are: - direct cranking electric with hand crank; combination hand and electric inertia; and, the combustion type. Of these three types, it has been found that the inertia type starter provides the highest average cranking speed for the first two revolutions of the engine. The direct cranking type can be designed to provide the same cranking force as the inertia type for substantially continuous cranking but the battery supply is limited. Therefore, in general, the cranking speed of direct cranking starters is considerably less than that of the inertia type although they do turn the engine more revolutions.

The combustion type starter obtains its energy from expansion of the gases arising from the burning of a powder in a cartridge. This energy is transferred to a piston in the starter and by means of the starter mechanism, the linear motion of

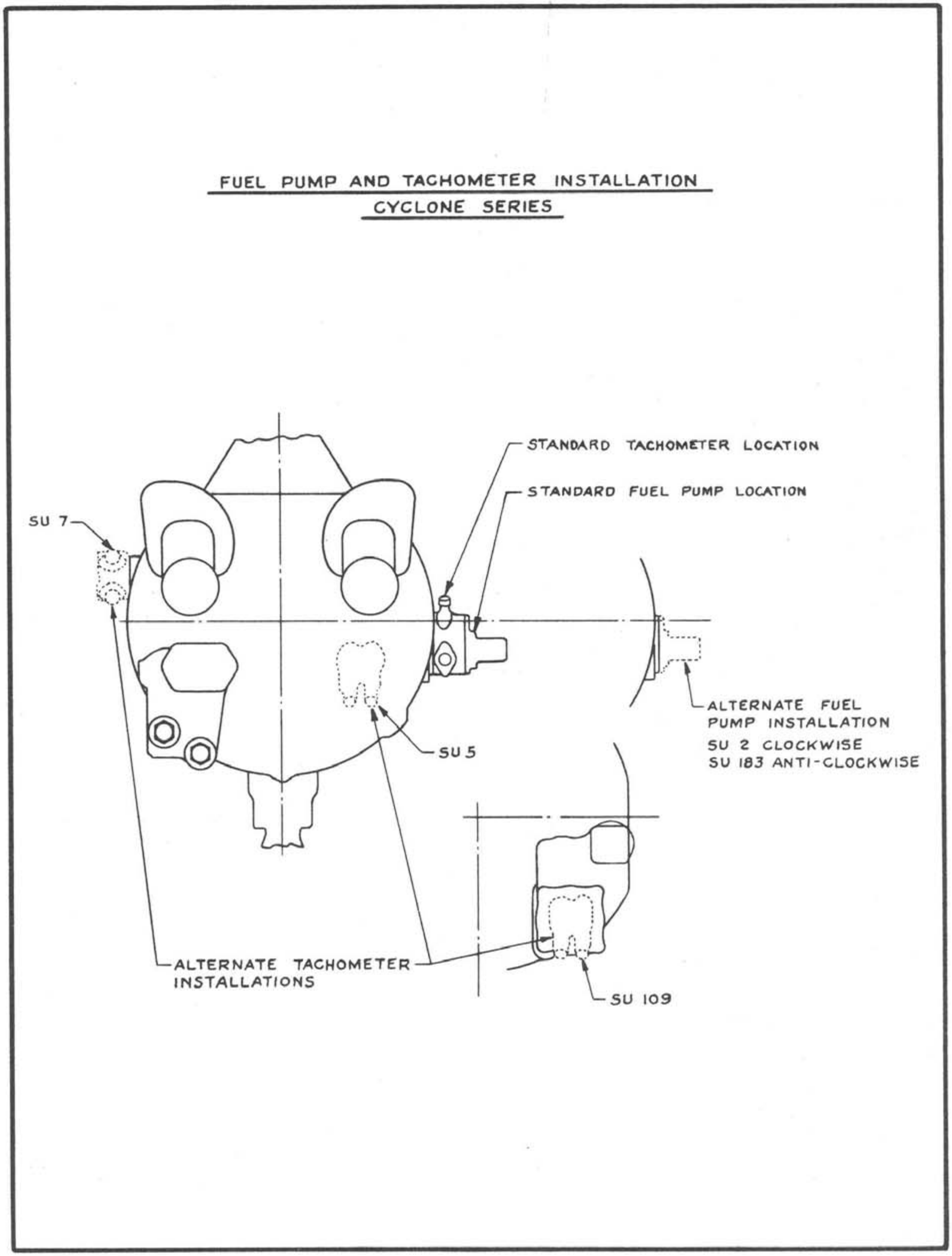

FUEL PUMP AND TACHOMETER INSTALLATION
CYCLONE SERIES
STANDARD TACHOMETER LOCATION
STANDARD FUEL PUMP LOCATION
SU 7
ALTERNATE FUEL PUMP INSTALLATION
SU 2 CLOCKWISE
SU 183 ANTI-CLOCKWISE
SU 5
ALTERNATE TACHOMETER INSTALLATIONS
SU 109

Figure 88

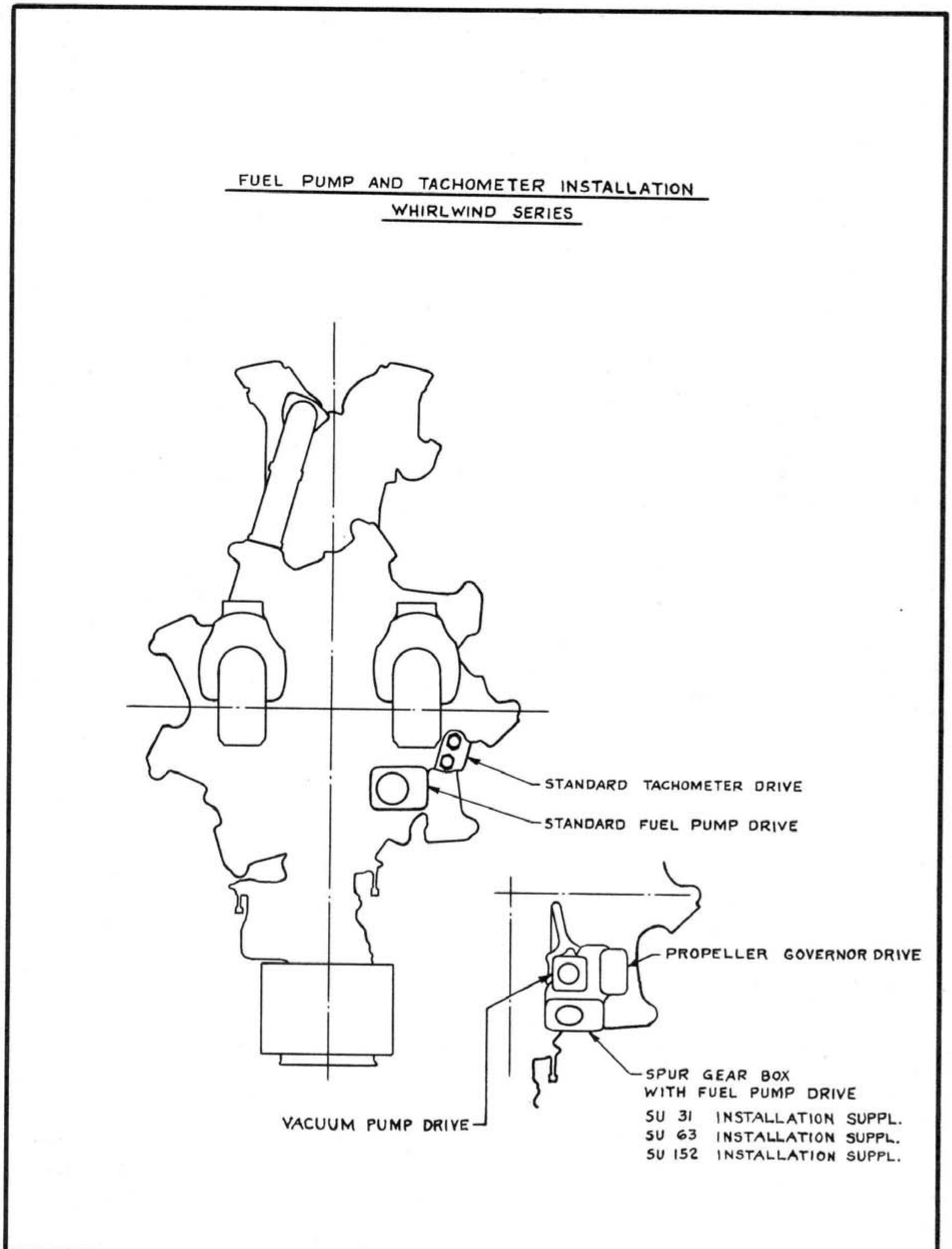

FUEL PUMP AND TACHOMETER INSTALLATION
WHIRLWIND SERIES
STANDARD TACHOMETER DRIVE
STANDARD FUEL PUMP DRIVE
PROPELLER GOVERNOR DRIVE
SPUR GEAR BOX
WITH FUEL PUMP DRIVE
SU 31 INSTALLATION SUPPL.
SU 63 INSTALLATION SUPPL.
SU 152 INSTALLATION SUPPL.
VACUUM PUMP DRIVE

Figure 89

the piston is converted into rotational motion at the crankshaft without the use of slipping clutches. With this type starter, torque is applied to the crankshaft for only one revolution and the inertia of the propeller and engine must provide any additional cranking that is necessary. The initial starting torque is very high but it decreases rapidly.

For starting an engine the priming arrangement is somewhat related to the type of starter used. The direct cranking type starter provides the best opportunity for proper priming. No matter how many revolutions the engine makes, if the priming charge is not correct the engine will not start. Therefore, with the direct cranking starter the primer can be used while the engine is being turned over and, when the prime is correct, the engine will fire. With the inertia type starter it is necessary to pre-prime somewhat before engaging the starter since there is usually insufficient time for adequate prime before the starter inertia has spent itself. In other words, a certain amount of guess is involved in the priming procedure with this type starter. Using the combustion type starter this priming condition is almost entirely a guessing problem and experience must be gathered on the starting of the engine in question.

The inertia and combustion type starters are particularly attractive for small airplanes, such as trainers and military ships where weight is a major consideration. In airplanes with large power supplies the direct cranking electric or the electric inertia type starters are most applicable. From the standpoint of installation, the direct cranking electric starter is by far the simplest, it requires only the most elementary wiring. Refer to Figure 83.

Generators

Airplanes equipped with a battery form of power supply require a means of recharging the battery during flight. This is usually accomplished by an engine driven generator. All Wright engines are equipped with provision for a generator on the rear cover. Two styles of mounting pads are used. All engines, except the Cyclone G and G-100 series, have the 4 stud mounting pad. The 8 stud mounting pad is used on the Cyclone G and G-100 engines. Both of these mounting pads are illustrated in Figure 90. The 4 stud mounting has 5/16" diameter studs while 3/8" diameter studs are used for the 8 stud mounting. A generator with a 4 stud mounting flange can be used on the 8 stud mounting pad provided the holes are large enough to fit over the 3/8" diameter studs. Generator flanges must be absolutely true and the stud holes should be spot faced with an adequate radius at the edge of the spot face.

A list of tested and released generators is given in Table IX in the Appendix.

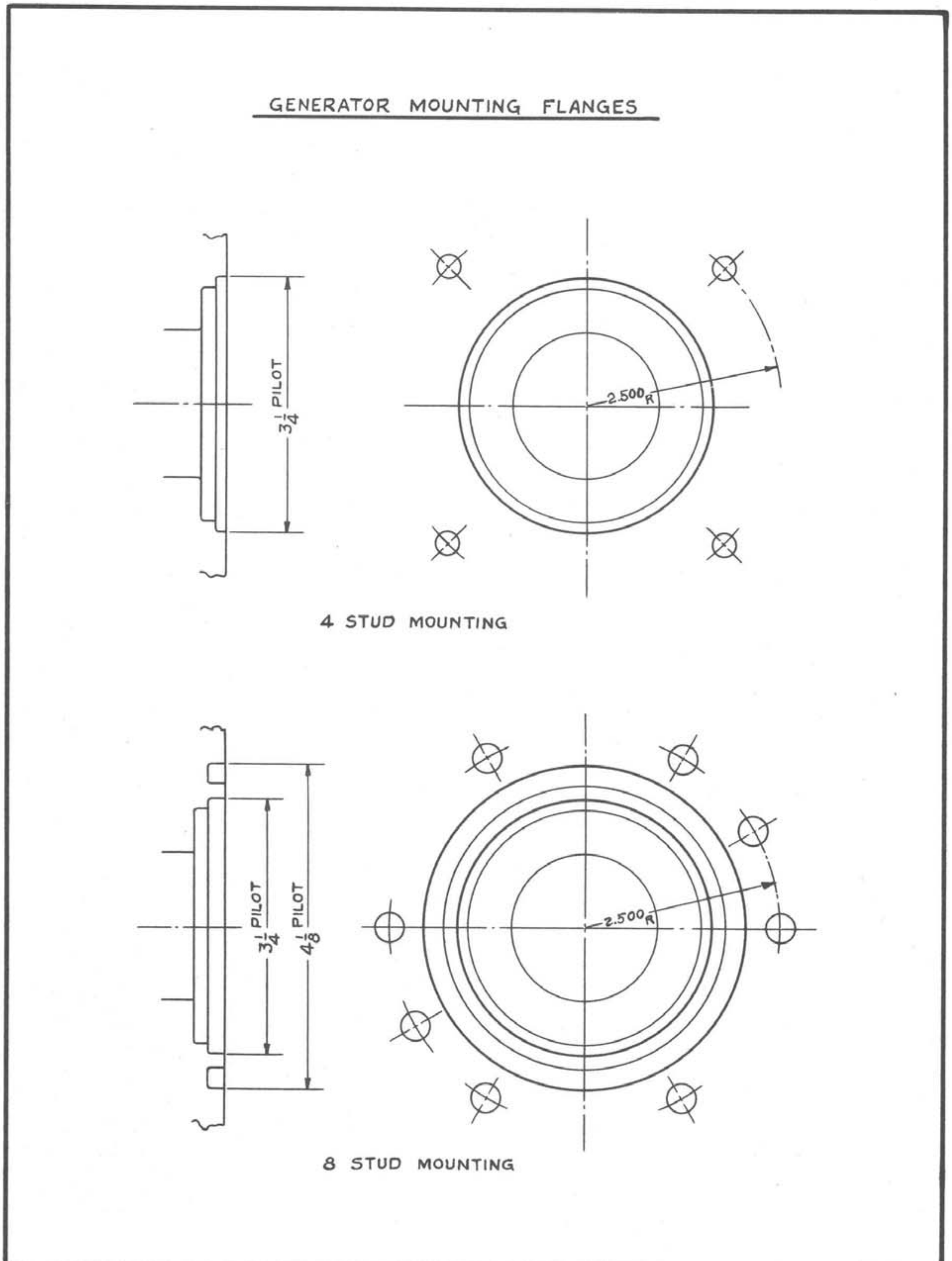
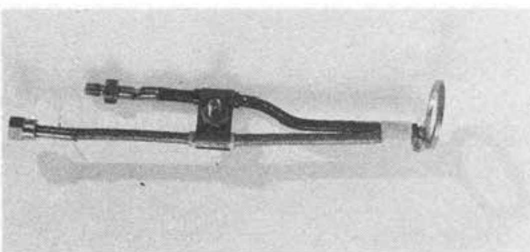

GENERATOR MOUNTING FLANGES
3 1/4 PILOT
2.500 R
4 STUD MOUNTING
3 1/4 PILOT
4 1/8 PILOT
2.500 R
8 STUD MOUNTING

Figure 90

Cylinder Temperature Indicator

It is essential to install at least one cylinder head thermocouple on every engine in the airplane. The cylinder to which the thermocouple is attached is determined during the installation flight tests. The cylinder that runs consistently hottest during these tests should be equipped with a permanent thermocouple installation. If it is found that the temperature distribution among cylinders is within $\pm 10^{\circ}$ F. during these tests, then the permanent thermocouple installation should be made on #1 cylinder.



Courtesy of
Lewis Engineering Co.
Figure 91

Several types of thermocouples have been tested and as a result the spark plug washer type has been found most satisfactory. This style thermocouple is illustrated in Figure 91. It is available in either iron and constantan or copper and constantan leads, both of which are satisfactory. Approved styles of these thermocouples can be obtained from the Weston Electric Instrument Company or the Lewis Engineering Company.

Tachometers

All Wright engines are equipped with dual tachometer drives which are located on the right hand side of the rear crankcase. Several alternate locations are possible on the Cyclone engine and these are illustrated in Figure 88. No alternate locations are possible on the Whirlwind engines.

When electric tachometers are used the tachometer generator should be mounted remotely from the engine and driven by a flexible drive. A tachometer generator of this type is illustrated in Figure 92. Future engines will, in all probability, have provision for mounting this unit directly on the engine.

Figure 92

Courtesy
Kollsman
Instrument Co.

Pressure Connections

The airplane should always be equipped with instruments to indicate the manifold pressure, oil pressure, and fuel pressure readings of all engines. The location of these pressure connections is given on the engine installation drawing. It is desirable to install a small blow out valve in the manifold pressure line, accessible to the pilot, so any condensate or oil that may accumulate in this line, and thereby affect the instrument reading, can be cleared out when necessary.

Fuel pressure should always be measured directly at the connection provided on the carburetor. When the indicator is not at the same elevation as the carburetor the difference in head must be taken into consideration when setting the relief valve. Forty inches of gasoline head is equivalent to one pound per square inch.

Fuel Air Ratio Indicator

With the advent of constant speed propellers and the requirement for more exacting limits on fuel consumption, the fuel air ratio indicator has become a necessary piece of flight equipment. This instrument operates by using the thermal conductivity of a sample of the exhaust gases to indicate the constituent of that sample. This analysis is given to the engine operator by means of an indicator in terms of fuel-air ratio. Obviously, it is important that the sample taken be representative of the engine conditions as a whole and this thought must be kept well in mind when planning the installation of this equipment.

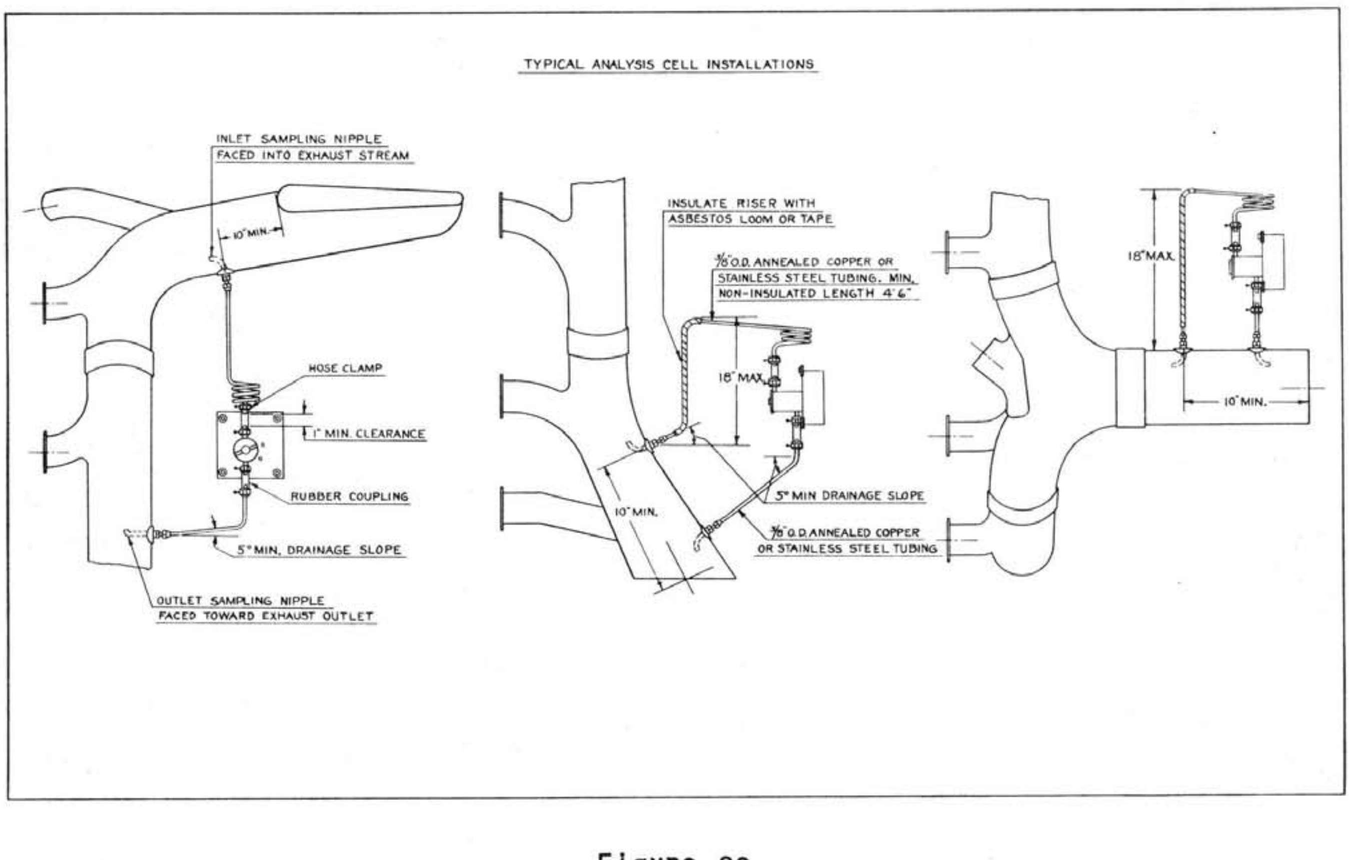


Figure 93

This equipment consists of two units; (1) an indicator which is mounted on the instrument board, and (2) an analysis cell mounted near the exhaust system where the sample and its return to the manifold can easily be accomplished. Some typical installations of analysis cells are illustrated in Figure 93. For detailed installation instructions regarding these units the aircraft designer should apply to the individual vendor. Following is a list of general recommendations which should be adhered to when installing this equipment. Wide experience with these units has indicated that any malfunctioning of the instrument has almost always been due to improper installation or maintenance.

Recommendations for Installation of Fuel-Air Ratio Indicator

1. The sampling tube should be located in the exhaust manifold at a point where it will be in the stream of exhaust gases from at least four cylinders. The opening of this tube should face into the exhaust stream.

2. The outlet tube from the cell should be led into the exhaust manifold and the tube outlet furnished with the instrument should be used in the manifold. It should face in the same direction as the flow of the exhaust gases. Do not locate it so close to the inlet sample tube that it will interfere with the flow into the inlet tube. The waste gas from the cell should not be led outboard since it is highly corrosive and may attack some of the metal surfaces of the airplane. Also, an outboard drain may freeze and thereby stop the sample flow through the cell.

3. Both the inlet and outlet tubing must be free from pockets where condensate can gather and restrict the gas flow. Drainage of condensate must be through the cell and then to the exhaust manifold.

4. When the installation necessitates a riser in the sampling tube before entering the cell, its length should not exceed 18" and it should be well insulated with asbestos loom or tape. This is done to prevent any condensation of the exhaust gases in the riser section of the tubing.

5. These instruments are calibrated with saturated exhaust gas and for this reason the temperature of the sample in the cell must not exceed 125° F. during normal flight operation. To obtain this temperature it is necessary to use at least 5 feet of tubing on the inlet side and a portion of this length should be wound into a coil over which cooling air can be circulated if necessary.

6. A suitable pressure drop in the exhaust gas must be obtained across the cell to insure adequate flow of the sample. The limits on this pressure

drop are given in the manufacturers detailed installation instructions. To avoid collection of condensate in the outlet line, the line must have a minimum drainage angle of 5°.

7. The inlet sampling nipple should never be located closer than 10" from the exhaust manifold outlet to avoid obtaining a diluted sample.

8. The tubing used should be 3/8" O.D. annealed copper or stainless steel. It should be adequately supported but equipped with sufficient synthetic rubber connectors to provide the necessary flexibility. Rubber connectors should always be used at the cell. When used on the inlet tube they should never be closer than 18" to the exhaust manifold to avoid burning.

9. The indicator unit should be mounted in the airplane in such a location that it is in clear view of the member of the crew that is responsible for adjustment of the mixture. This indicator should not be located too close to the airplane's compass so as to affect its accuracy.

When ordering a fuel air ratio indicator the engine model number and its fuel requirements should be specified. This information is necessary for proper setting of the indicator scale, which has on it a correlation between manifold pressure and fuel-air ratio. This correlation serves as a guide to the operator for selecting the proper fuel-air ratio for the power (manifold pressure) being used.

Special Accessory Drives

Modern airplanes are being equipped with controlled vacuum flight instruments, hydraulicly operated wing flaps and landing gear, pressure actuated de-icers, and many other devices that all require pumps of some kind for their operation. Up to the present time these pumps are being driven from the accessory drives on the engine. The Cyclone engine is equipped with a dual accessory drive such as illustrated in Figure 94.

This drive, located at the lower right hand side of the rear cover, in standard form is equipped with a small, square vacuum pump type pad on the upper drive with a standard tongued coupling, and a 4-stud generator type pad on the lower drive with a generator type splined coupling. Both drives have the same speed ratio. The 1.125:1 ratio drive is standard on the Cyclone F50 and F60 series and the 1.687:1 ratio is standard on the Cyclone G and G-100 series. It is possible to get either ratio on these engines but as such it is termed special equipment. The lower drive can be adapted for a vacuum pump tongued drive by using a coupling and an adapter plate. Data pertinent to these drives and the other drives furnished on the engine are given in Figure 110 in the Appendix.

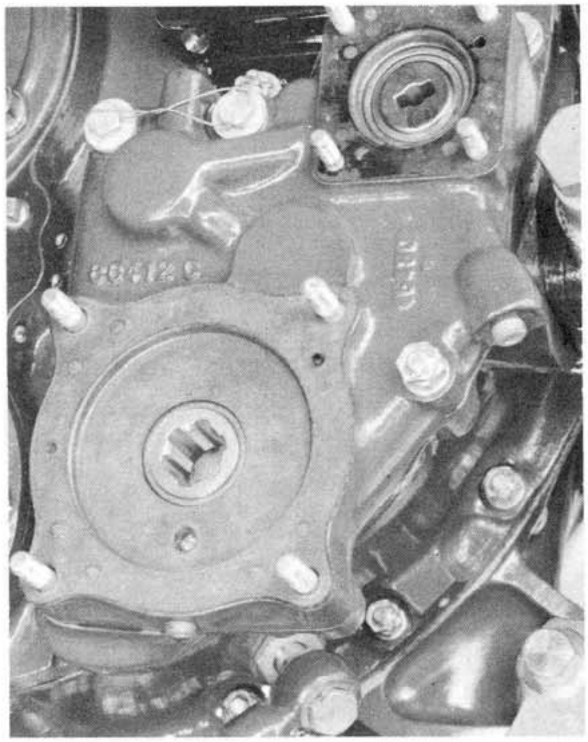


Figure 94

The standard Whirlwind engine is furnished with only a fuel pump drive, and a vacuum pump drive on the oil pump. This latter drive is not recommended for use, however, because of the possibility of failure in the accessory causing failure of the oil pump. To use this drive specific approval must be obtained from the Wright Aeronautical Corporation.

The Whirlwind engine can be equipped with a spur gear box as special equipment. This drive box which is located at the lower right hand side of the rear cover has mounting pads for driving a fuel pump, vacuum pump and a constant speed propeller governor. This latter drive is no longer used since the nose section of the engine now is equipped with this drive.

Data pertinent to the accessory drives on the Whirlwind engines are given in Figure 109 in the Appendix.

Pumps

All the accessory drive pads on Wright engines have provision for oil pressure supply to the accessory when necessary. This is accomplished by an oil hole in the pad that mates with a similar hole in the mounting flange of the accessory. Such method of lubricating eliminates the need for external oil pressure lines to the accessories. Practically all pumps requiring lubrication from an external source have provision to take advantage of this method of lubrication. Certain pumps, such as hydraulic pumps, obtain their lubrication from the fluid they are circulating and therefore require no oil supply from the engine. In these cases, the flange of the accessory has no oil hole and a blind gasket is used on the accessory mounting pad.

Vacuum pump installations, when used in conjunction with de-icing equipment, usually include an oil separator in the pump discharge line. The Wright Aeronautical Corporation does not approve of returning the separated oil to the engine crankcase or oil supply for the following reasons.

1. With the use of certain types of oil dilution systems there is at times a considerable quantity of gasoline in the engine crankcase, and it is possible for a combustible mixture to result if the vacuum pump or separator discharge is piped into the crankcase.

2. Excessive quantities of air and subsequent internal pressure within the crankcase may encourage oil scavenging troubles.

3. Introduction of foreign material into the engine lubricating system occasioned by vacuum pump wear or failure may result ultimately in early engine wear or failure.

For the above reasons it is recommended that the vacuum pump or separator discharge be either led into the exhaust manifold where it will be burned or led outboard.

Gun Synchronizers

Military airplanes are usually equipped with machine guns timed to fire through the propeller blades. In order to accomplish this without striking the propeller blades some method of synchronism between rate of fire and engine speed is necessary. The machine gun synchronizing system provides the means of producing and controlling timed impulses which are synchronized with the propeller. These timed impulses are transmitted from an impulse generator, mounted on the engine to the trigger motor on the machine gun, through the use of an impulse wire and tube assembly or similar fixture. The impulse generator unit times the impulses which, when transmitted to the trigger motor, will synchronize the firing of the gun with the propeller blades. Because of the lack of uniformity of engine design, the shape, construction, and location of this unit will vary somewhat with each type of engine. For this reason impulse generators for use on Wright engines should be purchased from the Wright Aeronautical Corporation. These units are designed and manufactured by them for use on their engines. When ordering such a unit, the type cam desired should be specified. The cam should have one or two lobes depending on whether it is to be used with a three-bladed or two-bladed propeller. This impulse generator unit rotates at propeller speed and is rigidly attached to the engine. Provision is made for two of these units on every Wright engine.

Drain Lines

Figure 95 shows the drain lines that must be connected to the engine. These will be discussed individually.

CARBURETOR WATER DRAINS - These are only necessary on Stromberg carburetors for Cyclone engines. Provision is made for drainage of the top deck of these carburetors, and both the fore and aft drains should always be piped outboard with 1/4" O.D. tubing. It is permissible to tee the two drains together into a common line which is led outboard. These lines should never be left to drain inside the engine compartment because the water coming from them may freeze on some control and make it inoperative.

The Chandler-Groves carburetor has no water drains that have to be piped to outboard.

SUPERCHARGER HOUSING DRAIN - This is the most important drain on the engine and should be given careful consideration. This drain is an overflow for the supercharger housing which prevents the cylinders from becoming overloaded with gasoline. A 3/8" O.D. line should be connected to this drain and it should be led outboard with the end of the tube faced into the slip-stream.

When the engine is not running the valve is open and allows any over-primed fuel to drain from the supercharger housing. When the engine is running, the valve closes due to the intake suction and to assist this suction the tube outlet is faced into the slipstream putting a ram on the under side of the valve. Care should be taken to avoid pockets in this drain line, it should have positive drainage to outboard. Since gasoline drains from this line, care should be taken in locating this line so the drainage will clear all parts of the airplane including the landing gear.

FUEL PUMP DRAIN - The fuel pump shaft gland should always be drained to the outboard with a 1/4" O.D. line to prevent gasoline from leaking into the engine crankcase. This drain should never be teed into the supercharger drain line since in flight there is a ram on this line which would prevent the drainage that should take place from the fuel pump gland.

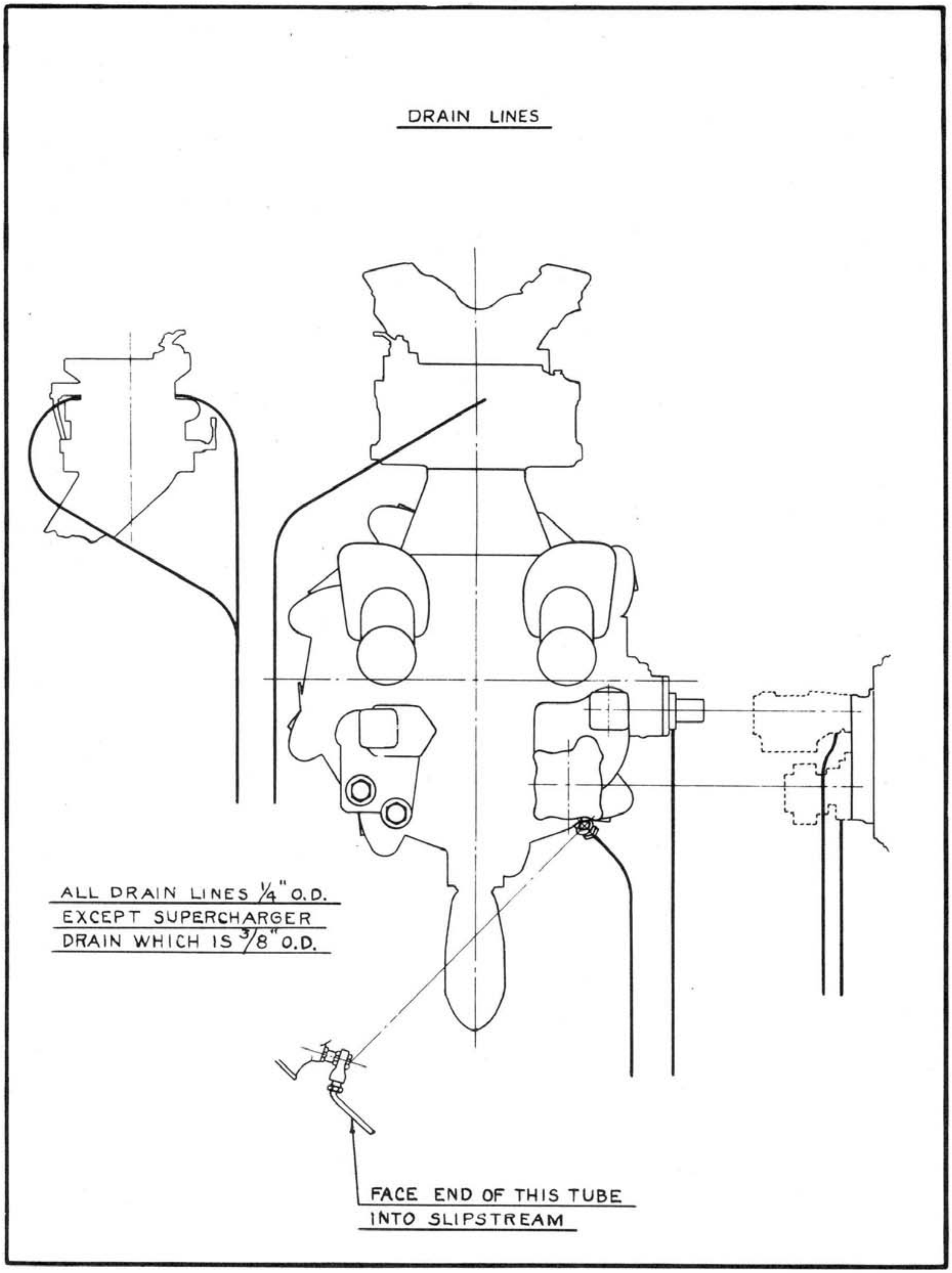

DRAIN LINES
ALL DRAIN LINES 1/4" O.D.
EXCEPT SUPERCHARGER
DRAIN WHICH IS 3/8" O.D.
FACE END OF THIS TUBE
INTO SLIPSTREAM

Figure 95