SERVICE
INSTRUCTION MANUAL

AEROPROP
CONSTANT SPEED PROPELLERS

Model A632S-A1
A632S-A2
A632S-B1
A632S-B5
A632S-C1
A632S-C4 *Supplement No. 1*
A642S-D1 *Supplement No. 2*

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Compiled by the Aeroproducts Service Department

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FOR INFORMATION ONLY

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Litho. U.S.A. January, 1943

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SECTION I

INTRODUCTION

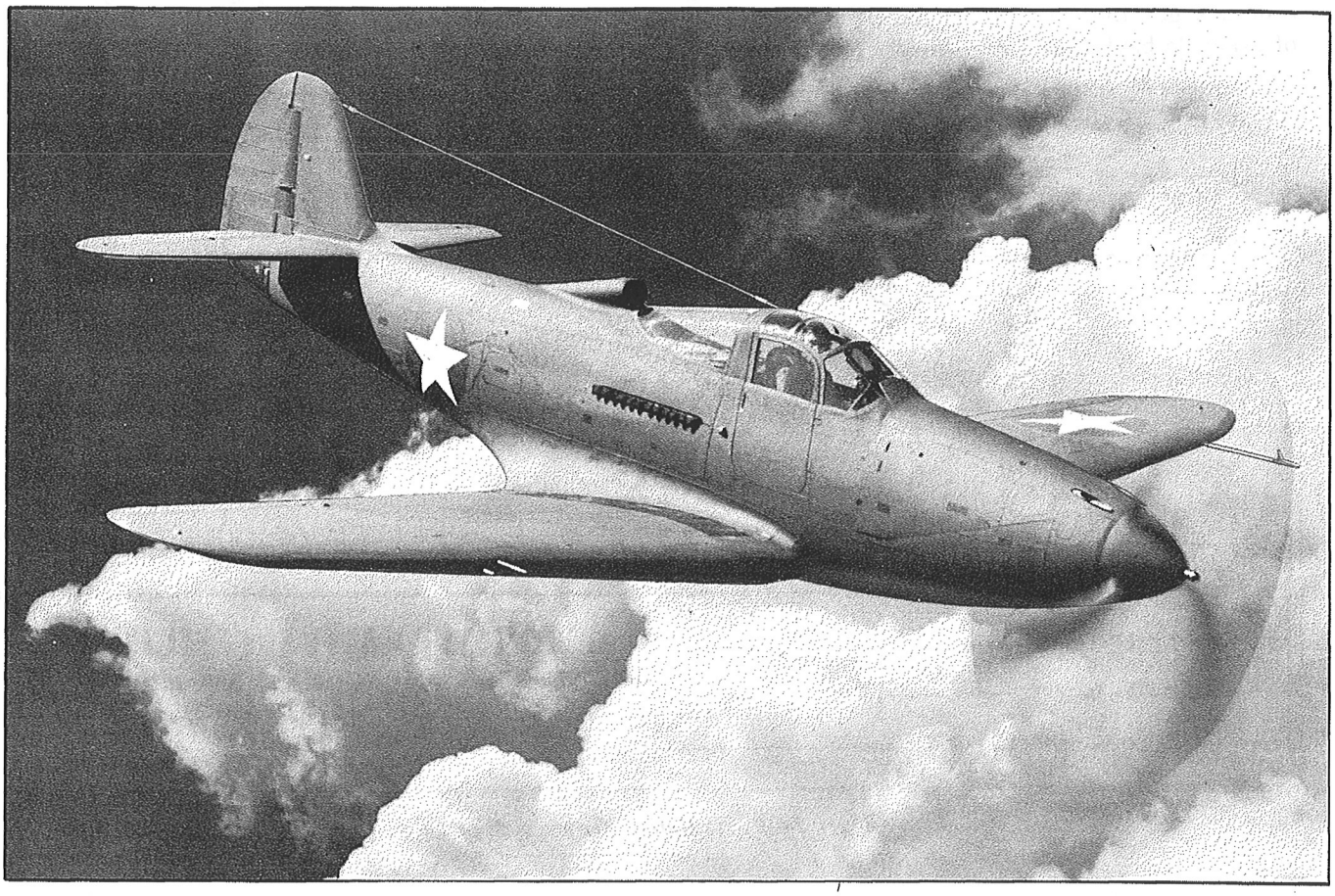

Figure 1—Typical Aeroprop Installation

1. The Aeroprop Constant Speed Propeller is manufactured by the Aeroproducts Division of General Motors Corporation at Vandalia, Ohio.

2. This manual is issued to acquaint aircraft mechanics with the theory behind the operation of the Aeroprop Constant Speed Propeller, and to familiarize them with the details of installation, maintenance and overhaul. Step by step procedures have, necessarily, been written around ideal conditions where proper tools and equipment are instantly available. We realize, however, that under emergency conditions many of the steps listed herein will have to be modified if not entirely changed, and that the mechanic, under those circumstances, will be entirely dependent on his own ingenuity in order to properly maintain and repair this propeller.

3. Until ten years ago, the only propellers available were those which had the blades set at a *fixed angle.* Such a design represented a compromise, since the blade angles could be originally set to cover only one operating condition, whether it was low pitch for take-off, medium pitch for optimum cruising, or higher pitch to prevent overspeeding the engine in dives. This was as obviously inefficient as having an automobile with only one gear.

4. In order, therefore, to compensate for varying conditions, propeller engineers next developed a *two-position* propeller, the blade angles of which could be adjusted during flight. This allowed the pilot to obtain a more advantageous blade setting for take-off and at the same time to correct the blade angles for cruising R. P. M. in level flight. Such a design was a marked advance over the fixed pitch propeller and greatly increased flying efficiency. In other words, our automobile analogy now has two gears.

5. The two-position propeller, however, still placed a definite limitation on engine-propeller efficiency under all conditions. For this reason, therefore, the *constant speed propeller* was introduced. This design couples a governor to a propeller having a wide range of available blade angles. It provides for an automatic, continuous variation of blade pitch necessary for utmost flying efficiency at any selected R. P. M., and at the same time, removes a great burden of responsibility from the pilot. The Aeroprop produced by the Aeroproducts Division of General Motors Corporation is a constant speed propeller.

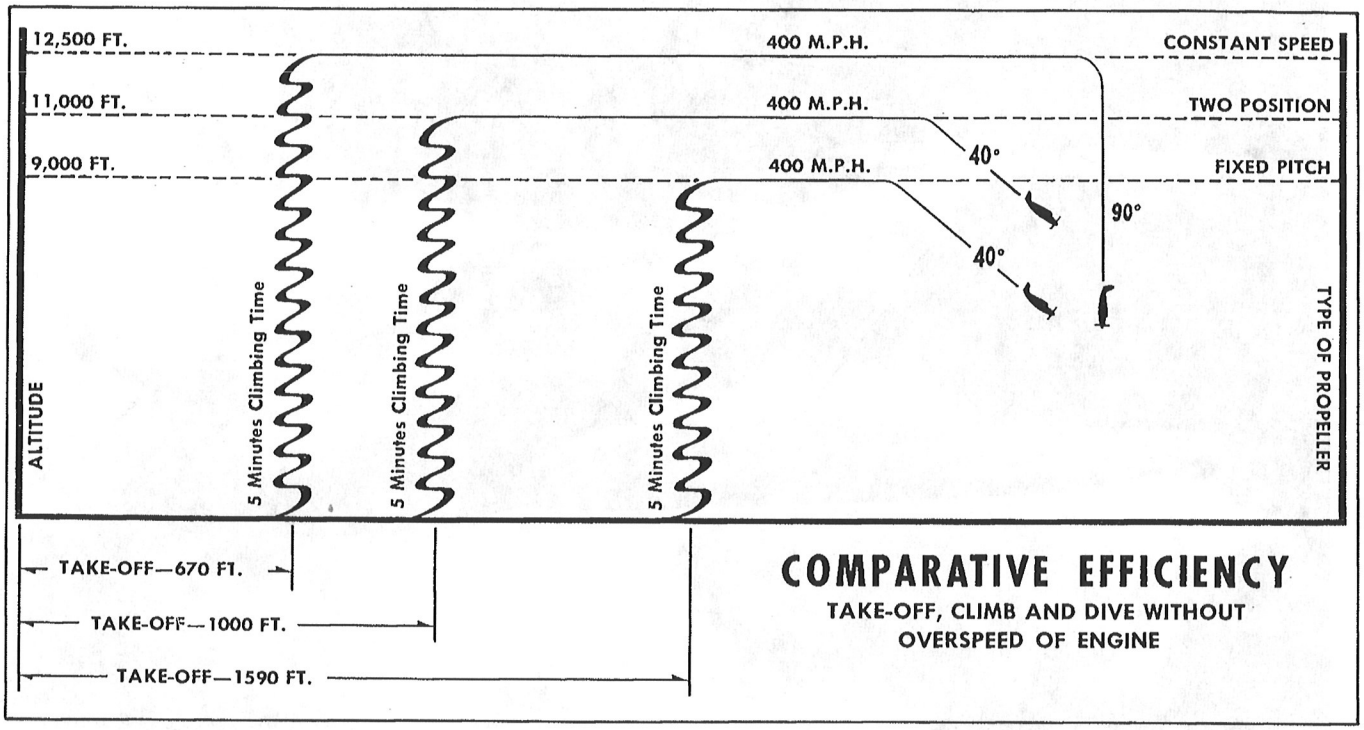

Figure 2—Comparative Propeller Efficiency

SECTION II
OPERATION AND DESCRIPTION

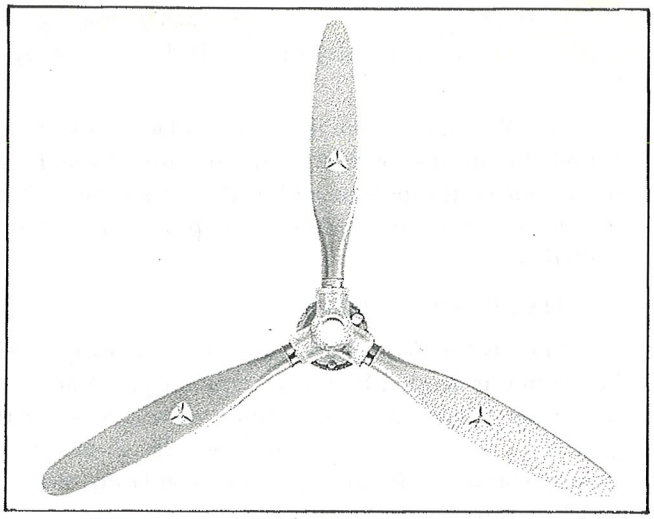

Figure 3—Aeroprop—Face View

1. OPERATION OF THE AEROPROP.

a. GENERAL.

(1) The Aeroprop constant speed propeller described herein is of exceptionally simple design, being hydraulically operated and entirely contained within a single unit. No special fittings are necessary for installation other than the control arm connection to the cockpit of the airplane, and the stop lug mounted on the engine reduction gear case.

(2) Having available a wide range of blade angles coupled with a sensitive and fast-acting governor, the Aeroprop has a rate-of-pitch change of approximately five degrees per second which is adequate to maintain constant engine speed throughout the most extreme pursuit maneuvers.

b. BLADE ANGLE VARIATION.

(1) Change of blade angles (pitch) in the Aeroprop is accomplished by a pitch change mechanism located in each blade socket of the hub. This pitch change mechanism will hereafter be referred to as a *torque unit.*

(2) As designed in the Aeroprop, the torque unit mechanism converts hydraulic pressure into turning action by the movement of a splined piston within a similarly splined cylinder. These torque unit pistons are pushed inwardly or outwardly from the hub through controlled hydraulic pressure supplied to the outward or inward side of the pistons, and, through helical (or twisted) splines, they impart a turning action to the blades.

(3) One spline member (fixed spline) mounts solidly onto the hub in each blade socket; the piston with its internal and external splines fits over this, and the external splines of the piston in turn mesh with internal splines of a cylinder that is doweled directly to a blade. See Figure 4.

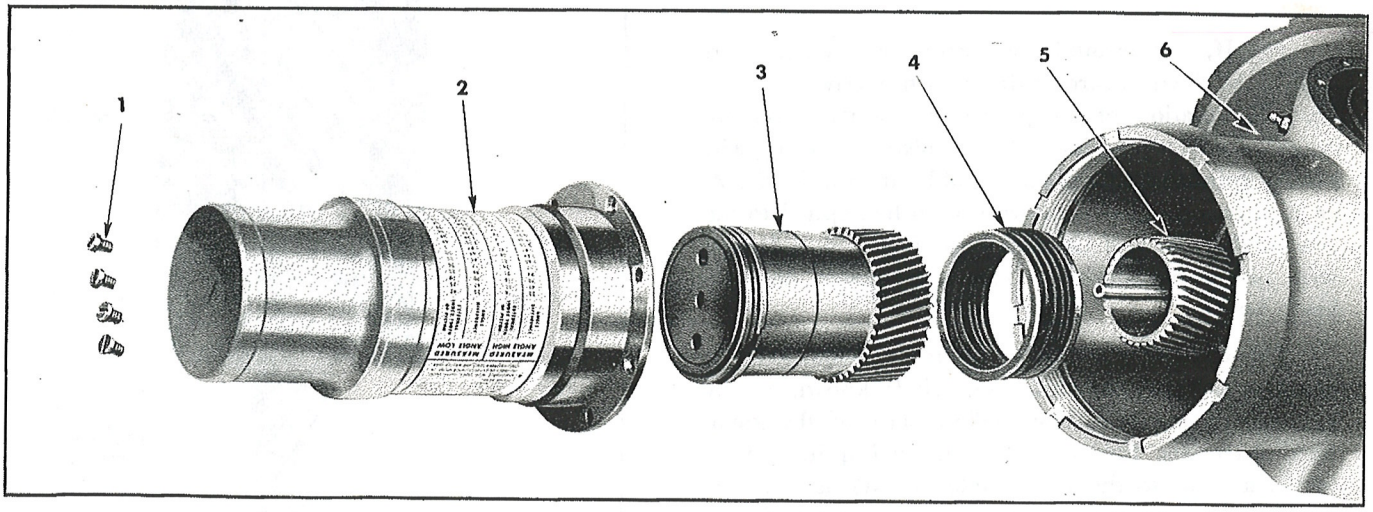

Figure 4—Torque Unit—Exploded View

1. Blade Cylinder Attaching Screws, 4 required
2. Blade Cylinder
3. Piston
4. Cylinder Seals
5. Fixed Spline
6. Hub

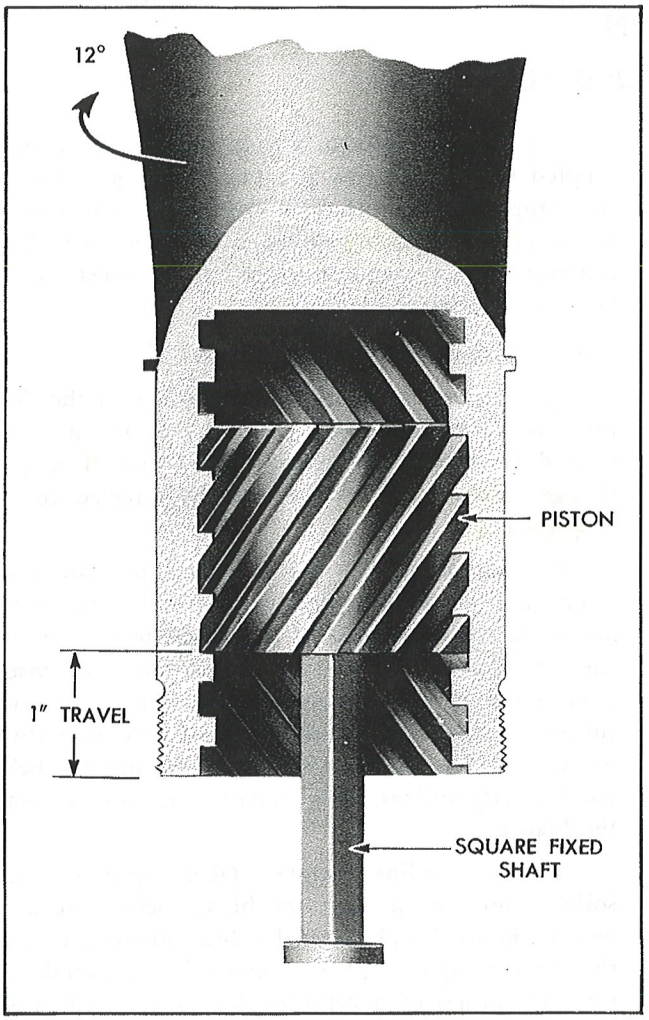

Figure 5—Diagrammatic View of Torque Unit

(4) If, for example, a piston was arranged to slide on a fixed square shaft in such a way as to prevent the rotation of the piston during its travel, the helical (twisted) splines of the piston, mating with similar splines in the blade, would turn the blade. As an illustration, if oil pressure was to be applied to one side or the other of the piston in Figure 5, a lengthwise piston movement of one inch would turn the blade approximately 12°.

(5) However, improving on the previous arrangement, a helically splined fixed shaft known as the fixed spline has been mounted in place of the square fixed shaft. See Figure 6. The internal splines of the piston are cut to the same angle (pitch) as those between the piston and the blade. Thus, instead of moving without turning, the piston is given an initial twist as it travels along the fixed spline. In this way the piston turns approximately 12° relative to the fixed spline for each inch movement along the fixed spline. In addition, the blade turns approximately 12° relative to the piston for each inch movement of the piston. Therefore, in relation to the fixed spline, the blade is turned 12° plus 12° or 24° per inch of total piston movement, just as if a step-up gear had been employed. See Figures 6, 7.

(6) We have seen how the blade angles are varied by means of hydraulic pressure through the movement of the pistons within the torque units. Now let us see how this pressure is provided and controlled—

c. HYDRAULIC SYSTEM.

(1) Hydraulic pressure supplied to the torque units in the hub is created by a gear type oil *pump* and controlled by an automatic distributor valve known as the *governor*. These are contained within a doughnut-shaped control unit known as the regulator, which is attached directly to the hub.

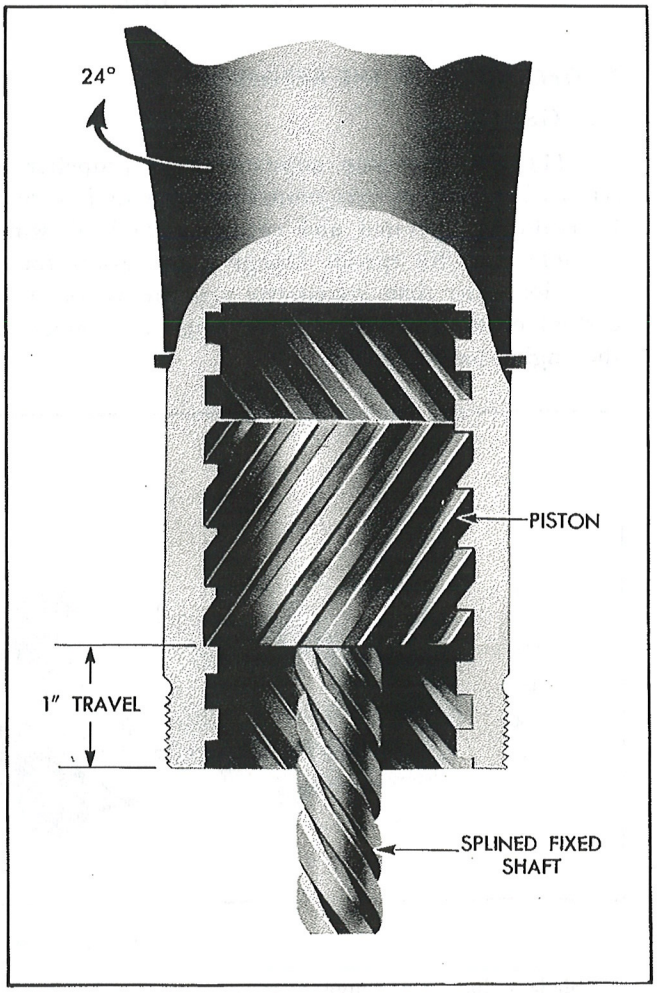

Figure 6—Diagrammatic View of Torque Unit

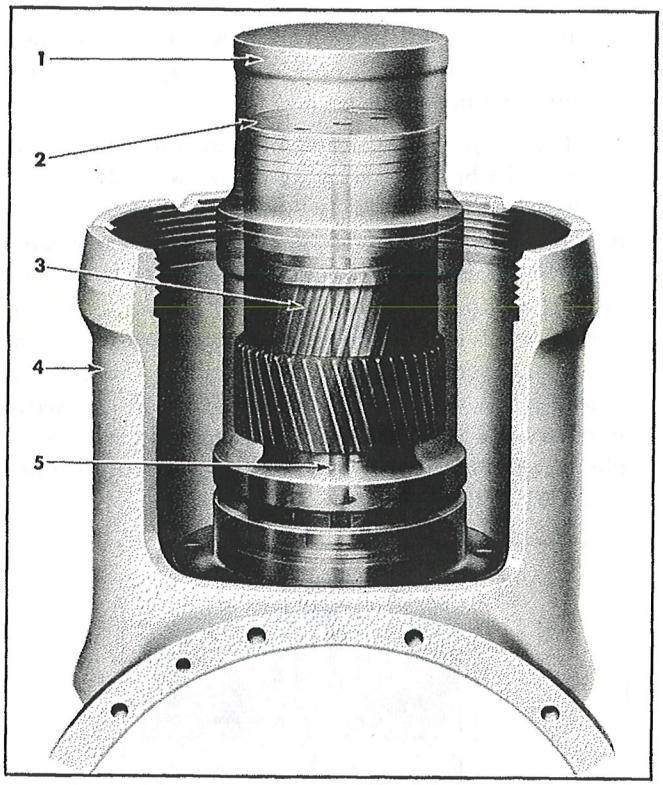

Figure 7—Torque Unit

1. Blade Cylinder
2. Piston
3. Fixed Spline
4. Hub
5. Fixed Spline Bolt and Tube

(2) In the simplified operational diagram, Figure 8, we will start with a pan of oil. Next we add a continuously-operating pump that creates pressure and withdraws the oil from the pan. Then, we put in a distributor valve which, at the will of the operator, may be moved in order to direct the hydraulic pressure through one or the other of two ports. A torque unit is next placed so that the oil passages within the torque unit mate with the ports of the distributor valve. Since the distributor valve may be placed in a position where the ports are completely closed, we add a pressure control valve to prevent excess pressure when that pressure is not used. This will allow the valve to bypass the oil and return it to the pan.

(3) It will be noted in Figure 9 that if we move the distributor valve to the left, a port is opened and hydraulic pressure is applied to the underside of the torque unit piston. At the same time, the other port opens and pressure is relieved from the outer end of the piston. Obviously, the piston will move outwardly, while the relieved oil drops back into the reservoir.

(4) Now, if we move the distributor valve to the right, the opposite action takes place, and the piston moves inwardly. See Figure 10. It can be readily seen, therefore, that movement of the distributor valve will operate the torque unit and change the angle of the blades.

(5) It would be possible, of course, to connect a long control handle from the distributor valve to the cockpit and allow the pilot to manually change the valve to obtain different blade angles for different flight conditions. Obviously, the pilot will have enough to do without burdening him with an additional control that would require his constant attention. Therefore, by attaching a *lever* to one end of the distributor valve, a *fulcrum* at the other end of the lever, and a *spring* load in between, our simple valve becomes automatic, and is now called a *governor*. See Figure 11.

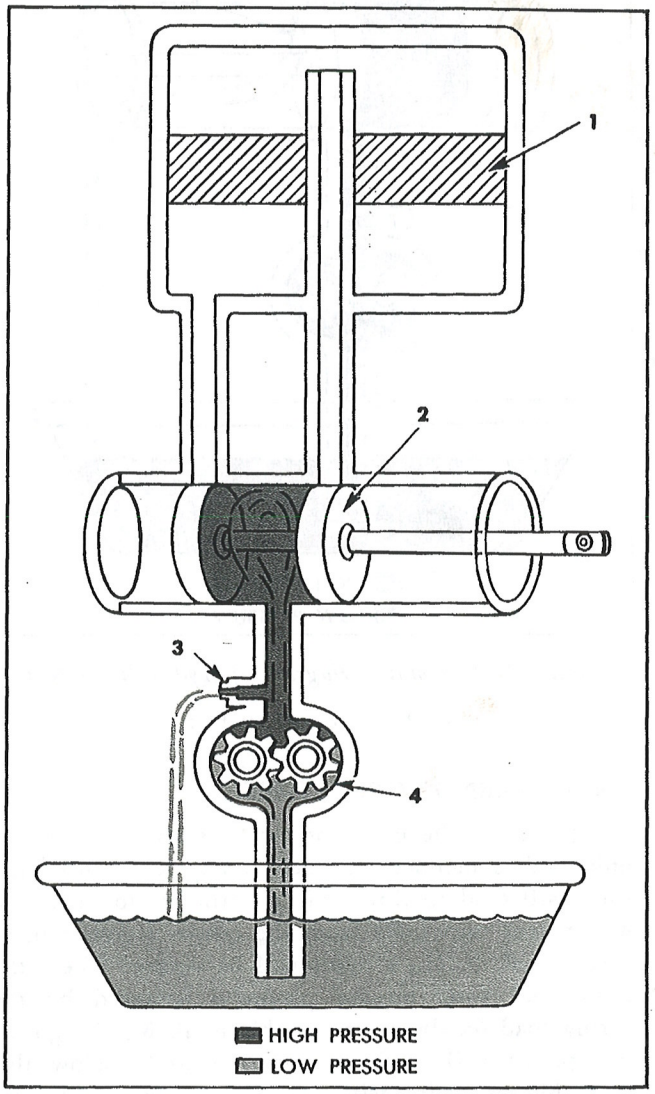

Figure 8—Schematic Diagram of Hydraulic System

1. Torque Unit Piston
2. Distributor Valve Piston
3. Pressure Control Valve
4. Pump

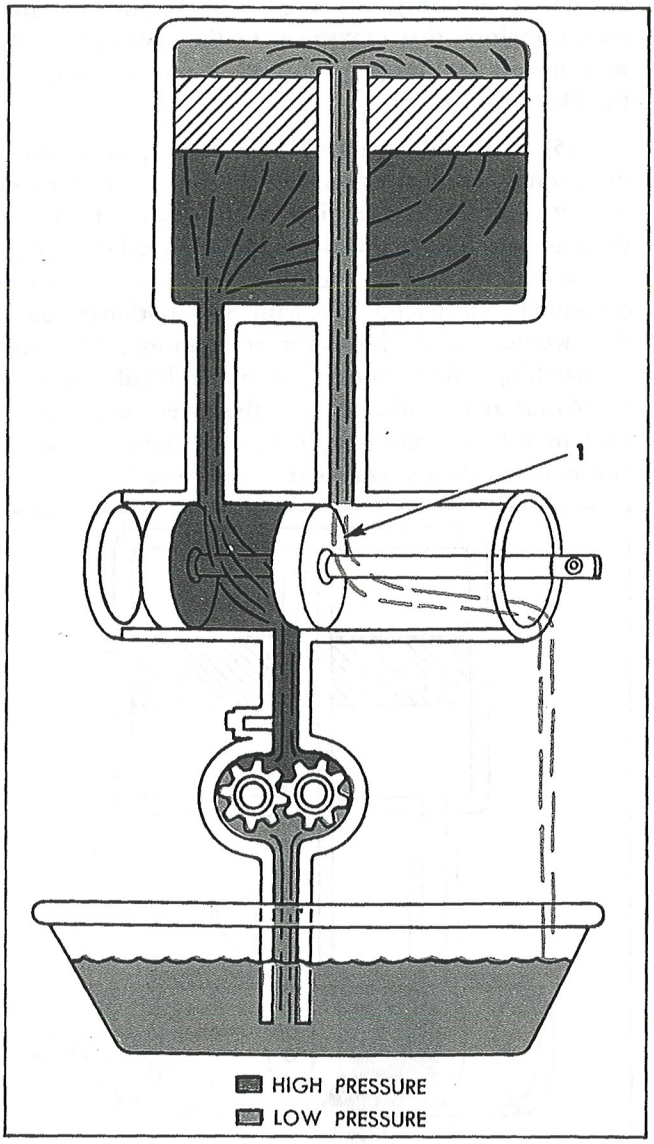

Figure 9—Schematic Diagram of Hydraulic System

1. Piston Moved to Left

d. GOVERNOR OPERATION.

(1) Since the governor rotates with the regulator unit, and is mounted in such a way that centrifugal force will tend to throw the governor piston (distributor valve) outwardly from the center of rotation, at a certain R. P. M., a point will be reached where the centrifugal force on the piston is balanced by the spring load on the lever. At this R. P. M. the governor piston will tend to remain neutral; below this R. P. M. the spring will force the piston to move inwardly allowing the oil pressure to reduce the blade angles and bring the R. P. M. up to the balance point; and above this R. P. M. the piston will move outwardly, distributing the oil so as to increase the blade angles and decrease the R. P. M., in this way maintaining a constant engine speed.

(2) As previously explained, with a fixed fulcrum, balance will be achieved at one R. P. M. only. In order to change the R. P. M. at which balance results, and thereby allow the pilot to set the control for whatever R. P. M. he desires, it must be possible for him to vary this balance point. This is done by changing the location of the fulcrum, which *in effect* lessens or increases the spring force against the governor piston, thereby allowing the operator to adjust the R. P. M. setting. A cross section of the governor assembly is shown in Figure 12. This is the heart of the Aeroprop Constant Speed Propeller.

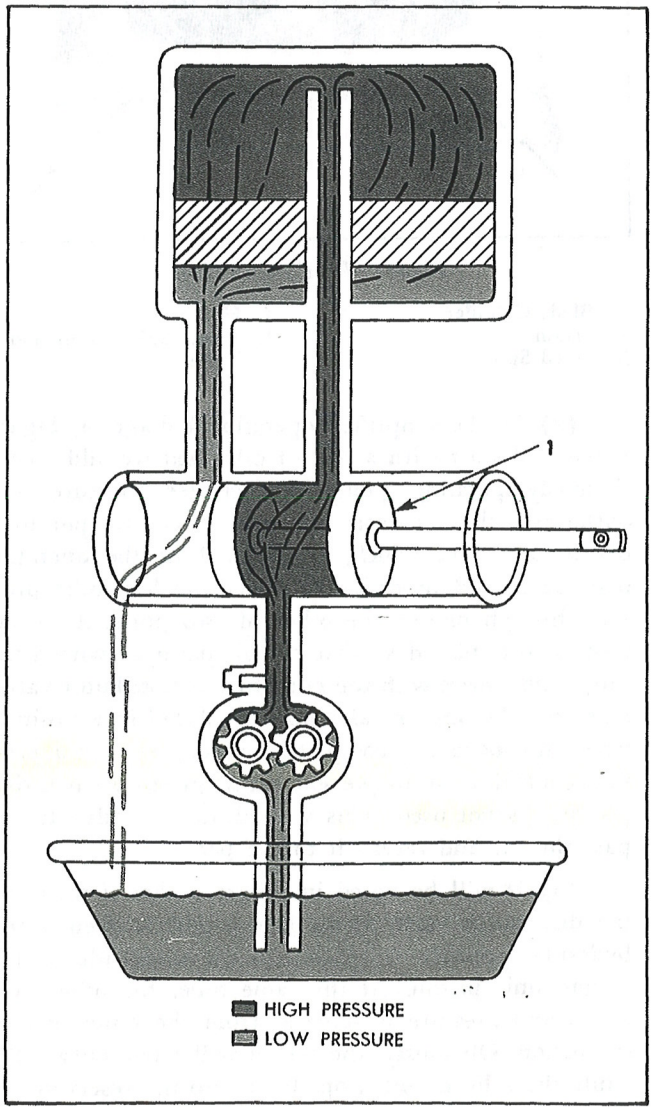

Figure 10—Schematic Diagram of Hydraulic System

1. Piston Moved to Right

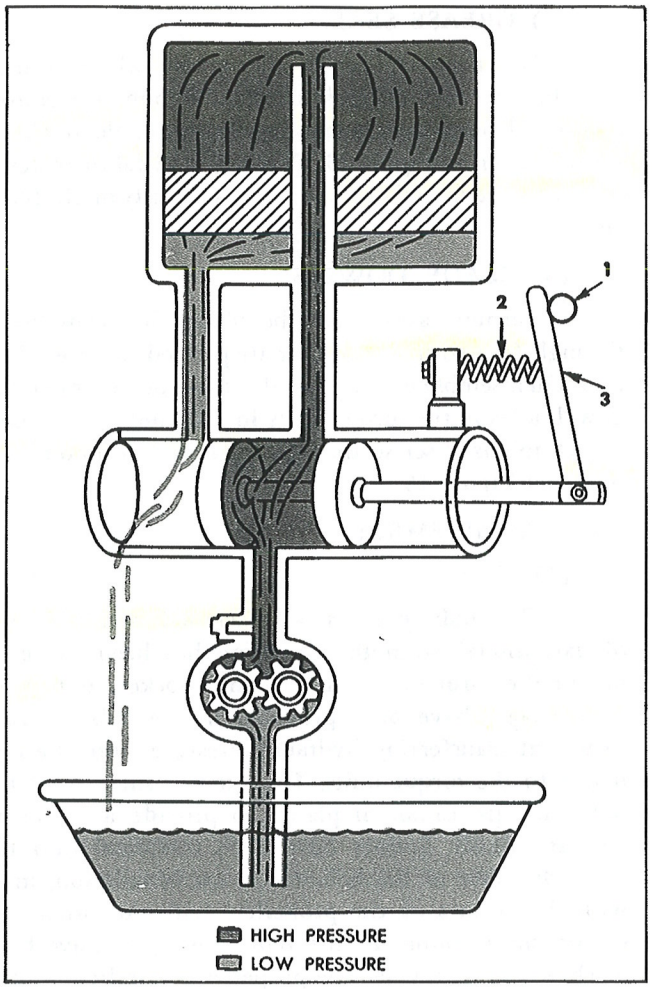

Figure 11—Schematic Diagram of Hydraulic System

1. Fulcrum
2. Spring
3. Lever

2. DESCRIPTION OF THE AEROPROP.

a. GENERAL.

(1) The following description of parts and assemblies is written around the present production model—A632S-C1. Four other previous production designs are now in service and differ only in minor variations in the control assembly (regulator) and in the blade design. The hub, torque units and sub-assemblies are identical.

(2) Basic features of the propeller are:

(*a*) Unit construction.

(*b*) Constant speed operation in which governor control covers a range from fast idling to maximum rated engine R. P. M. The actual R. P. M. may be set at any point within this bracket as desired by the pilot.

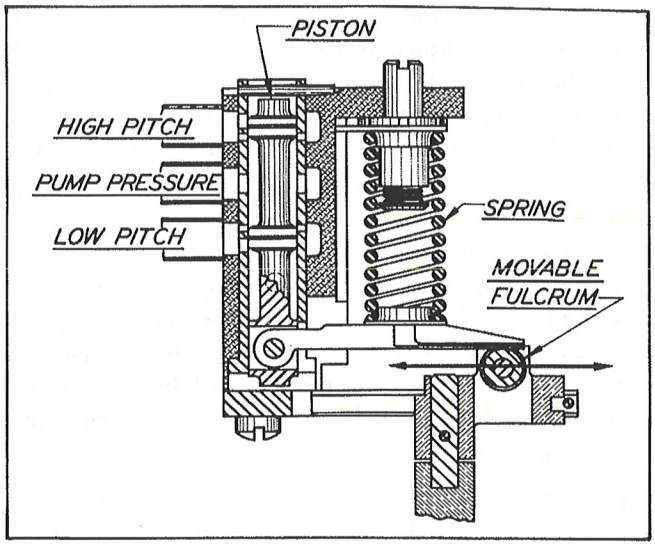

Figure 12—Governor

(*c*) Hollow steel blades incorporating a longitudinal rib.

(*d*) An unrestricted hole through the center of the propeller hub to permit the installation of aircraft cannon in military models.

b. BLADE ASSEMBLY.

(1) BLADE CONSTRUCTION.

(*a*) The Aeroprop blades are of hollow steel construction, incorporating a longitudinal strengthening rib. The blade is composed of two members, namely, the *thrust member* and the *camber sheet* which are brazed together as shown in Figure 13. The thrust member is a machined steel forging which forms the thrust face, blade shank, longitudinal rib, and leading and trailing edge re-enforcements. This member is

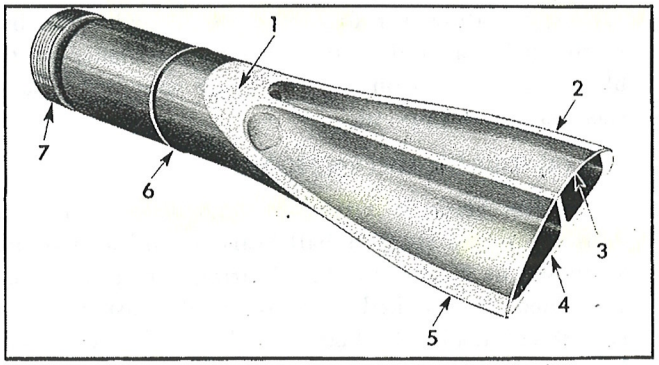

Figure 13—Blade Section

1. Brazed Surface
2. Leading Edge
3. Camber Sheet
4. Thrust Member
5. Trailing Edge
6. Cuff Ring
7. Buttress Thread

completely ground and polished as is also the steel camber sheet which is formed, polished and attached to the forging by means of brazing. This design has such an ample margin of safety that tests indicate that the brazed joint is much stronger than the steel itself.

(*b*) On the root of the blade is machined a special buttress type thread which is designed to adequately handle the centrifugal load, yet retains the self-centering and load distributing characteristics of a normal "V" thread. At the outer end of the shank a cuff ring is provided for attaching blade shank fairings. For protection of the external blade surfaces, a corrosion-resistant hard chrome finish has been applied. See Figure 13.

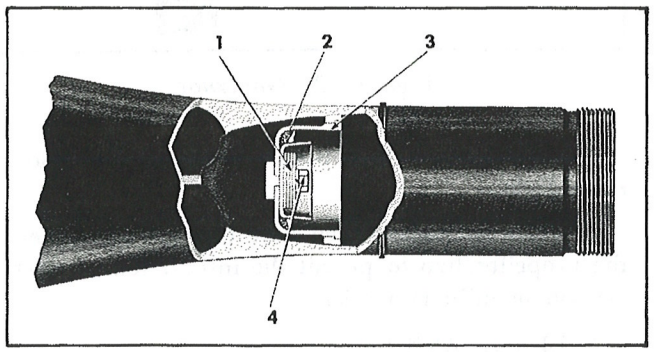

Figure 14—Blade Balance Cup and Washer

1. Balance Washers
2. Lead
3. Balance Cup
4. Balance Washer Stud

(2) BLADE BALANCE.

The internal surfaces of the blade are rust-proofed and hermetically sealed. Each blade has a balance cup in the shank which has lead added in the proper location to give uniform vertical and horizontal balance. *This lead should never be tampered with in service.* To allow for final balance of blades and hub in the field, a stud is provided in the center of the blade balance cup on which may be mounted balance washers. See Figure 14.

(3) BLADE RETENTION.

The blade is retained in the hub by a blade retaining nut, a stack of ball bearings and a blade nut as shown in Figure 15. The bearings are ground and assembled in matched sets to evenly distribute the centrifugal load. The blade nut holds the stack bearings on the blade shank, while the blade retaining nut faces against the stack bearings, and screws into the hub socket, holding the entire assembly in place. Each bearing stack is serially numbered and *should be kept intact* together with its proper blade.

(4) GREASE SEAL.

To effectively retain the grease which is used to lubricate the blade bearings and hub mechanism, a spring loaded seal is installed in the blade retaining nut as shown in Figure 15. This seal is of fabric material with a synthetic rubber lip that bears directly on the blade shank.

(5) BLADE DOWELS.

Turning action on the blades is accomplished through four steel dowels that are pressed into the blade butt. On assembly of the propeller these dowels mount in dowel holes in the torque units in each hub socket. One dowel hole is offset so that the blade will fit in one way only. See Figure 15.

c. HUB ASSEMBLY.

(1) HUB.

The hub part is a machined steel forging of exceptional strength. Provision has been made to mount the torque units in each hub socket, and transfer passages have been provided in the hub in order to permit transferring hydraulic pressure from the regulator to the torque units. The exterior surfaces of the hub part are cadmium plated to provide a corrosion resistant finish. Splines have been machined into the inner diameter of the hub which, on installation, mate with the splines of the propeller shaft. At either end of the shaft splines in the hub, cone seats have been machined so that, when the propeller is installed, proper alignment will be assured.

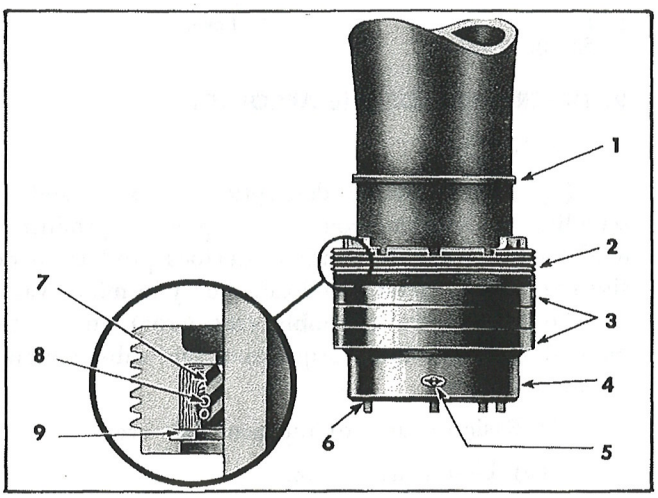

Figure 15—Blade Bearings and Retention

1. Cuff Ring
2. Blade Retaining Nut
3. Stack Bearings
4. Blade Nut
5. Blade Nut Lock
6. Dowels
7. Blade Retaining Nut Seal
8. Springs
9. Lock Ring

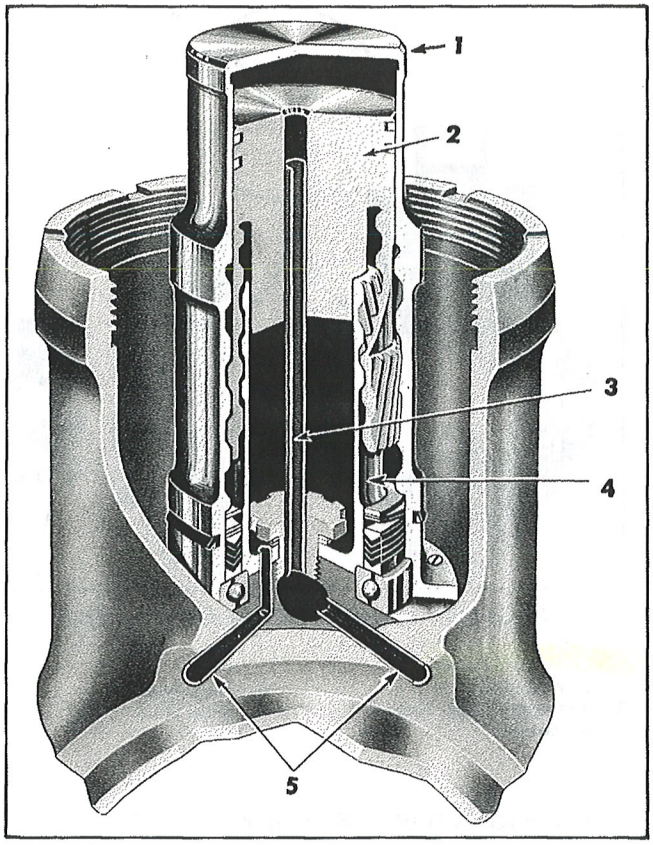

Figure 16—Torque Unit

1. Blade Cylinder
2. Piston
3. Fixed Spline Bolt
4. Fixed Spline
5. Increase and Decrease Pitch Tubes

(2) TORQUE UNITS.

(*a*) The torque units consist of a steel fixed spline, a bronze piston, and a steel blade cylinder, the operation of which has been described in previous paragraphs. See Figure 16. The *fixed spline* is attached to the hub by a fixed spline bolt which incorporates a long steel tube that extends outwardly through the piston head, providing an oil passage to the outer side of the piston. An offset hole at the base of the fixed spline permits passage of oil to the inner side of the piston.

(*b*) Between the blade cylinder and the fixed spline is a synthetic rubber *high pressure seal* located inwardly from the piston. This is spring loaded to hold against alternating pressure as shown in Figure 16.

(3) MASTER GEAR.

So that all blades will change pitch to exactly the same degree, it is necessary to use a synchronizing device. Therefore, a master gear is installed in the hub which meshes with a segment gear doweled to the root of each blade as shown in Figure 17, thus coordinating the movement of all blades. These gears are machined from steel forgings.

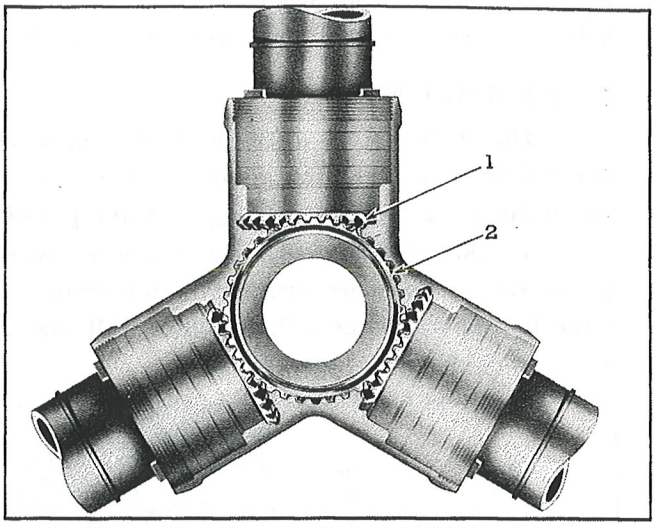

Figure 17—Master Gear and Blade Gears

1. Blade Gear
2. Master Gear

(4) REAR AND FRONT CONES.

A split bronze cone mounts on the propeller shaft, and mates with the rear cone seat machined into the hub. The seating surface of the cone is precision ground to assure even contact. The front cone is a machined steel part that is later cut into halves. This

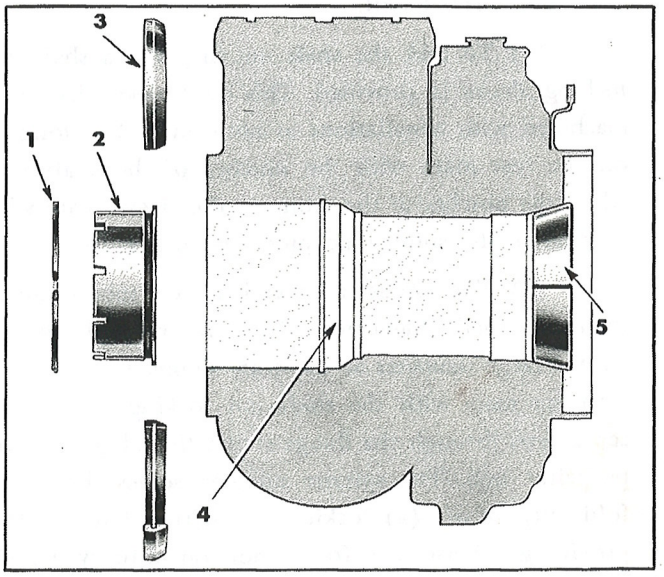

Figure 18—Rear and Front Cones

1. Shaft Nut Locking Ring
2. Shaft Nut
3. Front Cone Halves
4. Front Cone Hub Taper
5. Rear Cone

part is also ground, and is locked into the front of the hub by the shaft nut and lock ring. See Figure 18.

(5) SHAFT NUT.

The shaft nut is machined from bronze, and castellations have been cut into the front of the nut to provide a means of locking it on the propeller shaft. A land on the rear of the nut mates with a groove cut in the inner diameter of the front cone. Loosening the shaft nut will, therefore, pull the propeller from the shaft. See Figure 18.

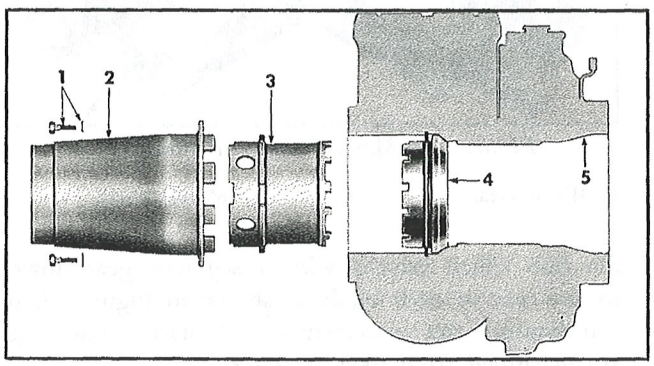

Figure 19—Shaft Nut, Sleeve and Adapter

1. Adapter Attaching Screws and Washers—9 required
2. Spinner Adapter
3. Shaft Nut Locking Sleeve
4. Shaft Nut and Front Cone
5. Rear Cone Hub Taper

(6) LOCKING SLEEVE AND SPINNER ADAPTER.

(*a*) To lock the shaft nut in place, a shaft nut locking sleeve is provided. This steel sleeve has been machined with castellations at both ends. The tongues on the rear mate with the notches of the shaft nut, while the notches at the front of the sleeve mate with tongues in the spinner adapter. See Figure 19.

(*b*) The spinner adapter is a steel tube stamped to form a small diameter at the front end and a flange with a large diameter at the rear. Tongues in the rear diameter mate with the shaft nut locking sleeve, and cap screws through the flange secure the adapter to the propeller hub. The spinner adapter serves the threefold purpose of: (a) locking the shaft nut sleeve, (b) providing a blast tube for cannon on military models to prevent damage to the spinner shell, (c) providing a brace to the nose of the spinner shell. See Figures 19 and 34.

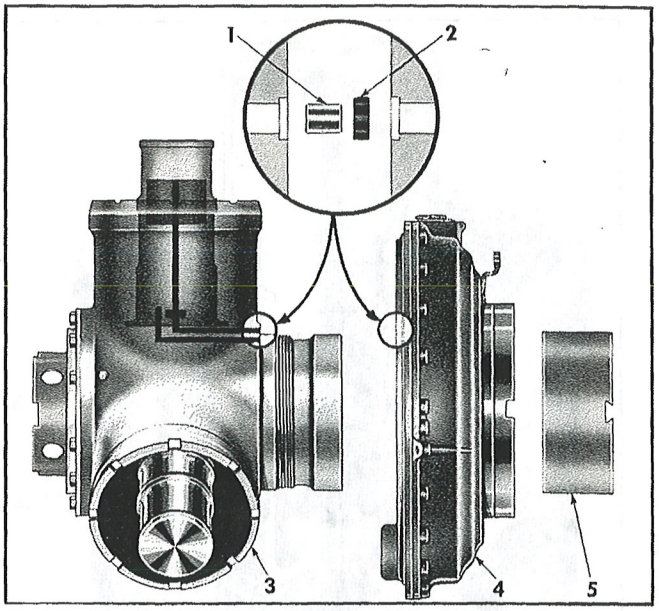

Figure 20—Regulator Exploded from Hub

1. Transfer Tube—6 required
2. Transfer Tube Seal—6 required
3. Hub
4. Regulator
5. Ring Nut

d. REGULATOR ASSEMBLY.

(1) GENERAL.

The regulator assembly is a doughnut-shaped unit mounted onto the rear of the hub by means of a ring nut having a left-hand thread. It provides controlled hydraulic pressure to the pitch change unit in each blade socket of the hub. Figure 20.

(2) REGULATOR FUNCTIONS.

(*a*) THE REGULATOR UNIT:

1. Acts as a *reservoir* for hydraulic oil; and when in operation should be kept half filled with this fluid at all times.

2. Contains a gear type *oil pump* to create the hydraulic pressure necessary to change the blade angles.

3. Contains a *pressure control valve* to limit the operating pressure to approximately 1000 lbs. per square inch.

4. Contains a *governor mechanism* that automatically distributes the supply of oil under pressure to the high or low pitch tubes of the torque units in the hub.

5. Contains a *control mechanism* to permit the pilot to manually set the governor while the plane is in flight.

(3) HOUSING.

The regulator unit is composed of a housing and a cover. The regulator housing is a flat machined aluminum casting that contains the transfer tubes for the hydraulic system. The oil pump, governor, and pressure control valve are attached to this part.

(4) COVER.

The regulator cover is a bowl-shaped aluminum casting that is fitted onto the housing and is attached to it by twenty-four cap screws. A removable steel plug is threaded into the cover to permit filling of the regulator with oil, and to offer access to the governor adjusting screw. A seal ring is included between the housing and cover to assure a leak-proof unit. A groove in the rear of the cover connects with tubes attached to each blade socket of the hub, and acts as a slinger for anti-icing fluid.

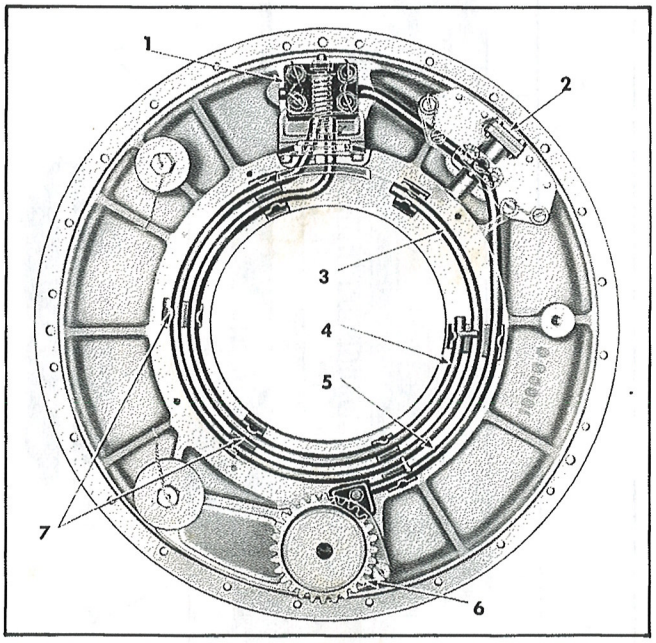

Figure 21—Regulator Housing Tube Assembly

1. Governor
2. Pressure Control Valve and Filter
3. Increase Pitch Tube
4. Decrease Pitch Tube
5. Pump Pressure Tube
6. Oil Pump
7. Hub Contact Pads—No. 2 Blade Socket

(5) TRANSFER TUBES.

Transfer of oil from the pump through the pressure control valve to the governor, and then to the proper high and low pitch ports for each hub socket is accomplished through three steel tubes which are cast into the regulator housing as shown in phantom view, Figure 21. These steel tubes are formed in a circular pattern, and brazed to steel pads at the points where the oil pump, pressure control valve, governor, and high and low pitch ports are attached. The entire tube assembly is then cast into the aluminum regulator housing.

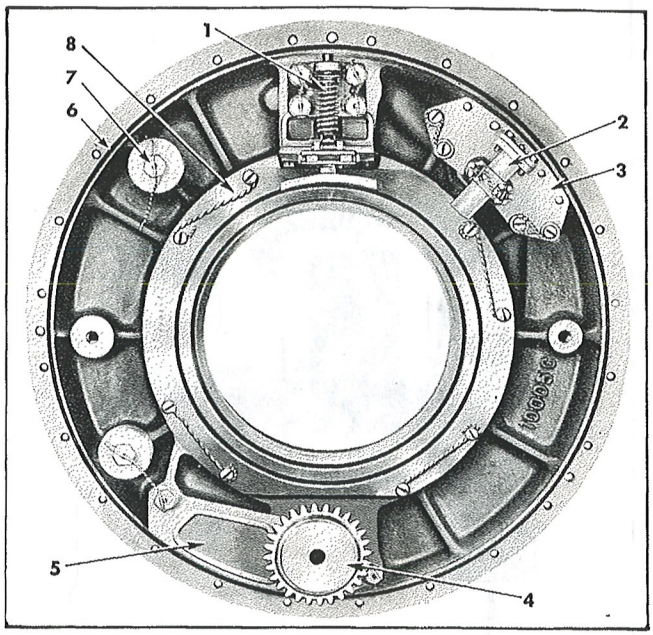

Figure 22—Face View of Regulator Housing

1. Governor
2. Pressure Control Valve
3. Filter
4. Oil Pump
5. Oil Pump Screen
6. Cover Outer Seal
7. Balance Washers
8. Housing Bearing

(6) OIL PUMP.

The pump is a simplified gear type consisting of two precision steel gears within a machined aluminum body. It is designed to turn at a maximum continuous operating speed of 5000 R. P. M. and to provide a continuous working pressure up to 1200 pounds per square inch. The pump rotates with the regulator and is driven by a bronze gear which is meshed in a planetary arrangement with a stationary steel part known as the regulator gear. This stationary ring gear is indirectly fixed to the nose of the engine reduction gear case. See Figures 22 and 27.

(7) PRESSURE CONTROL VALVE.

The pressure control valve and filter assembly is fastened to the regulator housing on the outlet side of the oil pump. The valve is a simple spring-loaded steel piston within a steel cylinder and is mounted in the regulator in such a way that the greater the R. P. M. and centrifugal force, the greater is the pressure required to open the valve. The filter assembly is a two-piece aluminum compartment consisting of a

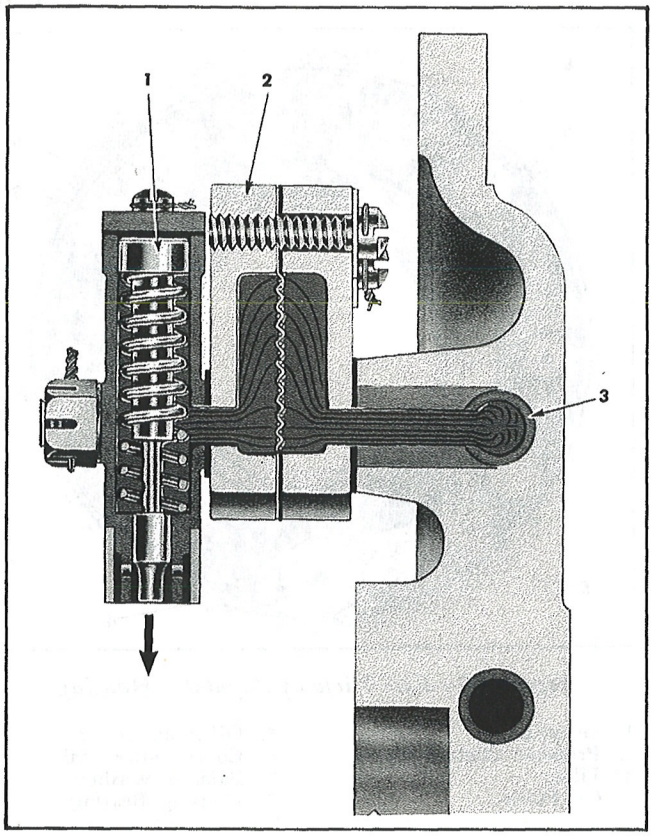

Figure 23—Pressure Control Valve

1. Pressure Control Valve
2. Filter
3. Pump Pressure Tube, Regulator Housing

cap and cover, and is mounted between the pump outlet line and the pressure control valve. A filter screen is mounted between the halves in order to protect the pressure control valve. Since the governor piston is more often in neutral position than not, eventually all of the regulator oil is discharged through the pressure control valve filter assembly. This filter is so designed that it will accumulate and retain harmful foreign matter that may pass through the hydraulic system. See Figures 22 and 23.

(8) GOVERNOR.

The governor assembly has an aluminum body into which a steel sleeve is pressed. A lapped steel piston moves within a sleeve, and receives and distributes oil under pressure through ports machined in the sleeve. A ground steel lever is hinged to one end of the piston. The under side of this lever bears on a steel fulcrum roller, while a spring load bears on the upper side. An adjusting screw on the other end of the spring permits adjustment of the governor for *maximum* controlling R. P. M. The fulcrum roller is mounted onto a bronze carriage that slides on a steel guide ways, which is doweled and fastened to the governor body with cap screws, and a curved steel shoe extends from the under side of the carriage. It is through this shoe that the governing R. P. M. is controlled. See Figures 12, 22 and 24.

(9) CONTROL MECHANISM.

(*a*) Inasmuch as the regulator revolves with the hub, carrying with it the governor, oil pump and pressure control valve, it is obvious that a *control mechanism* and a stationary *gear* be incorporated in order to make possible control of the governor and operation of the oil pump. See Figures 24 and 27.

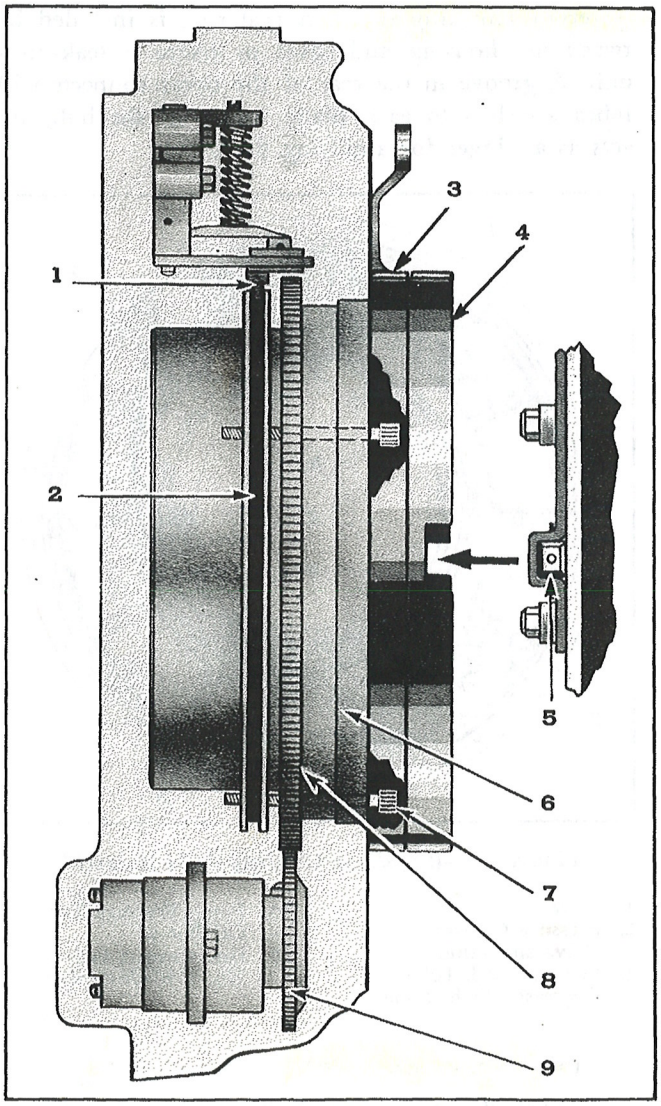

Figure 24—Regulator Control Mechanism

1. Governor Shoe
2. Control Ring
3. Control Gear and Lever
4. Adapter Plate
5. Adapter Stop
6. Adapter Ring
7. Control Screw—3 required
8. Regulator Gear
9. Oil Pump Drive Gear

(*b*) On the rear of the regulator, therefore, is a notched steel ring known as the *adapter plate.* The notch in this ring engages a *stop assembly* that is attached to studs on the engine reduction gear case. See Figure 24. On the other side of the adapter plate is a bearing surface for the *control gear and lever.* The control gear and lever is a steel ring gear with internally cut teeth, having a lever arm which is attached directly to the cockpit control. Three threaded *control screws* are mounted within the control gear and lever (ring gear) so that the pinion gear heads on the control screws mesh with the internal teeth of the control gear. See Figure 24. Movement of the lever, therefore, will rotate the control screws. A steel plate known as the *adapter ring* is mounted in front of the control gear and lever to act as a guide for the control screws. Within the regulator is a cylindrical steel part known as the *regulator gear* which forms the bore of the regulator unit. This piece has a gear flange, on the external edge of which are cut gear teeth, that, on assembly of the regulator, mesh with the oil pump drive gear. The adapter plate, adapter ring and regulator gear are all fixed together by capscrews to form a stationary, solid assembly. In front of the regulator gear flange and surrounding the regulator gear part is a grooved bronze *control* ring, the groove of which mates with the governor carriage shoe. Figures 24 and 27. The threaded ends of the control screws mate with threads in the control ring so that rotation of the control screws imparts a fore and aft movement to the control ring, allowing governor control. For an over-all schematic diagram, see Figure 27.

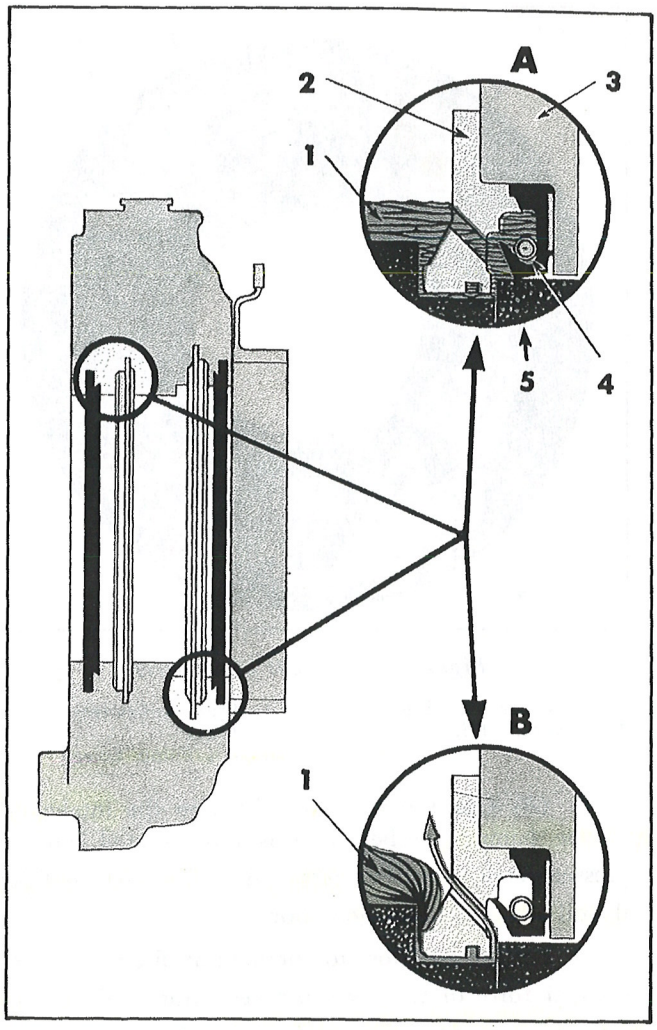

Figure 25—Bearing and Seal Function

A. Seal in stationary, or *closed,* position

1. Oil Level
2. Bearing
3. Regulator
4. Seal
5. Regulator Gear

B. Seal in running, or *open,* position

1. Oil slung back through bearing slinger holes

(10) REGULATOR BALANCE.

The rotating section of the regulator, excluding the control mechanism and stationary gear, is statically balanced. Balance weight bosses are provided in the regulator housing so that perfect balance may be attained. See figure 22.

(11) BEARINGS AND SEALS.

The regulator gear and attached parts float within the regulator on plain bronze bearings attached to the housing and the cover. To provide for oil that may pass these bearings, a slinger effect has been incorporated by utilizing centrifugal force to throw the oil back into the regulator through holes in the bearings. See Figure 25. Spring-loaded seals have been installed in both the housing and the cover to the outer side of the bearings so that at low speeds, or when the propeller is stationary, they effectively retain the oil. Centrifugal force lifts the seals off from the regulator gear above a pre-determined R. P. M. where that force is sufficient to hold the oil away from the center portion of the regulator. In this manner, seal wear is kept to a minimum. Steel balls within the seal spring are acted on by centrifugal force so that above the desired R. P. M., they overcome the spring tension and permit the seals to withdraw.

(12) SCREENS AND FILTERS.

(*a*) In any hydraulic system it is essential that impurities be kept from close-fitting moving parts. The hydraulic fluid in the Aeroprop is adequately filtered through screens installed in the regulator unit. See Figure 26.

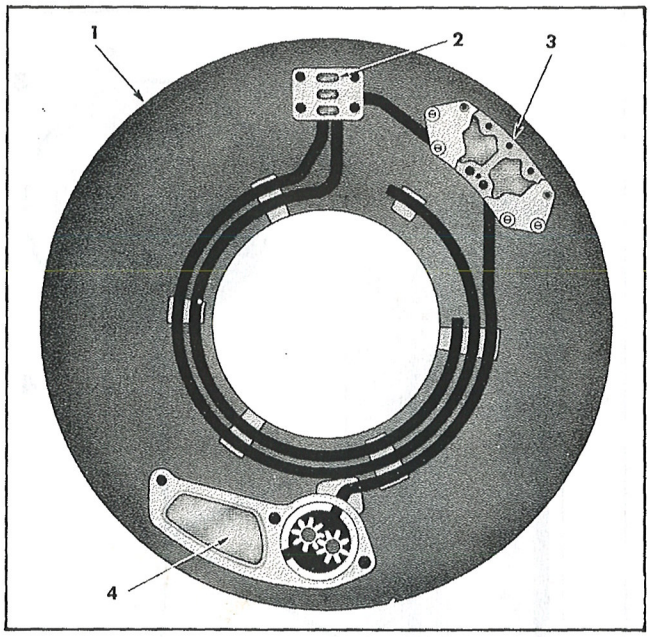

Figure 26—Screens and Filters

1. Regulator Housing
2. Governor Filter
3. Pressure Control Valve Filter
4. Oil Pump Screen

(*b*) One screen is assembled to the intake side of the pump; another filter is incorporated into the pressure control valve unit; and a third screen filters the oil as it enters the governor.

(*c*) In addition to mechanical filters, the centrifugal force of the revolving regulator tends to sling impurities to the outer portions of the housing and cover, and hold dirt or other foreign matter away from vital moving parts. As an added precaution, however, it is recommended that care be taken while filling the regulator to prevent entry of dirt.

(13) SPINNER AND BULKHEAD.

(*a*) Because modern military planes operate at very high speeds, the exterior of the airplane must be efficiently streamlined. The spinner shell of the Aeroprop blends with the contour of the planes on which it is used. This shell is a light-weight formed steel piece, perfectly balanced and rigidly braced.

(*b*) The bulkhead to which this piece is attached is a steel stamping that is also balanced at time of manufacture. This bulkhead is attached to the regulator by regulator cover screws between the regulator and the hub, and the spinner shell is attached to the bulkhead by counter-sunk screws. See Figure 34.

3. DESIGN VARIATION.

a. MODEL IDENTIFICATION.

(1) At the time of publication, one model is being produced, the designation of which is A632S-C1. Prior to its introduction, four other types were built which have minor variations in regulator and type of stop lugs used. These are known as models A632S-A1, A632S-A2, A632S-B1, and A632S-B5. This handbook, therefore, will deal particularly with model A632S-C1 and will be supplemented with discussions of the -A1, -A2, -B1, and -B5 wherever such a distinction is necessary. Below is a sample form to show how a model designation is obtained.

Model Designation	*A632S-C1*
A	Aeroproducts
6	60 Shaft size
3	Number of blades
2	Blade shank size
S	Short propeller shaft
C	Major variation in design
1	Minor design variation

(2) Although the outward appearance of the various models is similar, they may be readily identified by the model designation stamped on the rim of No. 1 hub socket.

b. MODEL A632S-C1.

(1) The model *A632S-C1* propeller is designed for engines up to 1325 H. P. and propeller speeds up to 1375 R. P. M. Governor control covers a range from 650 propeller R. P. M. to 1375 propeller R. P. M. The governor arrangement holds the propeller R. P. M. within extremely close limits of any given setting.

(2) SPECIFICATIONS.

A632S-*C1*

Overall Diameter	11′ 7″
Minimum Blade Angle	28°
Maximum Blade Angle	63°
Blade Angle Range	35°
Maximum Propeller R. P. M.	1345
Rated Horsepower	1325
Engine Reduction Gear Ratio	2.23:1

c. MODEL A632S-A1.

(1) The major differences in Model A632S-A1 from that described in the foregoing are:

(a) No bearings between regulator gear, and housing and cover, in contrast to model A632S-C1. Bearings in this particular model regulator are not required

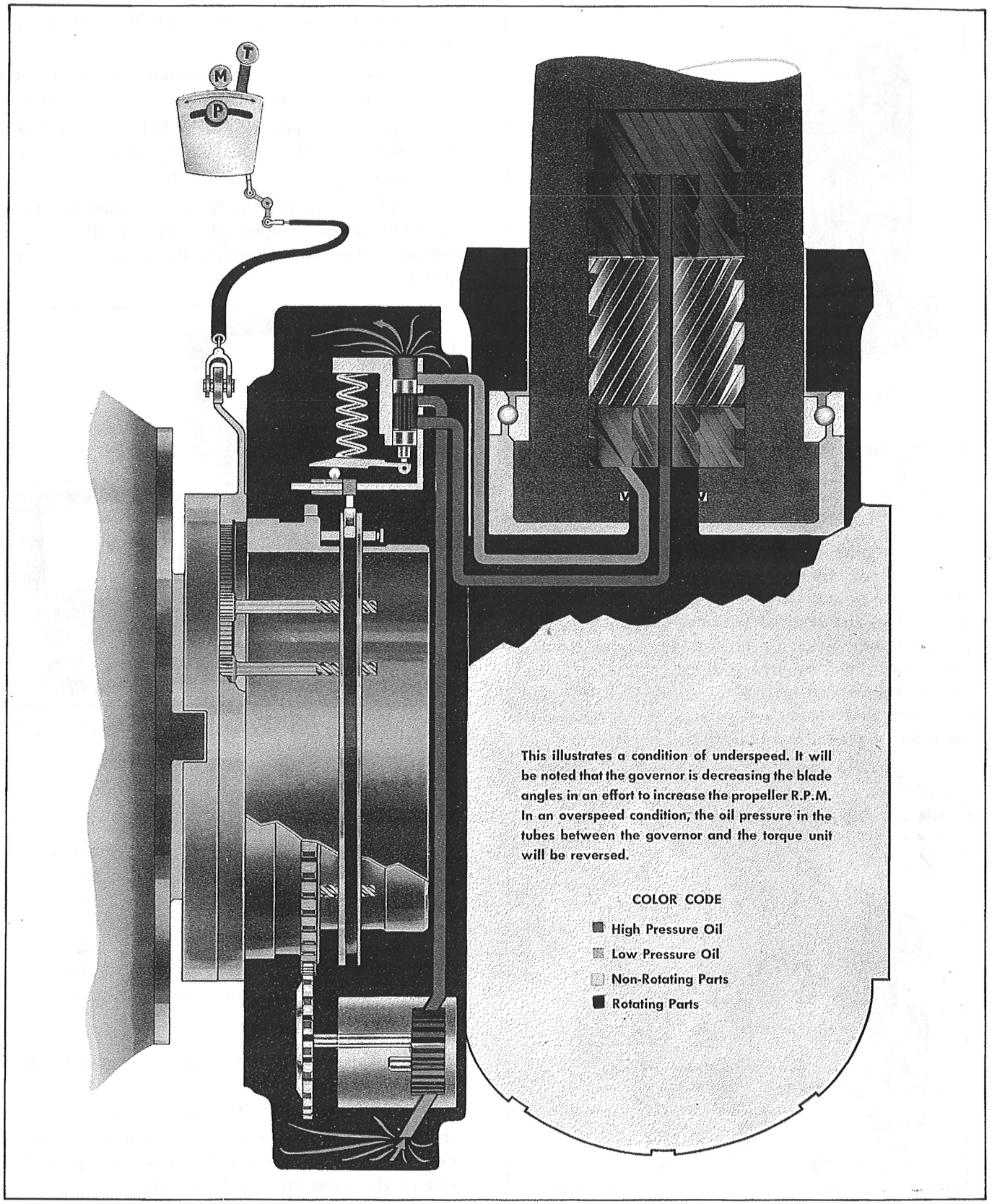

Figure 27—Operational Diagram of the Aeroprop

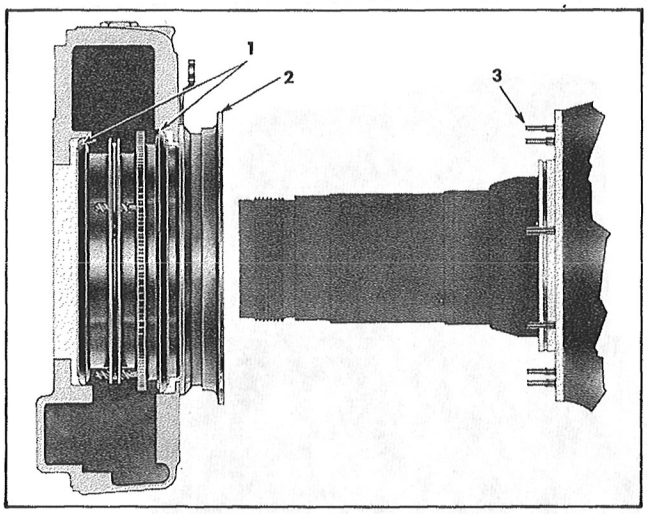

Figure 28—Sectional Regulator View—Models A632S-A1, -A2

1. Seals mounted on Regulator Gear
2. Adapter Plate Lobes Attach to Reduction Gear Case Studs
3. Engine Reduction Gear Case Mounting Studs

since the regulator is so designed that the non-rotating portion of the regulator is attached to studs on the engine reduction gear unit. The regulator unit, of course, is locked to and revolves with the propeller shaft and propeller hub. Since the face of the engine reduction gear case is closely aligned to the propeller shaft, fastening the regulator adapter plate to that face will assure alignment of the stationary portion of the regulator to the rotating propeller assembly. See Figure 28.

(b) High speed seals are attached to the regulator gear and bear on seal races in the housing and cover at all speeds. See Figure 28.

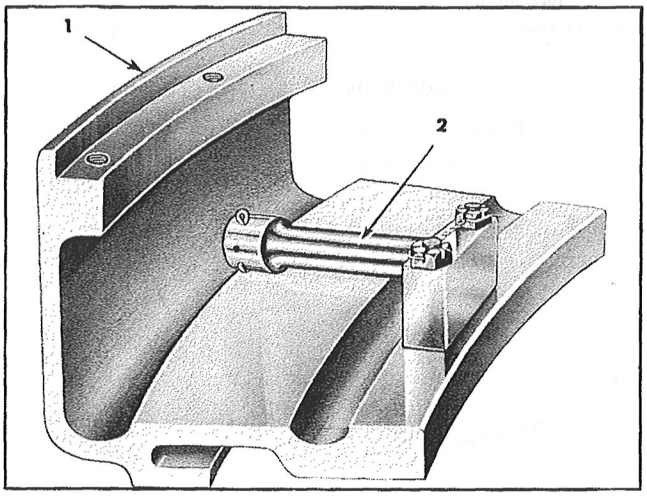

Figure 29—Check Valve—Models A632S-A1, -A2

1. Regulator Cover
2. Check Valve

(c) Pinion gears are detachable from the control screws.

(d) A *check valve* is installed in the cover to permit re-entry of oil passing the seals. See Figure 29.

(e) The *regulator gear* is bolted to the face of the engine reduction gear case by means of lobes on the adapter plate. See Figure 28.

(f) An *adjustable lever* stop plate is attached to a lobe of the adapter plate to limit the governor control within the designed R. P. M. range of the propeller.

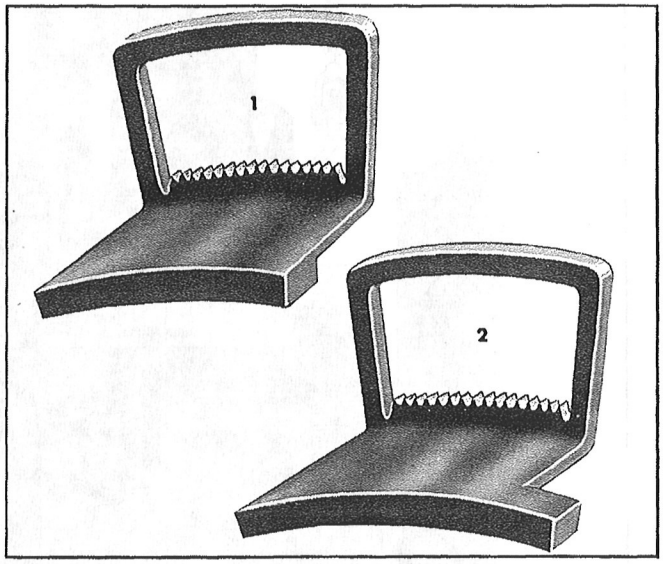

Figure 30—Lever Stop Plates—Models A632S-A1, -A2

1. For Model A632S-A1
2. For Model A632S-A2

(2) SPECIFICATIONS.

A632S-*A1*

Overall Diameter	10′ 4½″
Minimum Blade Angle	20°
Maximum Blade Angle	55°
Blade Angle Range	35°
Maximum Propeller R. P. M.	1670
Rated Horsepower	1150
Engine Reduction Gear Ratio	1.8:1

d. MODEL A632S-A2.

(1) This model is identical with model A632S-A1 except for the following:

(a) Inasmuch as this model rotates at a slower speed, a different *lever stop plate* is used in order to limit the travel of the control lever on the high R. P. M. side of the governor. See Figure 30.

(b) Since the engine reduction gear case for this model has only eight studs rather than sixteen,

model A632S-A2 propeller adapter plates will be attached to the engine reduction gear case at two lobes rather than four. Do not remove the other two lobes. See Figure 31.

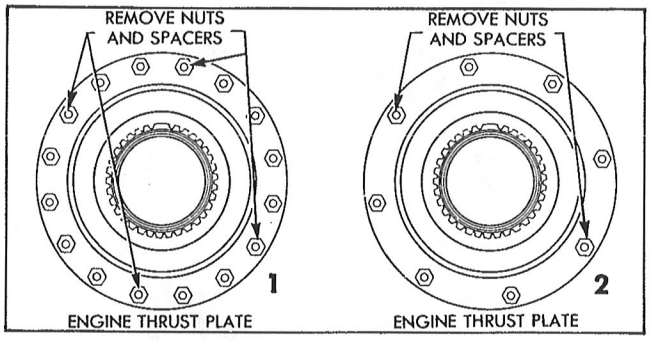

Figure 31—Mounting Studs—Models A632S-A1, -A2

1. Model A632S-A1 2. Model A632S-A2

(2) SPECIFICATIONS.

A632S-*A2*

Overall Diameter	10′ 4½″
Minimum Blade Angle	24.5°
Maximum Blade Angle	59.5°
Blade Angle Range	35°
Maximum Propeller R. P. M.	1500
Rated Horsepower	1150
Engine Reduction Gear Ratio	2:1

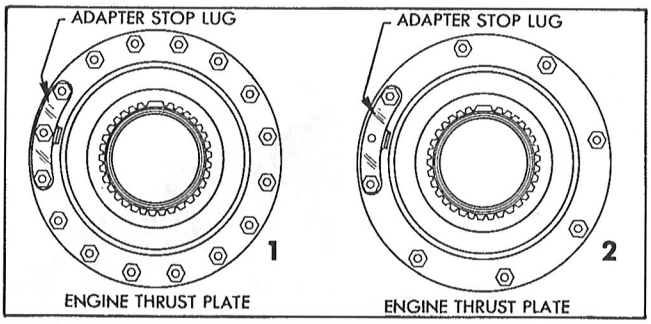

Figure 32—Stop Lug Mounting—Models A632S-B1, -B5

1. Model A632S-B1 2. Model A632S-B5

e. MODEL A632S-B1.

(1) The regulator for model A632S-B1 is similar to that used on propeller model A632S-C1 except for outward appearance. In addition, the adapter plate is fixed to the engine reduction gear case by means of a one-piece composition stop lug in place of the bracket and block as used on Model A632S-C1. See Figure 32.

(2) SPECIFICATIONS.

A632S-*B1*

Overall Diameter	10′ 4½″
Minimum Blade Angle	20°
Maximum Blade Angle	55°
Blade Angle Range	35°
Maximum Propeller R. P. M.	1670
Rated Horsepower	1150
Engine Reduction Gear Ratio	1.8:1

f. MODEL A632S-B5.

(1) This model is identical with model A632S-B1 except that a "softer" governor spring is used in order to compensate for the lower rotative speeds of this propeller.

(2) SPECIFICATIONS.

A632S-*B5*

Overall Diameter	10′ 4½″
Minimum Blade Angle	24.5°
Maximum Blade Angle	59.5°
Blade Angle Range	35°
Maximum Propeller R. P. M.	1500
Rated Horsepower	1150
Engine Reduction Gear Ratio	2:1

TABLE I.

AEROPRODUCTS PROPELLER INSTALLATIONS

Plane Model	*Prop. Model*	*Plane Model*	*Prop. Model*
P39F	A6325-A1	P39K	A6325-A2
P39F	A6325-B1	P39K	A6325-B5
P39N	A6325-C1		

NOTE

Because of the different reduction gear ratios between the P39F, P39K, and P39N model airplanes, and the consequent different rotative speeds of the propellers, a particular tension governor spring is necessary for each reduction gear ratio.

These are as follows:

TABLE II.

Propeller Model	*Spring Identification*	*Spring Tension*
A632S-A1, -A2 -B1	Unplated	29.5 to 30.5 lbs. at $1\frac{3}{16}$″ compressed length
A632S-B5	Half-plated	24.5 to 25.5 lbs. at $1\frac{3}{16}$″ compressed length
A632S-C1	All plated	18 to 19 lbs. at $1\frac{3}{16}$″ compressed length

SECTION III
PROPELLER REMOVAL AND INSTALLATION

1. GENERAL.

a. The five models of Aeroprop discussed herein are designed for the No. 60 short propeller shaft. These models, as far as removal and installation is concerned, differ only in the method of fixing the non-rotating portion of the regulator on the engine reduction gear case.

b. Inasmuch as model A632S-C1 is the current production type, the discussion on the following pages will center around this model and will be supplemented by variations in methods of installing and removing the other four types wherever such differences are encountered.

c. For installation and removal of the Aeroprop, only one special tool is necessary, as shown in Figure 33. Together with the propeller shaft nut locking sleeve, this Shaft Nut Wrench is used for tightening or loosening the propeller shaft nut.

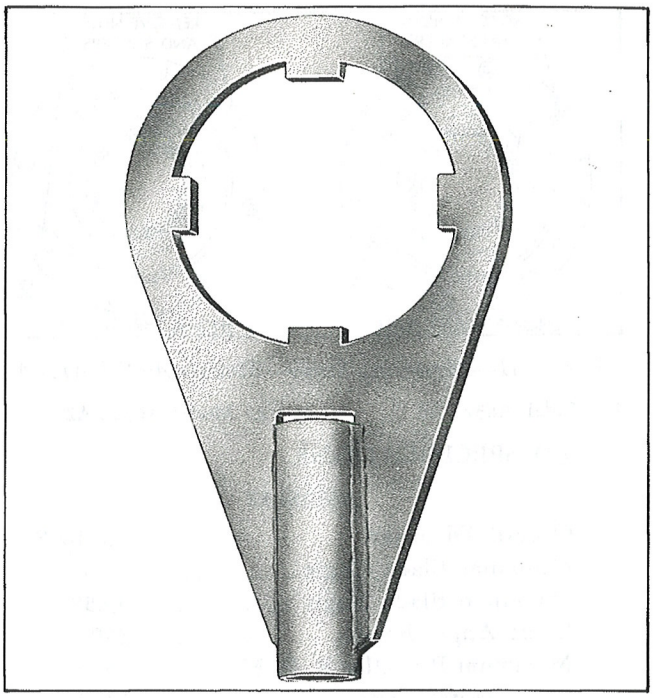

Figure 33—Shaft Nut Wrench

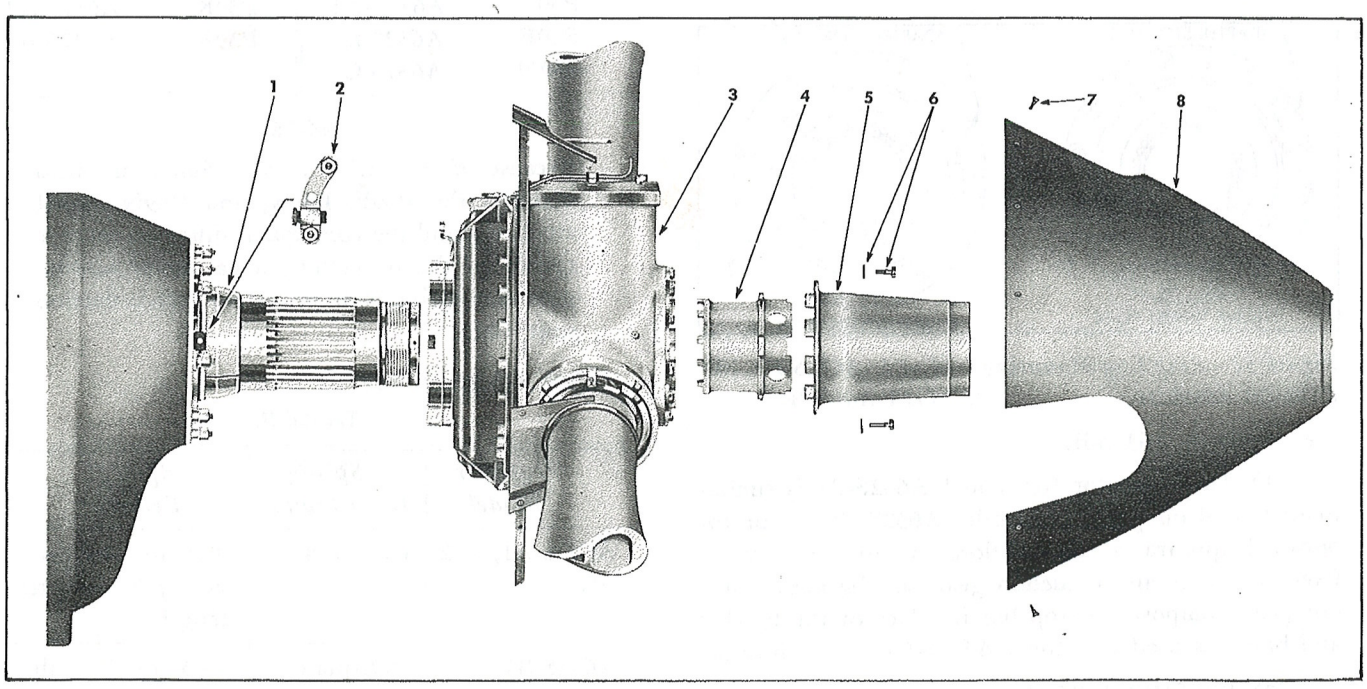

Figure 34—Propeller Installation

1. Rear Cone
2. Stop Assembly
3. Propeller
4. Shaft Nut Locking Sleeve
5. Spinner Adapter
6. Adapter Attaching Screws and Washers—9 required
7. Spinner Attaching Screws—12 required
8. Spinner Shell

2. PROPELLER REMOVAL AND INSTALLATION.

a. TOOLS AND EQUIPMENT FOR REMOVAL AND INSTALLATION.

Hoist and Sling
Shaft Nut Wrench
4' x 1" Steel Bar
10" Reed and Prince Screwdriver
10" Screwdriver
7/16" Socket with Speed Handle
Thread Lubricant, A. N. Specification 3590
1/16" Cotter Key
Diagonal Cutters
5/8" End Wrench
1" Socket Wrench and Handle
.032" Brass Safetywire
Duck-bill Pliers
Clean Engine Oil
Cleaning Materials
Dry Wiping Rags
300 lbs. of Sandbags or other weights
Fine India Stone
Regulator Oil, A. A. F. Specification Y3587

b. PROCEDURE FOR REMOVAL OF THE AEROPROP.

Step 1.—For planes equipped with tricycle landing gear, load the nose wheel strut fork with approximately 300 lbs. in order to compensate for removal of the weight of the propeller.

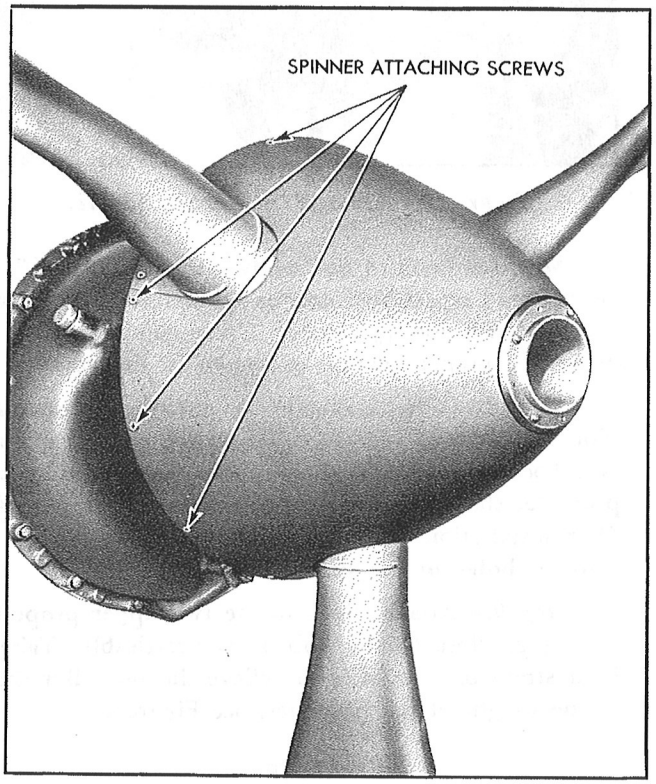

Figure 35—Removal of Spinner Shell

Step 2.—Remove the countersunk attaching screws that hold the spinner shell to the bulkhead as shown in Figure 35.

Step 3.—Remove the spinner shell by rapping with palm of hands *only.*

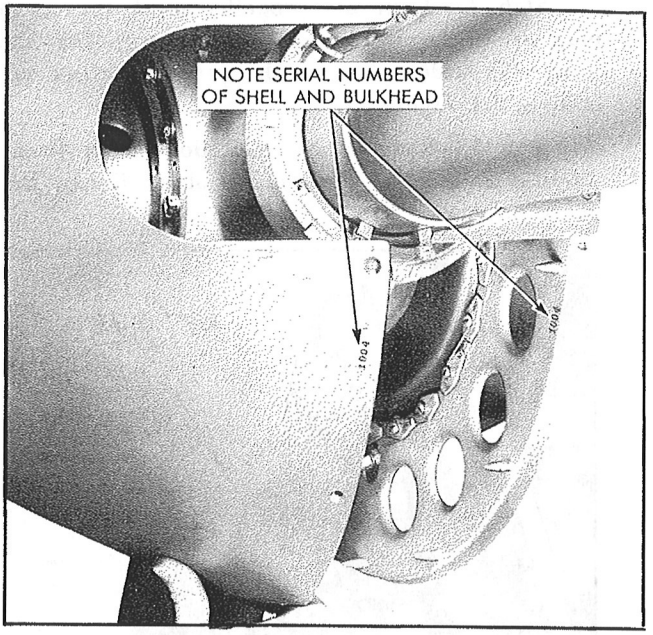

Figure 36—Removal of Spinner Shell

NOTE

It is not necessary to mark the mating sections of the spinner shell and the bulkhead. Because of offset dowels, the spinner shell can mount on the bulkhead in only one position. See Figure 36.

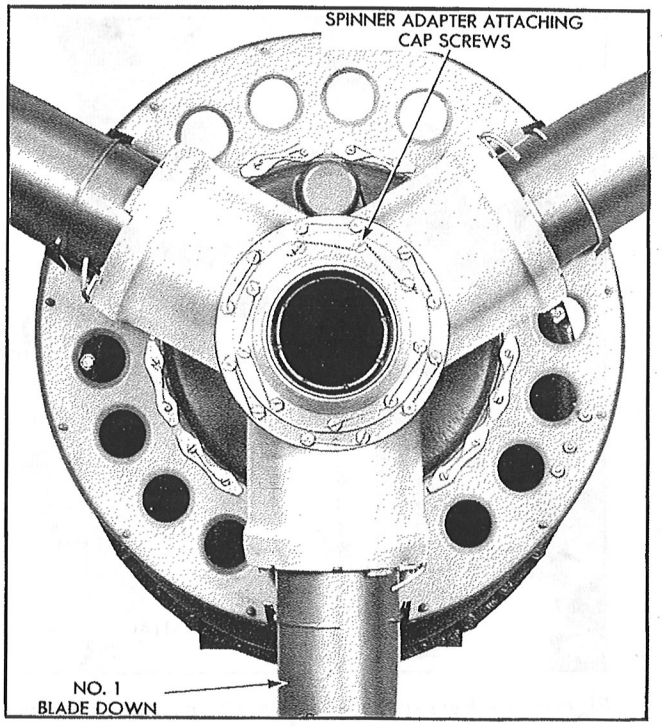

Figure 37—Removal of Propeller

Step 4.—Turn the propeller until the oil filler plug in the regulator points downward. This should bring the wide spline of the propeller shaft to the bottom. See Figure 37.

Step 5.—Remove the inspection doors from the cowling around the nose of the plane directly behind the spinner.

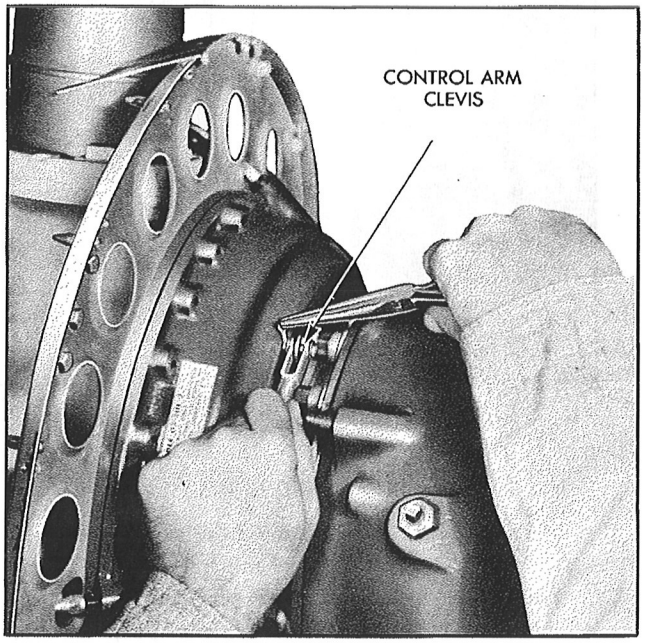

Figure 38—Disengaging Control Lever

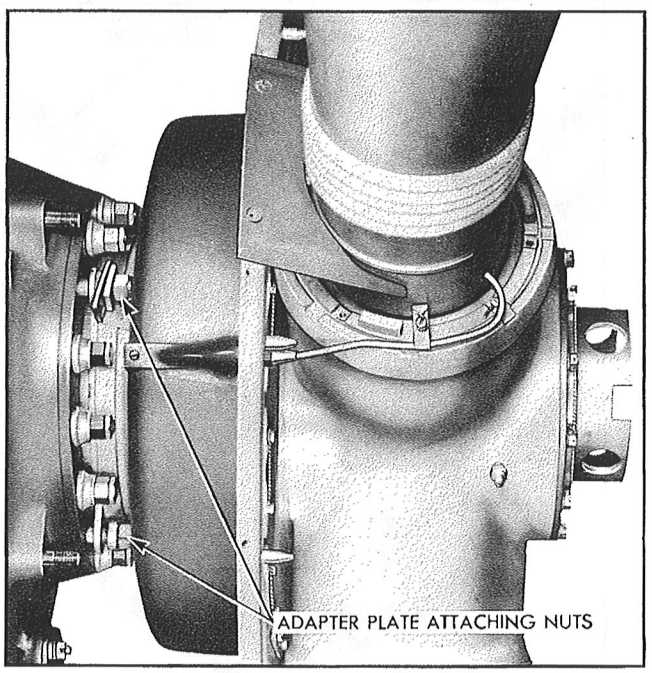

Figure 39—Removal of Adapter Plate Attaching Nuts—Models A632S-A1, -A2

Step 6.—Remove the cotter key and the clevis pin from the regulator control lever located between the engine reduction gear case and the rear of the regulator at the upper side of the plane. See Figure 38.

CAUTION

Look at the regulator adapter plate, and if it is of the bolted-on type (model A632S-A1 and -A2), loosen the adapter plate holding nuts shown in Figure 39 as far as possible using a 5/8" end wrench.

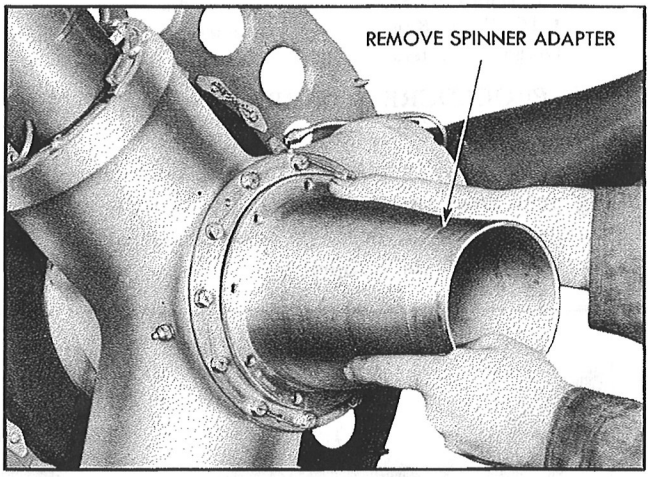

Figure 40—Removal of Spinner Adapter

Step 7.—Remove the safety wire and the 1/4" by 28 hex head capscrews from the spinner adapter, using a speed wrench and $\frac{7}{16}$" socket. Using hands only, withdraw the spinner adapter as shown in Figure 40.

Step 8.—Where cannon is mounted, use Shaft Nut Wrench and four foot bar on the propeller Shaft Nut Locking Sleeve. Turn counterclockwise and loosen propeller shaft nut two turns, as shown in Figure 41. (For installation without cannon, bar may be placed through holes in the sleeve itself.)

Step 9.—Attach slings to the two upper propeller blades, as close to the hub as is practicable. Take a light strain on the hoist to relieve the propeller shaft of the weight of the propeller. See Figure 42.

NOTE

If the propeller has a type A632S-A1 or -A2 regulator, the adapter plate and the adapter nuts *must be removed,* as the propeller shaft nut is backed off. Check the adapter plate after each turn of the propeller shaft nut until the adapter plate is clear of the engine reduction gear case studs. See Figure 39.

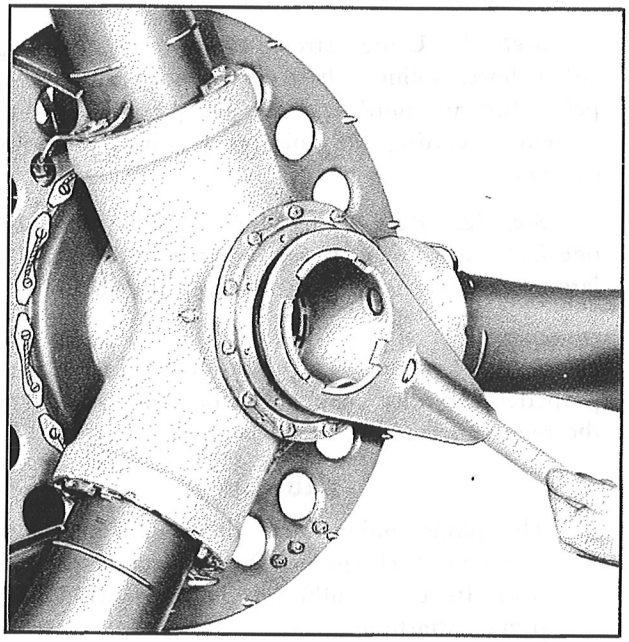

Figure 41—Loosening Shaft Nut

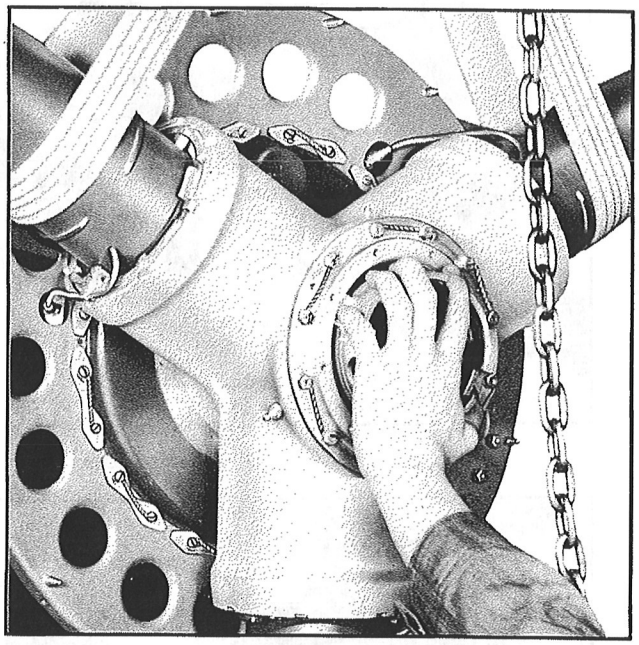

Figure 43—Loosening Shaft Nut

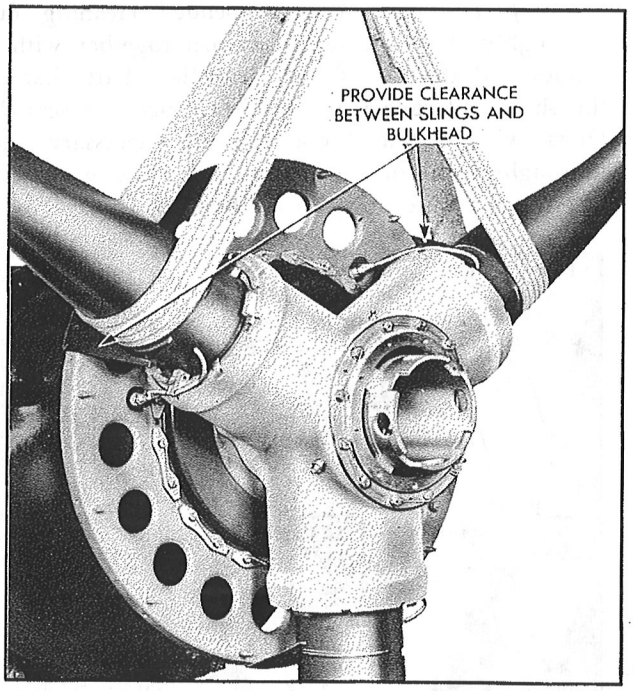

Figure 42—Attaching Slings to Propeller

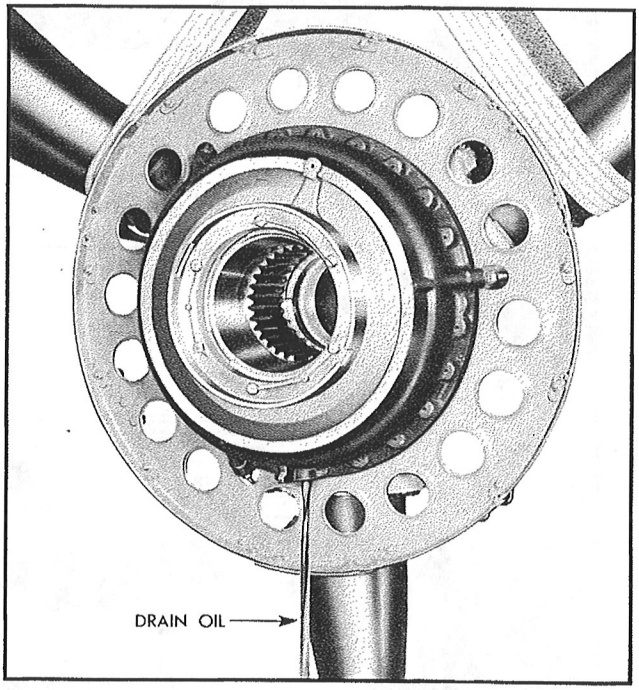

Figure 44—Draining Regulator Oil

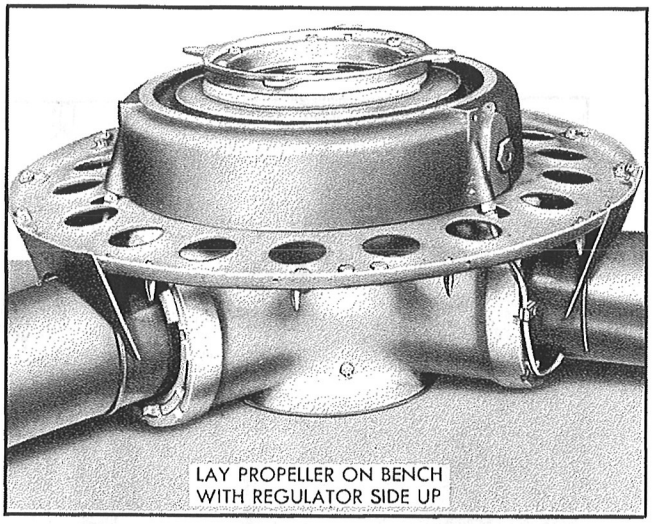

Figure 45—Placing Propeller on Bench

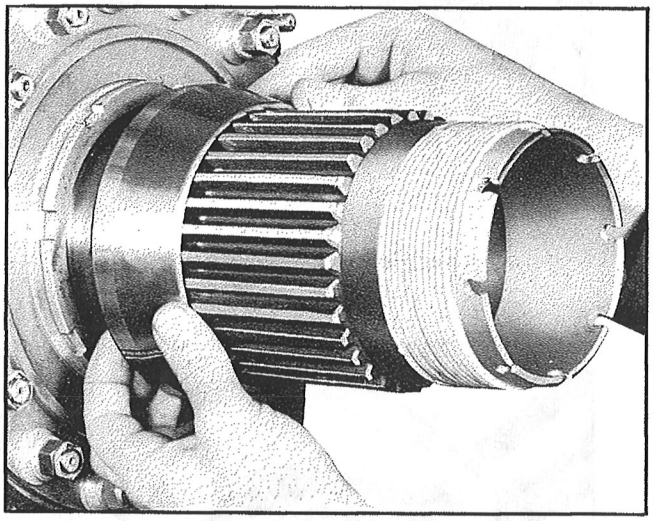

Figure 46—Removal of Rear Cone

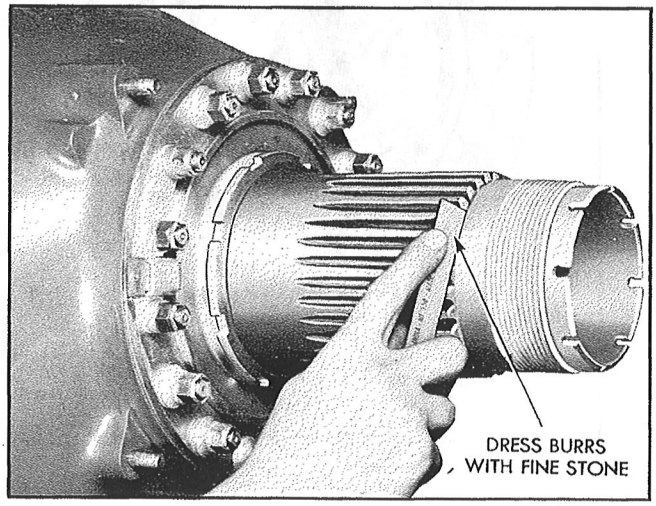

Figure 47—Inspecting Propeller Shaft

Step 10.—Continue to turn Shaft Nut Wrench counterclockwise until the propeller shaft nut is clear of the threads. See Figure 43.

Step 11.—Using extreme care to prevent damaging either bore, splines, shaft, or cannon, slide the propeller forward until clear of the propeller shaft and cannon, operating the hoist as required to maintain clearance.

Step 12.—Remove the regulator filler plug using a one inch socket wrench. Drain the oil out of the regulator as shown in Figure 44. Replace the plug and washer.

Step 13.—Supporting the free blade, place the propeller carefully on a bench or other support with the regulator side up, as shown in Figure 45.

CAUTION

The spinner and spinner bulkhead are balanced as a unit. Each spinner should be kept paired with its own bulkhead, together with the proper attaching screws.

Step 14.—Remove the rear cone and felt insert shown in Figure 46.

c. PROCEDURE FOR INSTALLATION OF THE AEROPROP.

Step 1.—Using a recommended cleaning fluid, thoroughly clean the rear cone seat together with the splines and threads of the propeller shaft. Examine the shaft and cone seat for nicks, burrs, or scratches. Dress with a fine India stone if necessary, clean thoroughly and dry. See Figure 47. Rotate the shaft to bring the wide spline to the bottom.

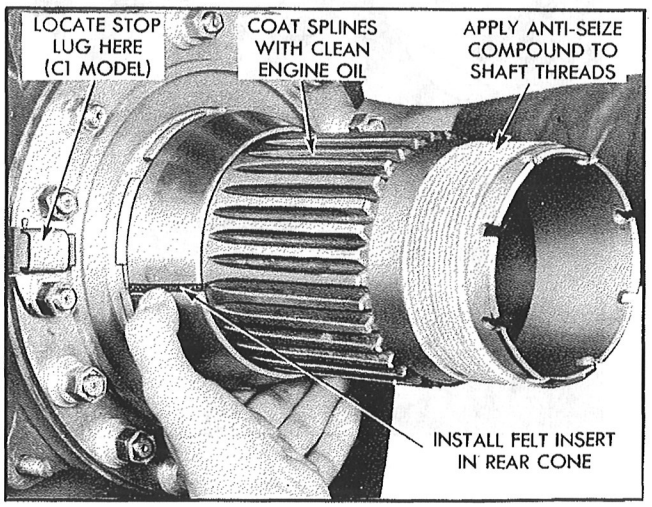

Figure 48—Installation of Rear Cone

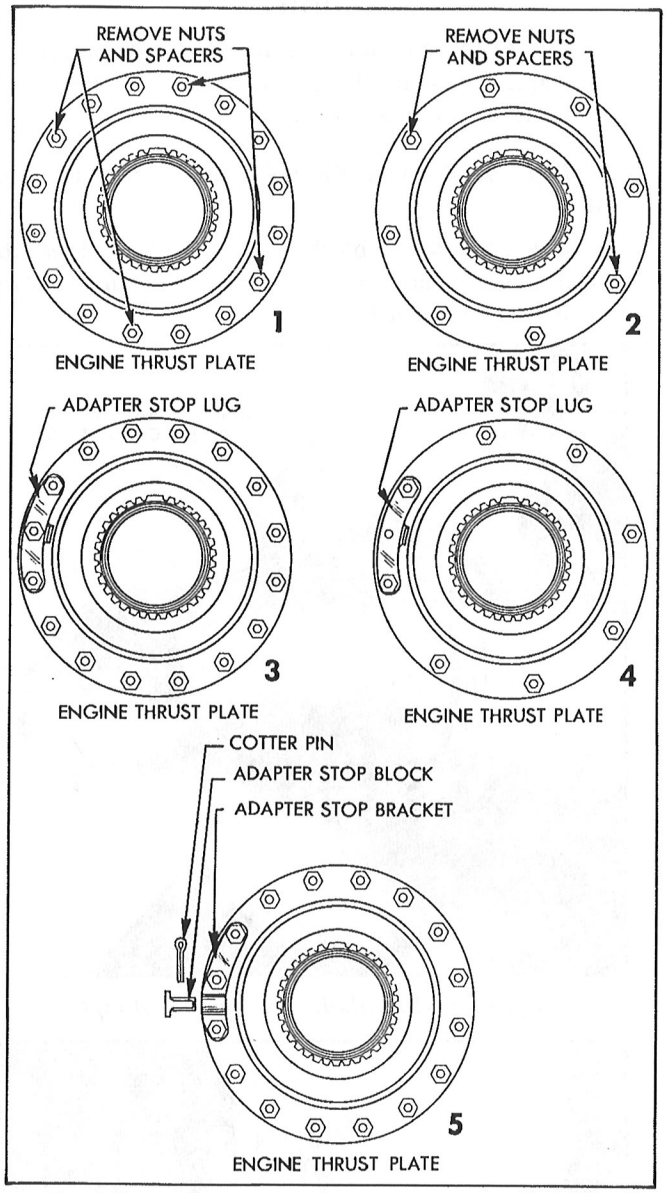

Figure 49—Mounting of Adapter Stop

1. A632S-A1
2. A632S-A2
3. A632S-B1
4. A632S-B5
5. A632S-C1

Step 2.—Install the rear cone clean and dry: Do not apply grease or oil. Install the felt insert in the rear cone slot as shown in Figure 48.

Step 3.—Apply a light coat of clean engine oil to the propeller shaft splines.

Step 4.—Apply a thin coat of approved anti-seize compound to the propeller shaft threads.

Step 5.—If Model A632S-C1, -B1 or -B5, install the adapter stop on the third, fourth and fifth studs down from the top on the right hand side of the sixteen stud engine reduction gear case, as viewed from the pilot's seat. Use the second and third studs down for the eight stud engine reduction gear case. If Model A632S-C1, use the two engine nose stud spacers between the stop lug bracket and the attaching nuts. If Model A632S-A1 or -A2, remove the thrust plate stud nuts and spacers as shown in Figure 49.

Step 6.—Clean the bore of the propeller hub thoroughly. All grease or anti-rust compounds must be removed completely from the propeller and the bore wiped thoroughly dry. See Figure 50.

Step 7.—Attach the slings to the two blades opposite the wide spline of the propeller hub. Keep the slings as close to the hub as is practicable.

CAUTION

Provide clearance between the sling and the spinner bulkhead plates to avoid damage when the hoist is raised.

Step 8.—Raise the propeller, manually supporting the free blade, and align the wide spline of the hub with the wide spline of the propeller shaft. Cautiously slide the propeller on the shaft until the propeller shaft nut engages the threads. Take care not to damage either the threads, splines, cones, or cannon. See Figure 51.

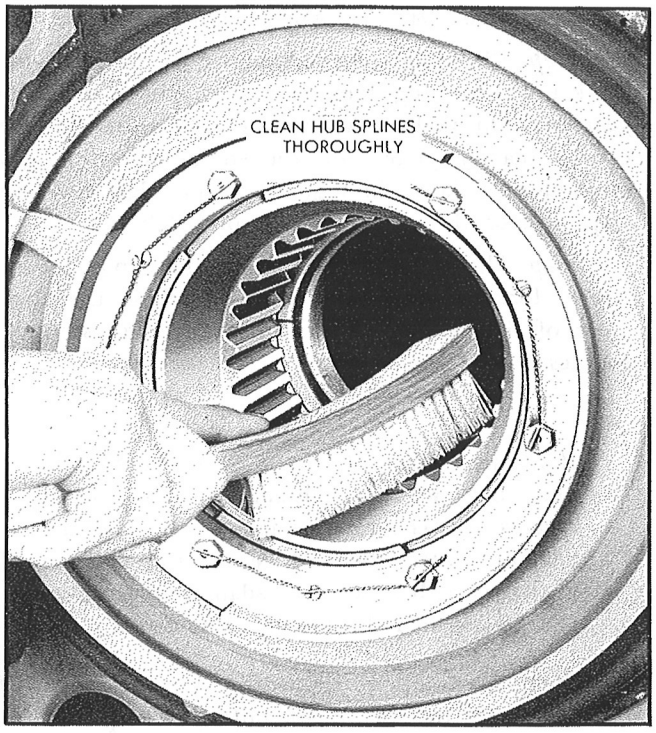

Figure 50—Cleaning Propeller Hub

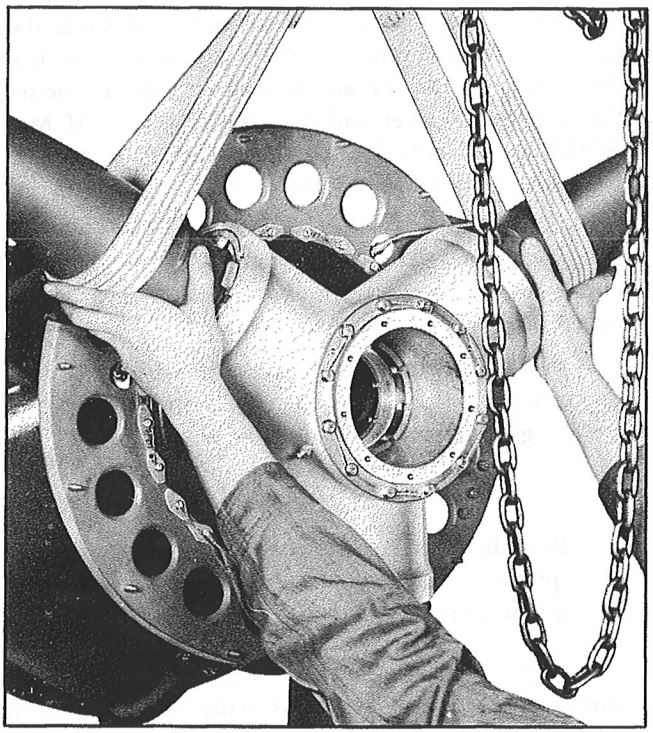

Figure 51—Mounting Propeller

Step 9.—Insert the propeller shaft nut locking sleeve into the hub, engage the nut and turn the propeller shaft nut three turns clockwise, using the shaft nut wrench and bar as shown in Figure 41.

Step 10.—Align the adapter slot with the stop bracket or stop lug located on the engine reduction gear case. On models A632S-A1 or -A2 align the lobes of the adapter plate with the engine reduction gear case studs as shown in Figure 49, and place the lever stop plate on the proper adapter plate lobe.

Step 11.—Turn the propeller shaft nut locking sleeve clockwise two turns while checking the alignment of the adapter plate with the adapter stop. See Figures 49 and 53.

NOTE

If Model A632S-A1 or -A2, start the adapter nuts, but do not tighten. Use the special spacers between each attaching nut and the adapter plate lobes. Make certain that no washers are between the adapter plate lobes and the engine reduction gear case thrust plate.

Step 12.—Continue tightening the propeller shaft nut, observing the adapter mounting line-up until the propeller is mounted solidly against the rear cone.

NOTE

For A632S-A1 and -A2 models, tighten all adapter plate attaching nuts except the one at the lever stop plate lobe.

Step 13.—Remove the hoist slings from the propeller.

Step 14.—While blocking one blade, tighten the propeller shaft nut, using 175 to 200 pounds at the end of the four foot bar.

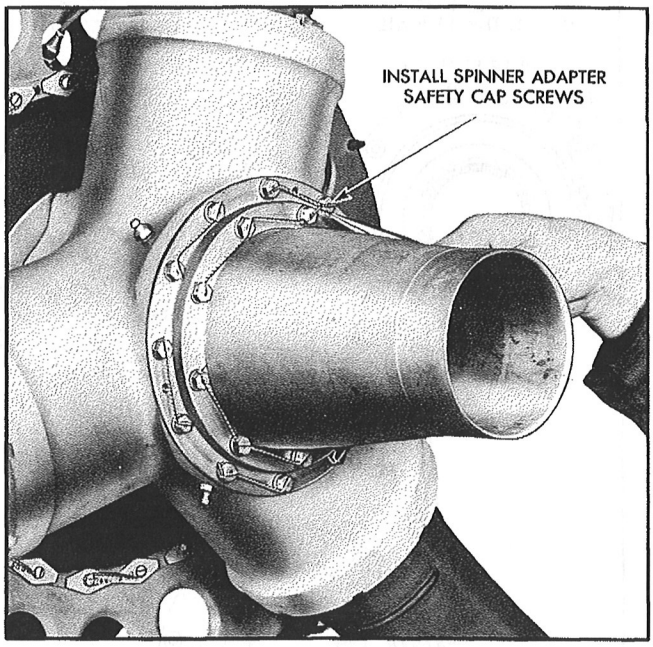

Figure 52—Installation of Spinner Adapter

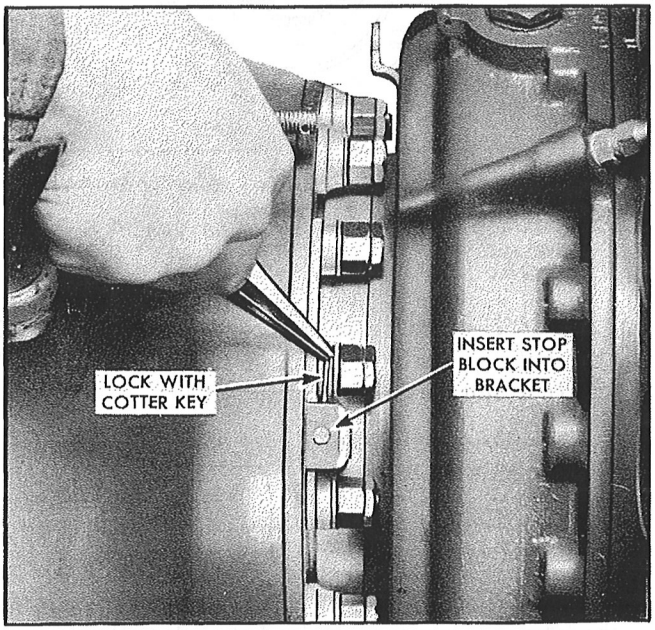

Figure 53—Adapter Stop Block—Models A632S-C1

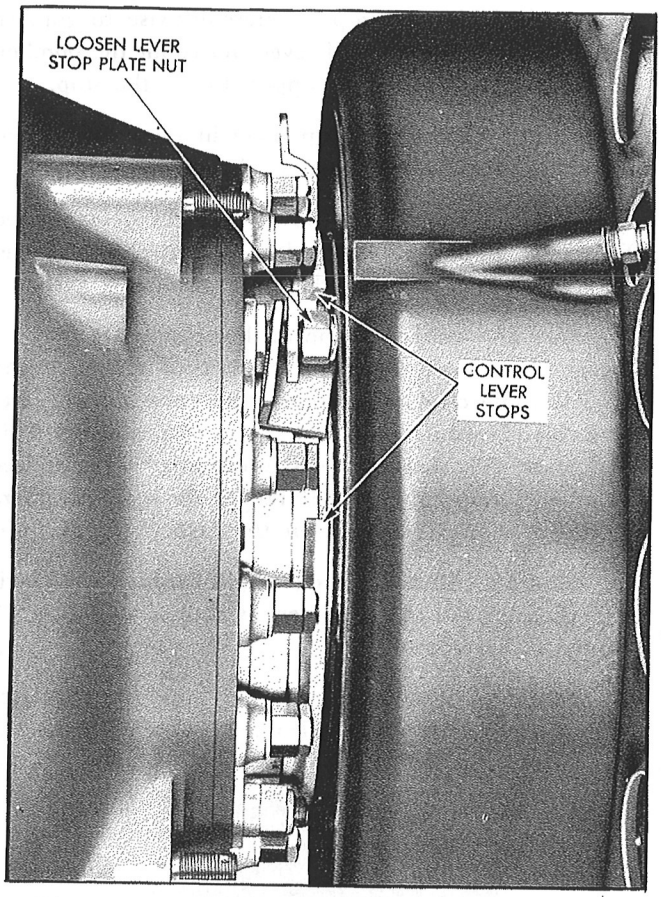

Figure 54—Adjustment of Lever Stop Plate, Models A632S-A1, -A2

Step 15.—Install the spinner adapter: Secure with the 1/4" x 28 hex head capscrews of proper length, and washers. Draw snug with a $\frac{7}{16}$" socket and speed wrench; safety with .032" wire. See Figure 52.

NOTE

If attaching screw holes in the spinner adapter do not line up with screw holes in the face of the hub, remove the adapter and rotate it one notch at a time until proper alignment is made. If alignment still is not attained, tighten shaft nut slightly and repeat procedure.

Step 16.—Install the block in the stop bracket on A632S-C1 models and safety the block with the cotter key as shown in Figure 53.

NOTE

If Model A632S-A1 or -A2, adjust the regulator control lever stop plate as follows:

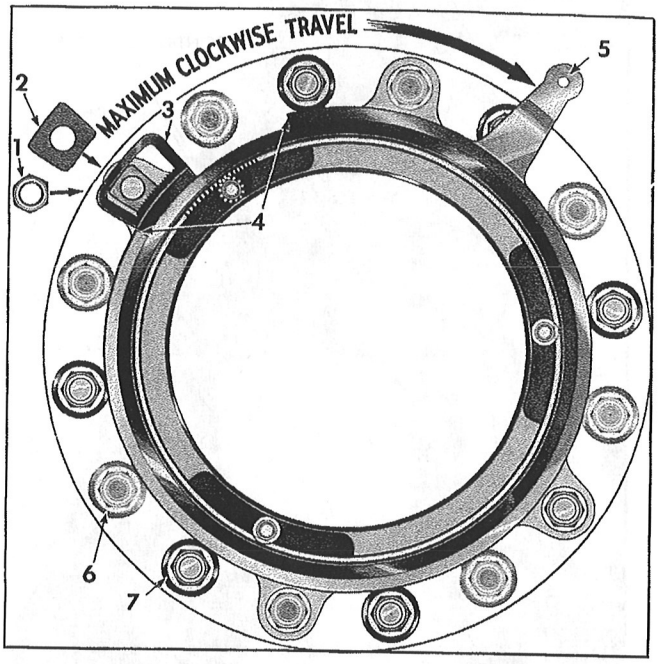

Figure 55—Adjustment of Lever Stop Plate, Models A632S-A1, -A2

1. Nut
2. Stop Plate Washer
3. Lever Stop Plate
4. Control Lever Stops
5. Control Lever
6. Light Studs Removed on Eight Stud Reduction Gear Case
7. Dark Studs Remain on Eight Stud Reduction Gear Case

(a) Facing the propeller, loosen the stop plate attaching nut and disengage the teeth of the stop from the adapter plate teeth. See Figure 54.

(b) Slide the stop clockwise as far as possible.

(c) Rotate the control lever clockwise toward the left side of the airplane to the end of its travel. See Figure 55.

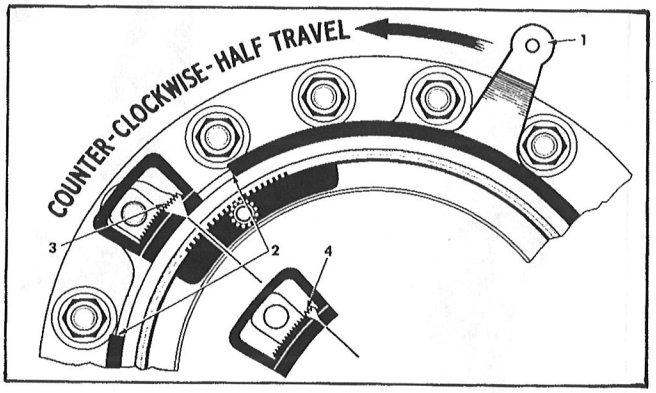

Figure 56—Adjustment of Lever Stop Plate, Models A632S-A1, -A2

1. Control Lever
2. Control Lever Stops
3. Count Exposed Teeth
4. Reduce Exposed Teeth by Three

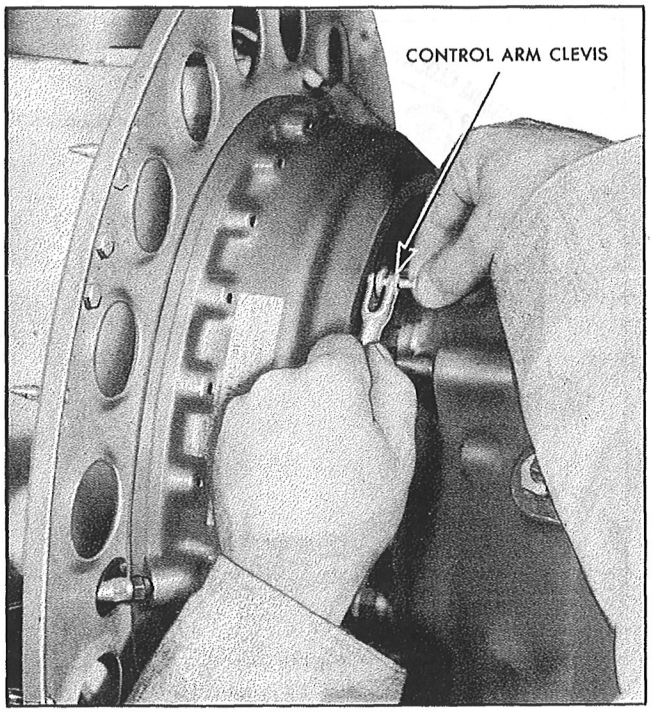

Figure 57—Attaching Linkage to Control Lever

(d) Slide the stop counterclockwise to contact the shoulder of the control lever and count the number of the teeth visible on the upper side of the stop.

(e) Holding the stop plate in place, rotate the control lever to approximately the center position.

(f) Slide the stop downward three teeth. See Figure 56. Engage the stop plate with the teeth of the adapter plate lobe and tighten the attaching nut.

Step 17.—Move the control lever to one end of its travel, then move the quadrant control to see if the flexible cable clevis will follow the same amount. Repeat this procedure at the other end of the range. This will make sure that the regulator control lever is free to move throughout its full range. *Be sure that there is sufficient control travel on the high R. P. M. side.*

Step 18.—Install the clevis pin through the clevis and through the control lever, as shown in Figure 57. Safety with a cotter key.

Step 19.—Rotate the propeller until the regulator filler plug hole is in a horizontal position on the left hand side of the plane. Fill the regulator with A.A.F. Specification Y3587 oil until half full, as shown in Figure 58. Replace the filler plug and washer. Safety with .032″ wire.

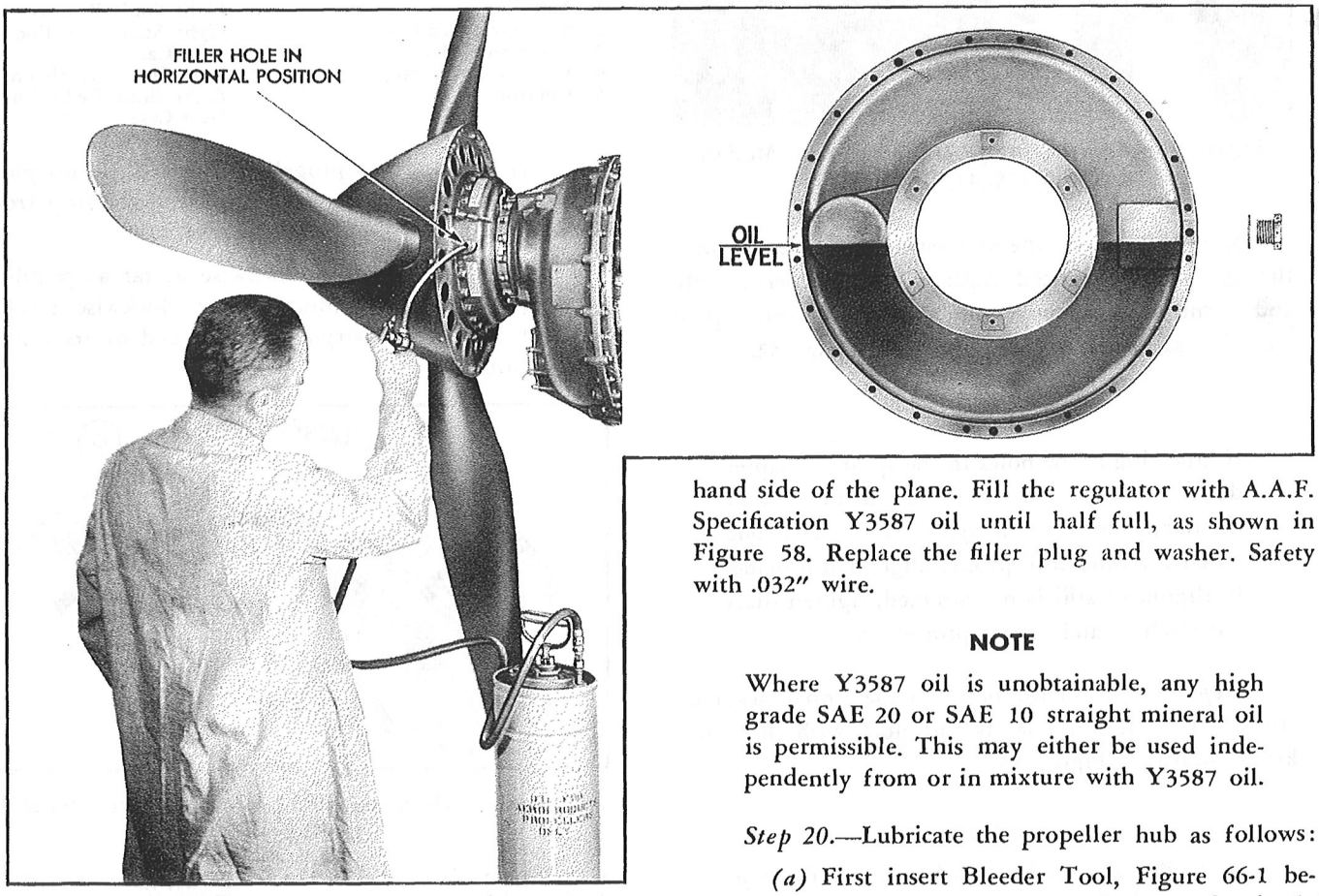

Figure 58—Filling the Propeller Regulator

NOTE

Where Y3587 oil is unobtainable, any high grade SAE 20 or SAE 10 straight mineral oil is permissible. This may either be used independently from or in mixture with Y3587 oil.

Step 20.—Lubricate the propeller hub as follows:

(a) First insert Bleeder Tool, Figure 66-1 between the blade retaining nut and the blade shank.

Take care not to damage the retaining nut seals. This is done to bleed air while greasing. See Figure 59.

(b) Using A.A.F. Specification 3581 AA grease (alternate 3581B), place the grease gun on the hub grease fitting and apply pressure until grease appears at bleeder tool.

(c) Repeat procedure at each fitting and at each hub socket.

(d) Remove one grease fitting to relieve any pressure that may have been built up in the hub during the greasing operation.

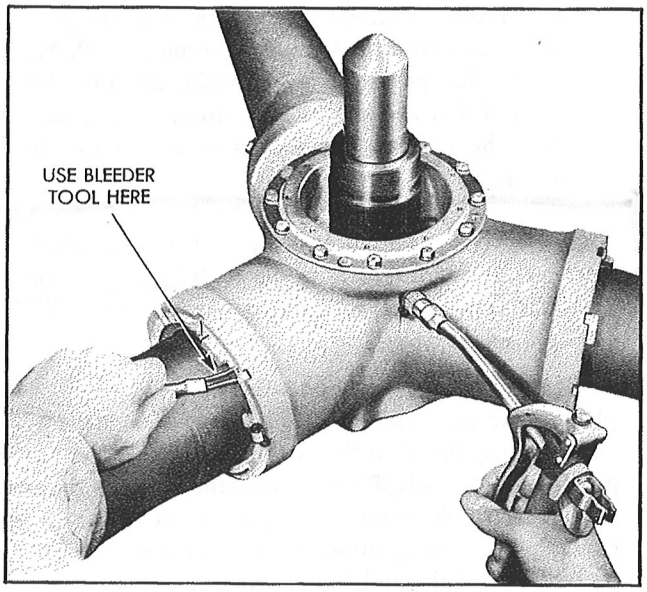

Figure 59—Greasing Procedure

NOTE

For regular refill lubrication, the bleeder tool is not required; air may be bled by removing grease fittings from the hub.

Step 21.—Replace the spinner shell, aligning the dowel holes in the shell with the proper dowels in the spinner bulkhead, as shown in Figure 60. Note that the serial numbers stamped on the exterior of the shell and on the face of the bulkhead must always match. Note also that the dowels adjacent to the blade in line with the regulator filler plug are closer together than either of the other pairs.

Tap the shell into place using the hands only. Set the countersunk attaching screws snugly, using a Reed and Prince screwdriver as shown in Figure 61.

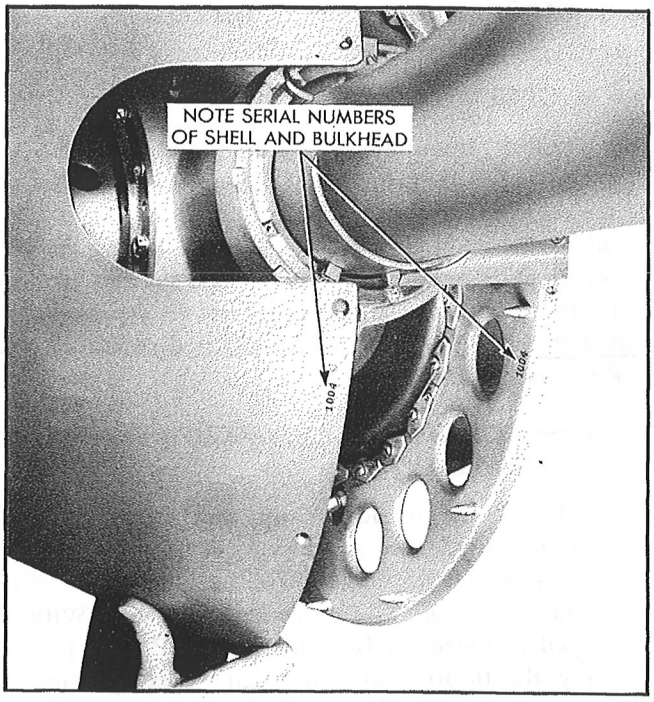

Figure 60—Installation of Spinner Shell

Figure 61—Installation of Spinner Shell

NOTE

Some of the earlier model spinner shells use standard slotted type countersunk attaching screws. *Do not replace* these screws with a patented head type.

3. GROUND RUN-UP AND FLIGHT TEST—P-39 INSTALLATION.

a. GENERAL.

After installation of the propeller, the airplane should be given a test run-up. Check to see that the regulator is filled with A. A. F. Specification Y3587 oil to the level of the filler plug hole with the filler plug hole in a horizontal position on the left hand side of the plane, as shown in Figure 58. Approximately four pints of regulator oil are required to fill the regulator half full.

b. PURGING THE PROPELLER'S HYDRAULIC SYSTEM.

Prior to ground run-up and flight test, and after the installation of a new or overhauled propeller, it is necessary to purge air from the hydraulic system of the Aeroprop. This is done as follows: With the propeller control in full "increase R. P. M." position, apply the throttle until an engine speed of approximately 2300 R. P. M. is reached. Then, while adjusting the throttle to maintain a constant manifold pressure, pull the propeller control to the full "decrease R. P. M." setting while still maintaining the original manifold pressure. Next, move the propeller control back to the full "increase R. P. M." position so that the manifold pressure remains constant. After following this procedure through three complete cycles a movement of the propeller control should bring a corresponding change in engine R. P. M., and the propeller may be considered to have been satisfactorily purged.

NOTE

Prior to every flight it is advisable to make a functional check of the propeller through one cycle as described above.

c. GROUND RUN-UP.

(1) Before flight test the governor should be tested to make sure that it is properly adjusted for maximum R. P. M. To check this governor adjustment under full engine power, it is necessary first to securely harness the airplane. With propeller control in full "increase R. P. M." position, the mechanic starts the engine and moves the throttle until 2800 engine R. P. M. is indicated by the tachometer. Then the throttle is advanced rapidly while the mechanic observes the tachometer to note that the R. P. M. increases slightly beyond 3000 R. P. M., and then settles back to and remains at 3000 R. P. M. This will indicate that the governor is properly set to hold the engine R. P. M. constant at that point. In order to protect the engine, the throttle must not be held in this advanced position longer than five or six seconds. If the tachometer does not settle back to and remain at 3000 R. P. M. the governor must be readjusted.

NOTE

This check of the governor adjustment is to be made only after the installation of a new or an overhauled propeller, and is not to be considered a part of the daily pre-flight run-up.

Due to the high minimum blade angle setting on Model A632S-C1 propellers, it is not possible to attain a maximum governing R. P. M. while the plane is held stationary on the ground. On this model, therefore, a flight test must be made before the governor is finally adjusted.

(2) After ground run-up, recheck oil level and refill to level of filler plug hole with hole in horizontal position. Repeat the greasing procedure as previously outlined under Step 20.

(3) Magnetos may be checked on the ground by placing the propeller control in high R. P. M. position and moving the throttle until an engine speed of approximately 2300 R. P. M. is reached, disregarding manifold pressure. Without moving the throttle or propeller control, turn the ignition switch and note the drop in R. P. M. on right and left magnetos.

d. ADJUSTMENT OF GOVERNOR.

The maximum governed R. P. M. of the engine may be changed by an adjustment of the governor spring as shown in Figure 62. This adjustment is readily accessible through the filler plug hole in the regulator cover. A slotted screw is located inside the regulator and has a bearing face in contact with the governor spring. By placing a screwdriver in the slotted screw head and pushing the screw in approximately $\frac{1}{16}$" to compress the spring and clear the locking pins, it is possible to turn the screw. See Figure 62. *At no time should this screw be turned without releasing the lock as noted above.* The governor spring pressure keeps the slots engaged with the pins at all times, thus assuring a positive lock. Turning the adjusting screw clockwise gives a decrease in R. P. M., and turning it counterclockwise increases the maximum R. P. M. Each $\frac{1}{6}$ turn (or one locking notch) varies the propeller speed approximately ten R. P. M. or approximately twenty-three

CW Decr RPM
CCW Incr RPM
1 NOTCH = 10 RPM

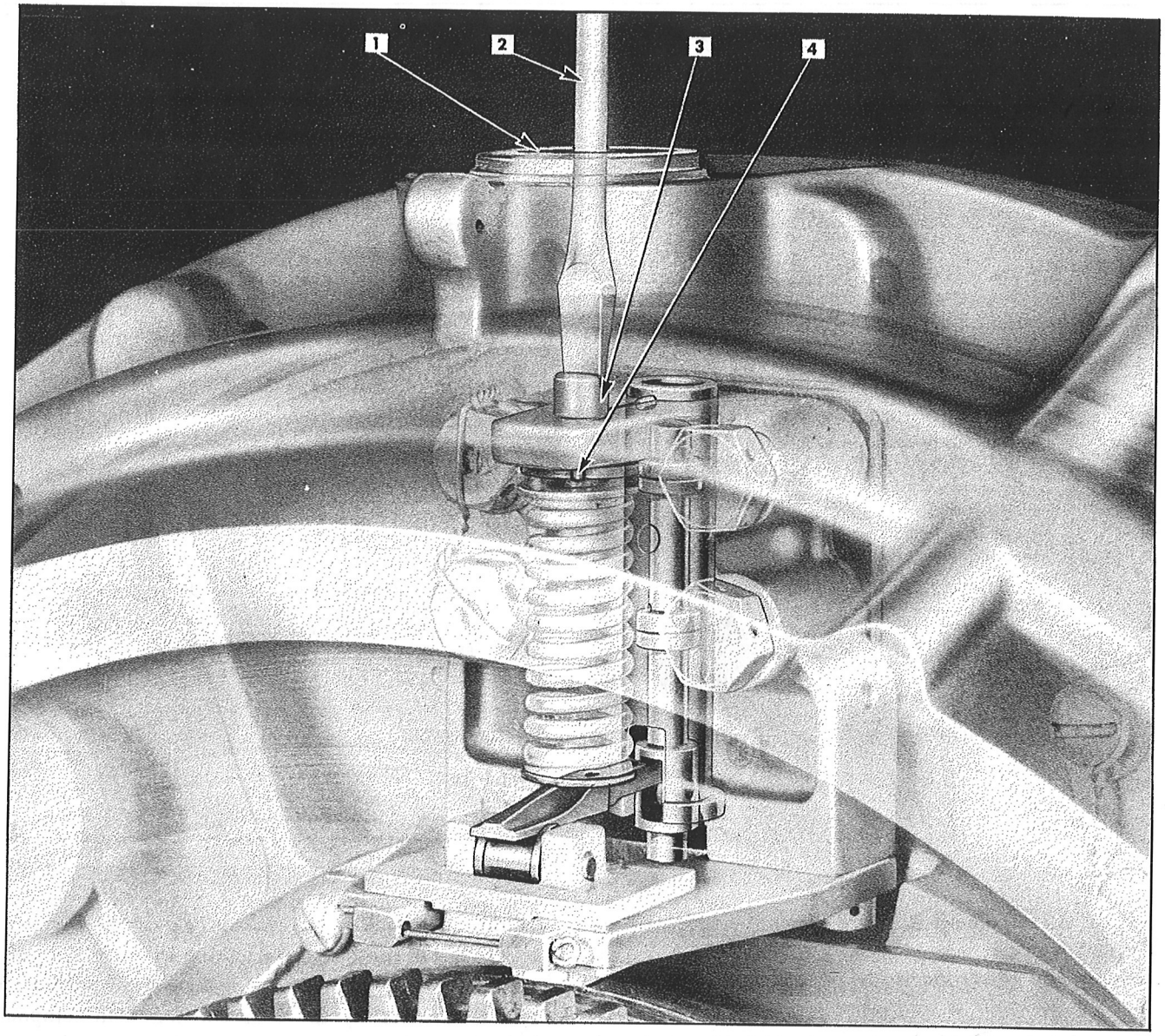

Figure 62—Governor Adjustment

1. Filler Plug Hole
2. Screwdriver
3. Adjusting Screw
4. Lock Pins

engine R. P. M. when installed on an engine having a 2.23:1 reduction gear ratio.

NOTE

Models A632S-A1, -A2, -B1 and -B5 are being used with engines having reduction gear ratios other than 2.23:1. Each notch adjustment of the governor will, therefore, vary the engine speed somewhat less than for model A632S-C1.

e. TEST FLIGHT.

(1) After the ground run-up is successfully completed, a test flight should be made, using full power on the take-off; the propeller control should be in full forward position or high speed setting. A careful check should be made to determine the R. P. M. that the engine settles to on the take-off. If the desired maximum R. P. M. is obtained, a check using full military power should be made with the plane in level flight. If the desired maximum R. P. M. is not obtained, the governor can be adjusted after test flight as described in previous paragraphs.

(2) If, during *regular* operation, the engine should

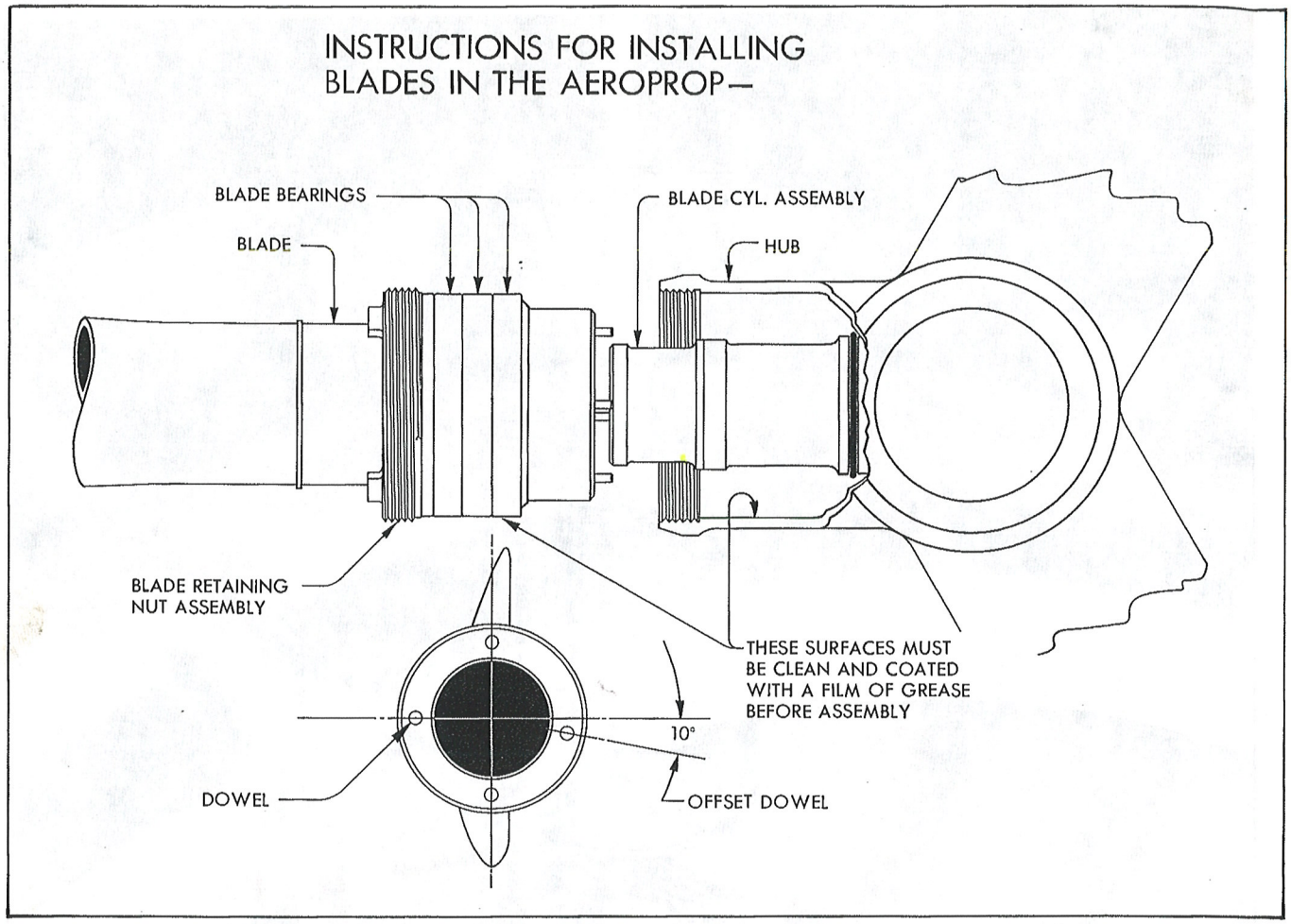

Figure 63—Installing Blades in the Aeroprop

fail to attain take-off R. P. M. with the propeller in take-off position, it is suggested that the following be checked and correction made for any irregularities before the governor is readjusted.

(a) Oil level in regulator checked. (Level should be at filler plug hole with filler plug hole in horizontal position.)

(b) Rigging of control system checked, assuring full travel of control lever.

(c) Tachometer checked for accuracy.

(d) Engine checked for loss of power.

(e) Manifold pressure gauge checked for accuracy.

4. ASSEMBLY OF CRATED PROPELLERS.

a. KNOCKDOWN SHIPMENTS.

Propellers crated for knockdown shipments are disassembled only to such an extent as is necessary to fit them into coffin-type crates. Two of the blades are removed, the third blade remaining in the hub together with the attached regulator. The propeller is so prepared that it is necessary to clean anti-corrosion compound only from the outer surfaces of the hub, regulator, blades, and the hub bore. The interior of the hub and blade retention parts are thoroughly wrapped, so that no cleaning of these sections is necessary at the time of reassembly. The regulator is filled with the proper hydraulic fluid to prevent corrosion of regulator parts during long periods of storage, and the interior of the hub is rustproofed by the original grease which is left within the hub. Blades, blade retaining nut lock slots and the balance weight slots of the retaining nut may all be identified by numbers or colored paint so that proper reassembly may be easily attained. All parts necessary for installation are included with the crate. The procedure for reassembly is as follows:

CAUTION

When handling the propeller, do not lift by the spinner bulkhead.

(a) Using clean rags, wipe the anti-corrosion compound from the hub bore and the exterior of the hub and regulator. Do *not* remove the film of grease from the blade sockets of the hub.

(b) Remove the nut lock from the blade retaining nuts of the removed blades. Clean the anti-corrosion grease from the blade exteriors but do *not* remove the grease from the bearings at the shank end. Apply anti-seize compound to the threads of the blade retaining nut and the hub threads.

(c) Install the blades in the hub so that the number on the blade shank corresponds with the number on the hub socket. See Figure 63.

NOTE

Due to offset dowels and dowel holes, the blades will fit into the hub in only one way.

(d) Tighten the blade retaining nut snugly using the Blade Retaining Nut Wrench, Figure 66-4, and 30" bar. Tighten the nut until the purple painted lock slot in the blade retaining nut meets the purple painted lock slot in the hub.

(e) Install the nut lock in the purple painted slot of the blade retaining nut and safety with .032" safetywire.

(f) Install the anti-icer tube and clamp on the hub. See Section VI 2*a* (3) and Figure 78. Attach the flare nut at the end of the tube to the fitting on the regulator. Provide sufficient clearance between the blade shank and the end of the tube.

(g) Install the balance weights in the red painted slots of the blade retaining nut. Provide at least .003" clearance between the end of the weight and the blade shank.

(h) Attach the spinner bulkhead plates to the spinner bulkhead so that the cutout in the plate surrounds the blade shank.

(i) **CAUTION:** Install the propeller on the ship. See the foregoing pages in this section. Rotate the propeller until the oil filler plug is in a horizontal position. Remove the filler plug and drain the oil from the regulator until the oil is level with the filler plug hole. This will assure that the regulator is *half-full* and only half-full of oil. Replace the filler plug and washer and safety. *Make absolutely certain that all spilled oil is cleaned from the regulator, spinner bulkhead, and the cowling of the airplane.*

(j) Grease the hub in accordance with step 20 of Section III, 2*c*.

(k) Install the spinner shell and follow the ground run-up and flight test as described in this chapter.

b. ASSEMBLED SHIPMENTS.

Propellers shipped in triangular crates are completely assembled and require only a cleaning of the exterior parts before installation. All parts necessary for installation are included with the crate, as shown in Figure 34 of this section. For proper installation procedure, see Section III, 2*c*.

SECTION IV
LINE INSPECTION AND MAINTENANCE

1. LINE INSPECTION.

a. DAILY INSPECTION.

For daily inspection of Aeroproducts propellers in service it is suggested that a check-off list be followed, similar to that given below.

(1) BLADES.

(a) Check for an excessive amount of grease on the shank of the blade to the outer side of the spinner shell.

(b) Clean the blades with gasoline or other recommended solvent.

(c) Examine the brazed joint between the camber sheet and the thrust member. This joint extends entirely around the profile of the blades.

(d) Wipe down the blades with clean engine oil at the end of each day. The blades are chrome-plated, but sand and other abrasive material may remove this rust proofing and allow corrosion to start. While oiling, check blades for nicks, scratches, or other damage.

(e) If a crack or other flaw is suspected, it is suggested that the mechanic carefully examine the surface of all blades with a magnifying glass. For a complete check, blades should be removed and magnetically inspected with magnetic inspection equipment.

(2) SPINNER.

(a) Check the spinner shell attaching screws for looseness.

(b) Check the spinner shell for nicks, cracks, or other damage.

(c) Check the interior of the hub bore for oil. If oil is found, remove the spinner shell and spinner adapter, and examine more closely.

(d) Examine the cowling behind the spinner for evidence of oil. If found, remove the inspection doors of the plane and determine if the leak is coming from the engine reduction gear case or the propeller.

(3) REGULATOR.

(a) Remove the inspection doors in the cowling to the rear of the spinner and:

1. Check the control arm clevis pin for safety.

2. Check the adapter stop block for safety.

3. Check for evidence of oil leaks. If found, see Trouble Shooting, Section V.

NOTE

Oil leaks must be corrected before flight.

(4) ENGINE WARM-UP—P-39 INSTALLATION.

(a) At the time of engine warm-up, the propeller operation should be checked with the propeller control in full "increase R. P. M." position. Apply the throttle until an engine speed of approximately 2300 R. P. M. is reached. Then, while adjusting the throttle to maintain a constant manifold pressure, pull the propeller control to the full "decrease R. P. M." position, while still maintaining the original manifold pressure. Then move the propeller control back to the full "increase R. P. M." position so that the manifold pressure remains constant. The engine speed should again rise to 2300 R. P. M. and will indicate that the propeller is functioning properly.

(b) If vibration is noted or reported, check the blade angle settings. If necessary, check the track of each blade. See Section VII, 4, Inspection.

NOTE

Blade track may be checked while the propeller is installed on the plane by rigging a pointer from the nose wheel strut to the center line at the tip of one blade. Rotate the propeller so that each blade may be checked. Measure the distance from the end of the pointer to each blade tip. Maximum allowable variation is $\pm \frac{1}{16}$" from perfect track.

b. TWENTY-FIVE HOUR INSPECTION.

At the end of every twenty-five hours of flying, or after one week or more of standing idle, the regulator should be checked for proper oil level. Oil should be at the level of the filler plug hole with the filler plug hole in a horizontal position on the left hand side of the ship. For proper operation, the regulator should be half-full of oil. See Section III, 2*c*.

SECTION V
TROUBLE-SHOOTING

1. GENERAL.

a. Trouble-shooting is relatively simple providing the mechanic has a thorough understanding of the principle of operation of the propeller and the functions of the parts involved.

b. It is suggested, therefore, that the reader go over the first chapters of this manual in order to make certain that he has a complete knowledge of the function of this propeller before attempting to determine the cause of any trouble encountered.

c. Careful analysis and complete checking of all details before attempting to draw conclusions will result in accuracy when trouble-shooting. The following table on trouble-shooting outlines some of the symptoms, causes, and corrections encountered in practice. A careful study and thorough understanding of this information coupled with practical experience will result in a fast and accurate determination and correction of difficulties encountered.

2. TROUBLE-SHOOTING.

TROUBLE	PROBABLE CAUSE	REMEDY
a. Incorrect maximum governing R. P. M.	(1) Engine loss of power	(a) Check engine ignition, carburetion, and valve timing.
	(2) Regulator oil supply at improper level	(a) Check the oil level with the filler plug hole in horizontal position. Regulator should be half-full. Section III 2*c*, step 19.
	(3) Insufficient regulator control lever travel	(a) Disconnect the control cable from the regulator control lever and check the quadrant control for full travel. Move the control lever to one end of its travel, then move the quadrant control to see if the end of the flexible cable control will move the same amount. Repeat at the other end of the range. If there is insufficient travel on cable, readjust linkage to the cockpit. (b) On Models A632S-A1 and -A2, check the control lever stop plate setting as described under step 16, Section III 2*c*. (c) Check the regulator control lever for proper indexing. See Section VI 2*e* (3).
	(4) Tachometer reading incorrectly	(a) Repair or replace the tachometer.
	(5) Propeller governor improperly adjusted	(a) Readjust governor. See Section III 3d.

2. TROUBLE	PROBABLE CAUSE	REMEDY
	(6) Incorrect propeller model for the engine reduction gear ratio	(a) See Table I, Section II.
b. Sluggish propeller response, or hunting condition	(1) Oil pressure below normal	(a) Check oil level—too much oil leads to a foaming condition which will reduce the oil flow. Too little oil will also lower the pressure. See step 19, Section III 2*c*. (b) Disassemble the regulator and check the governor screen and the pressure control valve filter for clogging. Clean or replace the screen. (c) Check for blown gaskets or loose screws. (d) Check the pressure control valve for opening and closing pressures. See Section VII 1. (e) Check oil pump for pressure and flow. Replace where necessary. Check oil pump seal for damage. (f) Check fit between governor piston and barrel—to be done by an instrument man only. Desirable clearance is .0005".
	(2) Governor binding	(a) Check governor for binding. The base might be warped due to uneven tightening of the mounting screws. See step 8, Section VI 2*e* (3), "Reassembly of the Regulator Unit."
c. Failure to change pitch	(1) Lack of oil in regulator	(a) Check oil level. See step 19, Section III 2c.
	(2) Lack of oil pressure	(a) Disassemble regulator and check governor and pressure control valve screens. Clean or replace. (b) Check oil pump drive gear and shaft. Replace if damaged. (c) Check pressure control valve for opening pressure. See Section VII 1.

2. TROUBLE	PROBABLE CAUSE	REMEDY
	(3) Governor binding	(a) Check governor to see if piston is sticking, due to dirt or other foreign matter. (b) Check governor mounting to make certain that body isn't warped due to uneven tightening of the attaching screws.
d. Stiff cockpit controls	(1) Flexible cable control jammed or bound due to corrosion or heavy oil	(a) Disconnect the control lever. Check movement of the control linkage and the control lever separately. Apply oil to the ends of the push-pull assembly and work the quadrant control. Check control linkage for dirt, heavy oil, or caked grease. Clean thoroughly and re-lubricate.
	(2) Regulator control lever binding	(a) To correct stiff control lever operation, remove the regulator and disassemble. On Models A632S-A1 or -A2, check the control screw packing for tightness. See Section VI 2*e* (3), step 31, "Re-assembly of the Regulator Unit."
e. Oil in hub bore, or I. D. of propeller shaft	(1) Leak in chevron type oil seals	(a) Remove the blades and the blade cylinders. Replace the chevron seals, taking care to avoid damaging seals during reassembly. See Section VI 2*d* (3).
	(2) Leak in hub pressure tubes	(a) Pressure test the hub pressure tubes. See Section VII. If leaking, repair the tubes.
f. Oil on spinner bulkhead	(1) Loose cover screws or damaged cover outer seal (or gasket)	(a) Tighten cover screws. (b) Replace cover outer seal (or gasket). See Section VI 2e (3).
	(2) Transfer tube seals	(a) Replace the transfer tube seals between hub and regulator. See Section VI 2*a* (3), "Reassembly of Regulator to Hub."
g. Oil on regulator cover, around adapter plate, or in anti-icer slinger ring	(1) Engine reduction gear leak. Paint with whiting and alcohol to determine if engine or propeller	(a) Repair the engine reduction gear case.

2. TROUBLE	PROBABLE CAUSE	REMEDY
	(2) Regulator oil level too high	(a) Check oil level. See Section III 2c, step 19.
	(3) Regulator housing or cover seals damaged	(a) Replace the regulator housing seal and cover seal. See Section VI 2e and 2f.
	(4) Adapter gasket damaged	(a) Replace adapter gasket. See Section VI 2e.
	(5) Control screw packing or seals damaged	(a) Replace packing or seals. See Section VI 2e.
	(6) Loose regulator filler plug or damaged filler plug washer	(a) Replace the washer and tighten the filler plug.
h. Leakage when propeller is stationary, but not in flight	(1) Regulator seals holding off, or cut	(a) See T. O. 03-20E-4, or Aeroproducts Field Service Change, No. 6—reworking of regulator bearings; or replace seals.
i. Rough operation — excessive vibration	(1) Engine misfiring	(a) Check the engine ignition system.
	(2) Propeller unbalanced	(a) Check the blades for damage. (b) Check the track and pitch of all blades. See Section VII 4 and 5. (c) Check the blade roots for oil in the balance cups. If found, replace the cylinder seal ring if damaged. If this does not correct the difficulty, replace the blade cylinder. See Section VI 2*d*.

SECTION VI
PROPELLER DISASSEMBLY AND REASSEMBLY

1. INTRODUCTION AND SPECIAL TOOLS REQUIRED.

a. The following pages relating to the disassembly and reassembly of the various propeller parts are subdivided into these major sections:

2*a.* Regulator and Hub

2*b.* Blades

2*c.* Replacement of Master Gear and Propeller Shaft Nut

2*d.* Torque Units

2*e.* Regulator Unit

2*f.* Regulator sub-assemblies

(1) Regulator Gear and Adapter Parts

(2) Pressure Control Valve and Filter Assembly

(3) Governor

(4) Oil Pump

(5) Check Valve

b. Each section is a complete operation from teardown to reassembly and *all* sections must be followed for a major overhaul of the Aeroprop. Reference will be made in each section to the desired tools and equipment for the operation.

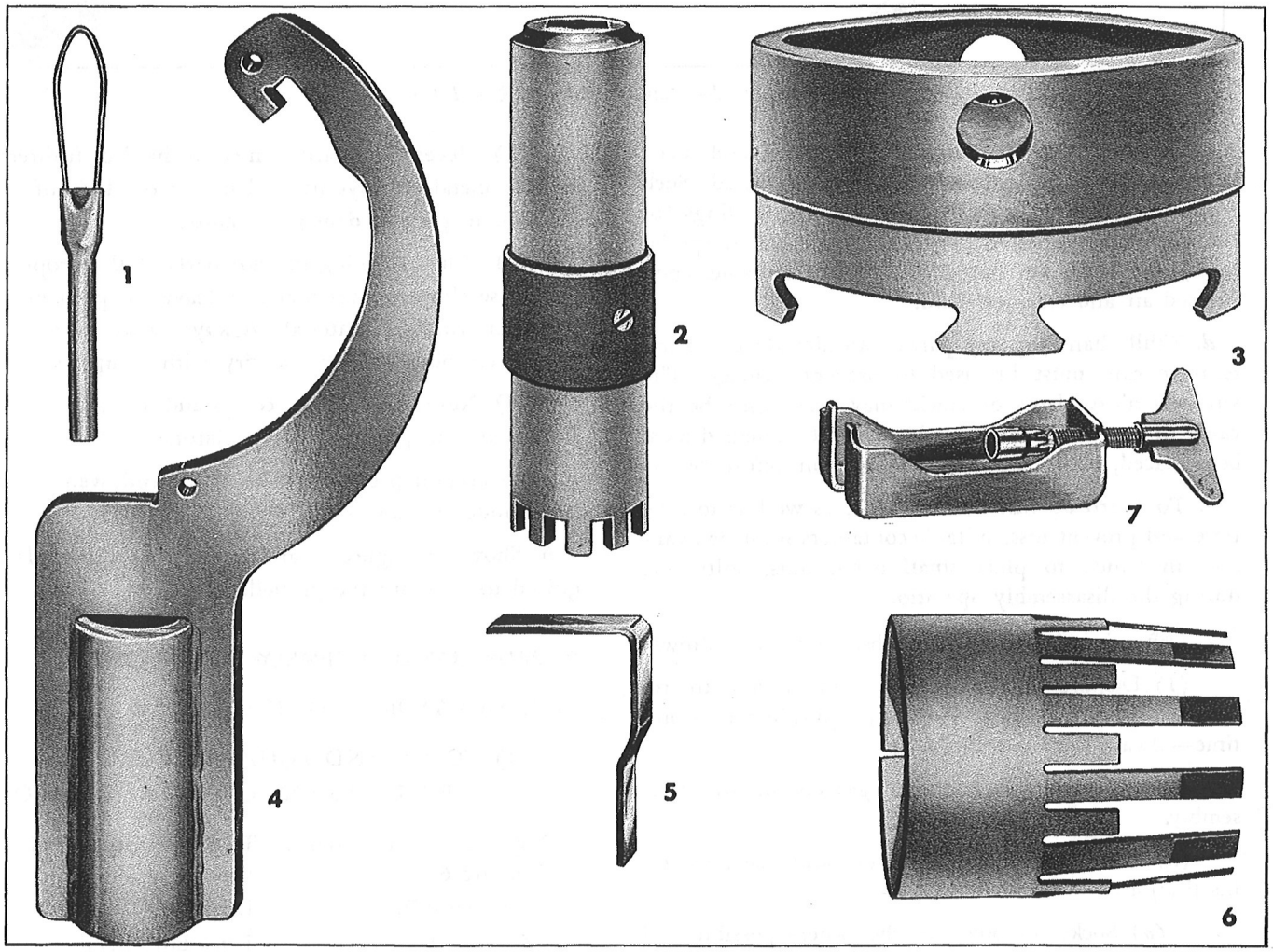

Figure 66—Special Tools Required

1. Bleeder Tool
2. Fixed Spline Bolt Wrench
3. Regulator Nut Wrench
4. Blade Retaining Nut Wrench
5. Indicator Tool
6. Piston Ring Assembly Tool
7. Governor Spring Clamp

(See detail drawings at end of this Section)

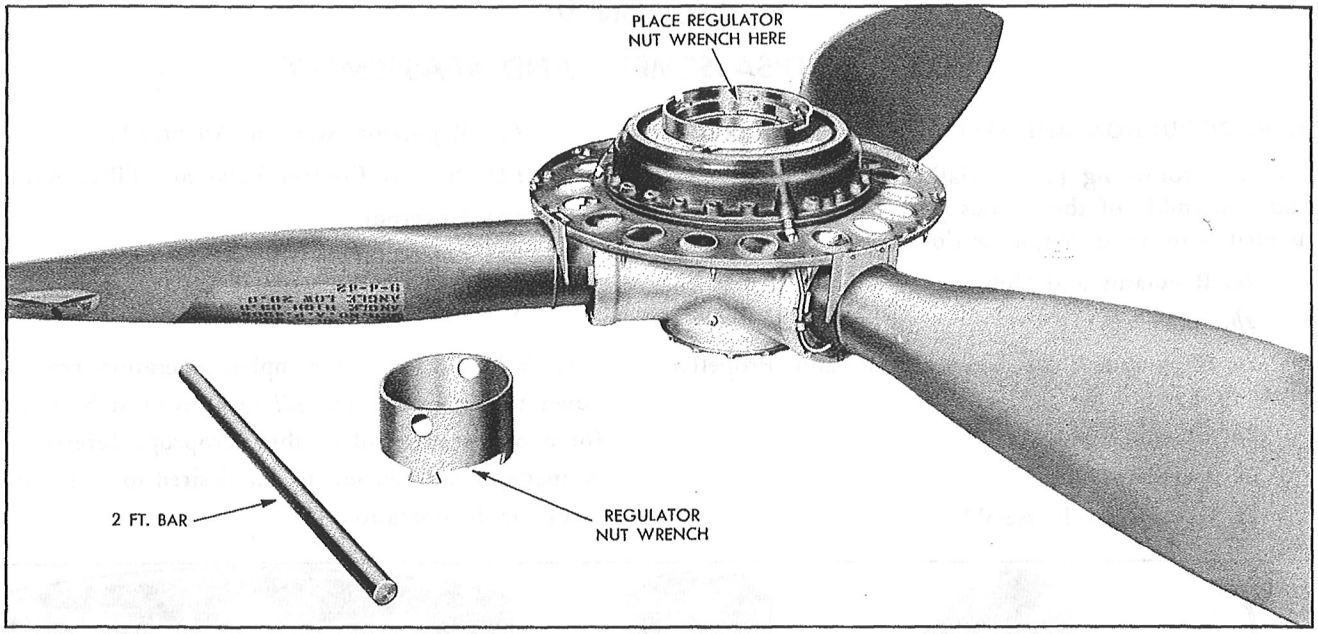

Figure 67—Removal of the Regulator

c. Proper equipment should be available and made ready before actual disassembly is commenced. Such equipment includes a chain hoist and lifting slings for the complete propeller, proper hand tools and special tools, receptacles for parts, work bench or table, compressed air and cleaning fluid.

d. While handling any part of an aircraft propeller, extreme care must be used to prevent damage. The slightest nicks, dents or cracks may very easily be the cause of operational failure. Any part so damaged must be replaced, or undergo rigid inspection before re-use.

e. To guard against such damage, as well as to save time and prevent loss, suitable containers must be available in which to place small parts, nuts, bolts, etc. during the disassembly operation.

f. Other important rules to observe are as follows:

(1) Dispose of all safety devices as they are removed. Never use safety wire, cotter pins, etc. a second time—always replace with new.

(2) Always replace paper gaskets before reassembly.

(3) Always use the proper tool and one that best fits the job:

(a) Socket or box wrenches where possible and of proper size.

(b) Screwdrivers that properly fit screw slots.

(c) Special tools where special tools are required.

(4) Never use a hard hammer or hard drift directly against metal—always use a hammer or drift of soft material to prevent damage to parts.

(5) When cleaning interior parts of the propeller, never use cleaning rags that may leave a deposit of lint or other foreign material. Always wash parts with proper cleaning liquids and dry with compressed air.

(6) Never use gasket compound on any sealing surface of the propeller or regulator.

g. Inspection procedures should be followed as outlined under Section VII.

h. Shown in Figure 66 are the seven special tools required to overhaul the propeller.

2. PROPELLER DISASSEMBLY AND REASSEMBLY.

a. REGULATOR AND HUB.

(1) TOOLS AND EQUIPMENT FOR REPLACEMENT OF THE REGULATOR.

Regulator Nut Wrench, Figure 66-3	Two $\frac{7}{16}$" Open End Wrenches
2' x 1" Steel Bar	Diagonal Cutters
Soft-faced Mallet	Duck-bill Pliers
10" Screwdriver	.032" Brass Safety Wire
	Thread Lubricant, A.N. Specification 3590

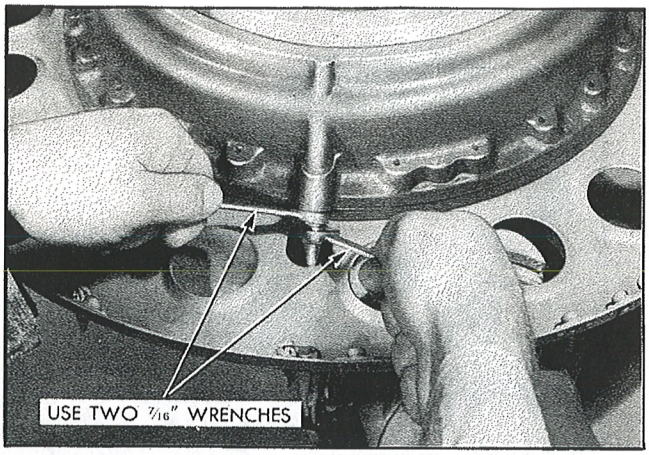

Figure 68—Removal of Anti-icer Tubes

(2) PROCEDURE FOR REMOVAL OF THE REGULATOR.

Step 1.—Separate the anti-icer tubes from the regulator using two $\frac{7}{16}$" open end wrenches, as shown in Figure 68. Place one wrench on the fitting which screws into the regulator cover to prevent that fitting from turning while the anti-icer tube flare nut is loosened by the second wrench.

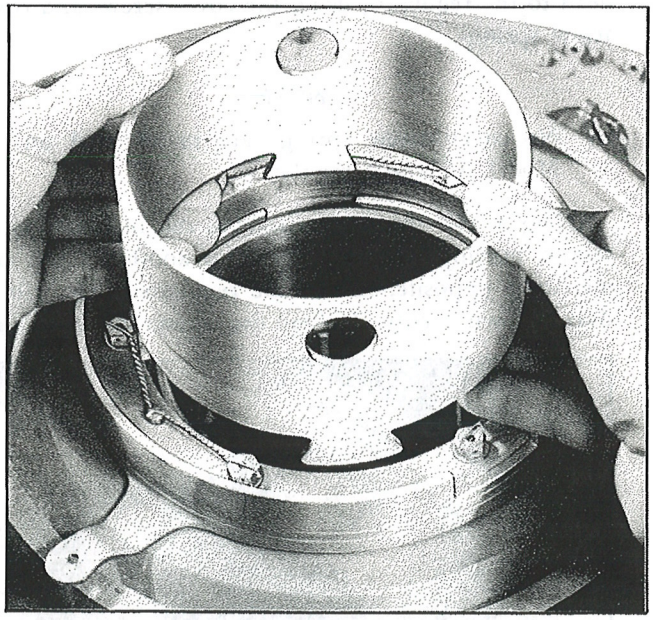

Figure 69—Insert Regulator Nut Wrench

Step 2.—Insert the Regulator Nut Wrench, Figure 66-3 in the center of the regulator. Engage the dove tail lobes of the wrench with the slots in the regulator nut as shown in Figure 69 then insert a 2' bar through the holes in the wrench.

CAUTION

The regulator nut has a *left hand thread.* Turn clockwise to loosen. Care must be taken to hold the wrench tightly in the nut to prevent slipping or burring the nut or wrench.

Step 3.—Turn the wrench clockwise and lift out the regulator nut when free.

Step 4.—Remove the regulator from the hub by lifting with hands only. The regulator is closely fit to the hub and will bind if cocked or tilted. If binding occurs, tap back in place with a soft-faced mallet before lifting again. Do *not* pry the regulator from the hub.

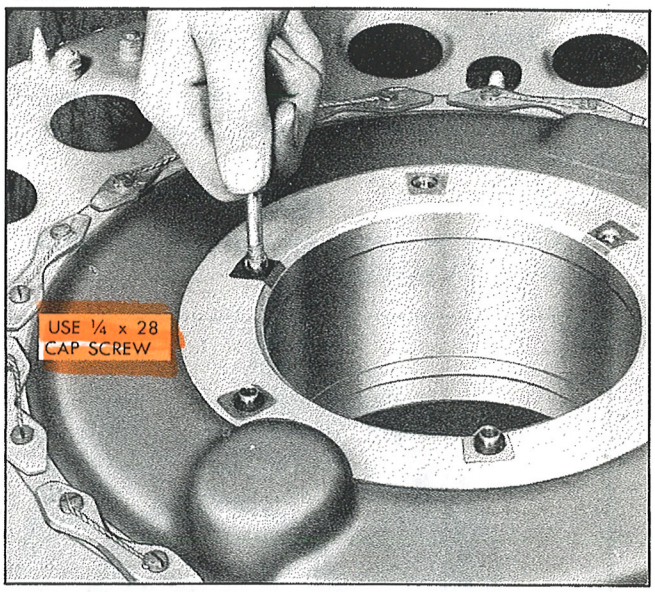

Figure 70—Removal of the Transfer Tubes

Step 5.—Remove the transfer tubes and seals from the face of the regulator.

CAUTION

Do not use pliers as this may damage the tubes. The transfer tubes are threaded on the inside and may be easily removed by screwing in a 1/4" x 28 capscrew and lifting out as shown in Figure 70.

Step 6.—Seal the regulator transfer tube holes with masking tape to prevent entry of dirt.

Step 7.—Using small diagonal cutters, remove the safetywire from the regulator cover screws and remove the 10 x 24 fillister head cover screws and cover screw springs. Lift the spinner bulkhead from the regulator, as shown in Figure 71. Replace the cover

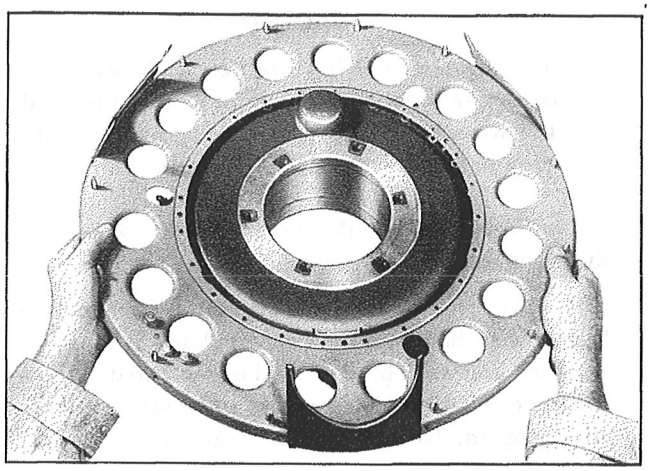

Figure 71—Removal of the Spinner Bulkhead

screws and cover screw springs, adding $\frac{1}{16}$" washer under the head of each screw to compensate for the removal of the spinner bulkhead.

NOTE

Cover screw springs are not used with Model A632S-C1 regulators.

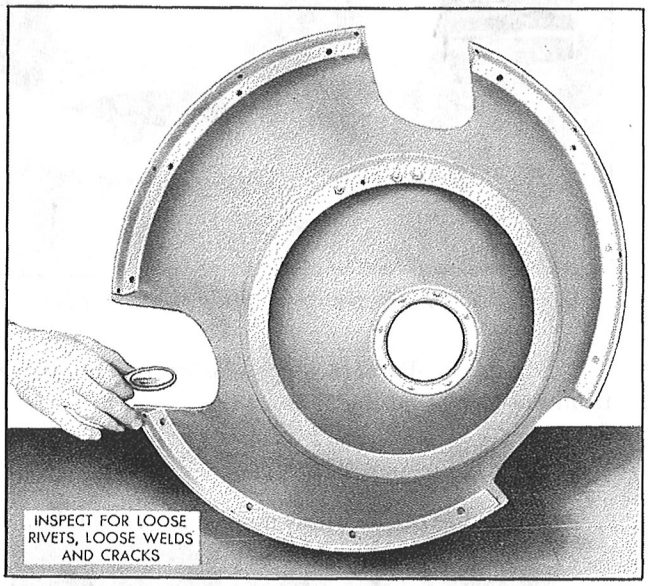

Figure 72—Inspection of the Spinner

Step 8.—Clean the spinner and the bulkhead thoroughly, and inspect them for cracks or damage. See Figure 72.

(3) PROCEDURE FOR INSTALLATION OF THE REGULATOR.

Step 1.—Clean thoroughly the regulator mounting face, regulator nut threads and regulator nut face as shown in Figure 73.

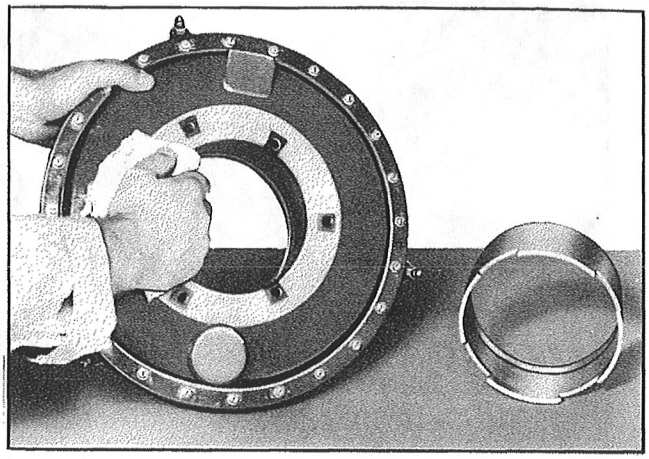

Figure 73—Cleaning the Regulator

Step 2.—Clean thoroughly the regulator mounting section on the hub.

Step 3.—Apply a light coating of thin anti-seize compound to the threads of the regulator nut.

Step 4.—Remove the 10 x 24 fillister head cover screws, cover screw springs and washers, and install the spinner bulkhead on the regulator, as shown in Figure 71. Line up the dowel holes of the bulkhead with the dowels in the regulator and attach the bulkhead to the regulator, using the cover screws and cover screw springs.

NOTE

No cover screw springs are to be used on Model A632S-C1 regulators.

Using a 10" screwdriver tighten the regulator cover screws, moving from one screw to another screw diametrically opposite, so that the regulator cover will be drawn down evenly. Tighten the screws a second time

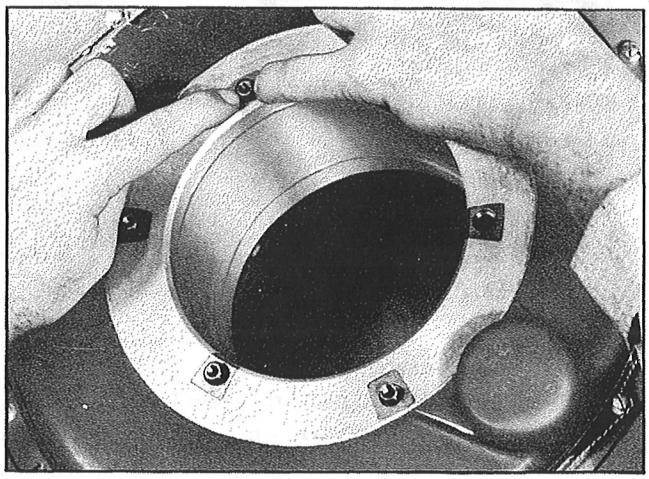

Figure 74—Installing Transfer Tubes and Seals

moving progressively from one screw to the next and safety with .032" wire.

Step 5.—Install the transfer tubes and new transfer tube seals:

1. Insert the transfer tubes into the ports of the regulator housing. Align the tubes with the regulator face, and using a soft-faced mallet, tap gently into place. See Figure 74.

2. Insert new transfer tube seals into the regulator ports and around the tubes, and press firmly and evenly into place.

Step 6.—Loosen the anti-icer tube clamp on the propeller hub by removing the safety wire and loosening the clamp screw. Swing the tube out of the way to prevent damage.

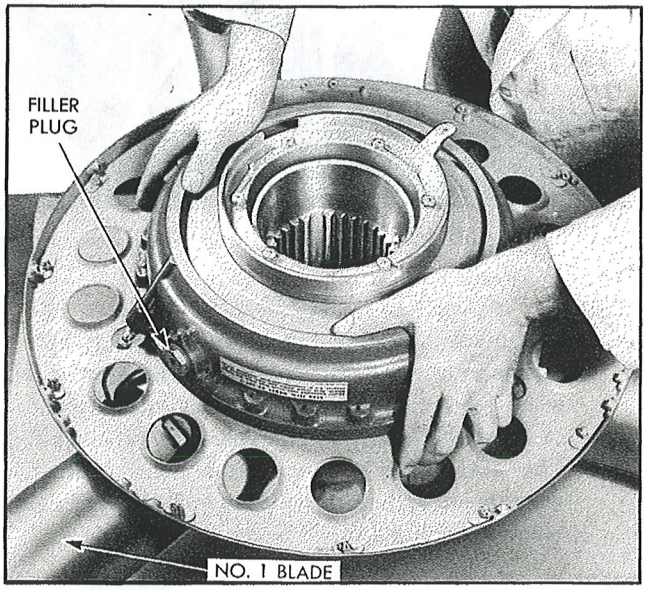

Figure 75—Installation of the Regulator

Step 7.—Using hands only, start the regulator on the hub, locating the regulator oil filler plug at the No. 1 hub socket, as shown in Figure 75.

NOTE

The regulator bore is a close fit to the hub and care must be taken when assembling to prevent cocking and binding of the regulator.

Step 8.—Start the transfer tubes into the ports in the hub. Tap the regulator into position using a soft-faced mallet, as shown in Figure 76.

Step 9.—Insert the regulator nut and start the threads. Using Regulator Nut Wrench, Figure 66-3 and 2′ bar, turn the nut counterclockwise until tight.

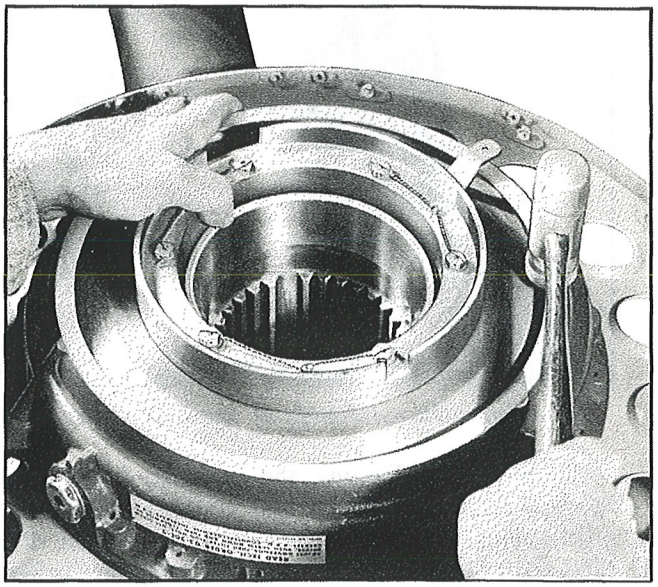

Figure 76—Installation of the Regulator

CAUTION

The regulator nut has a left hand thread. Hold the wrench firmly in the dove tails of the nut to avoid damage.

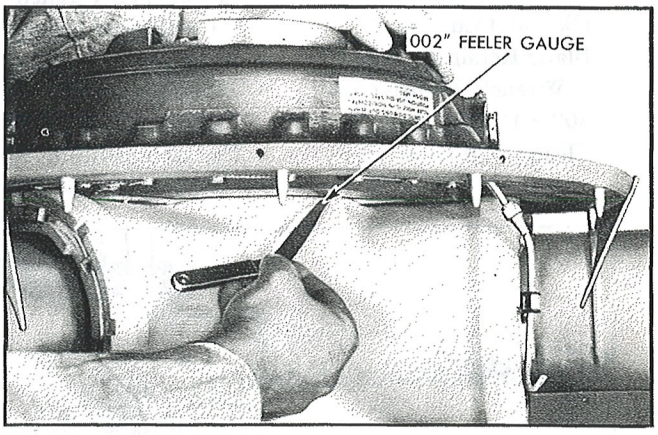

Figure 77—Checking Regulator Installation

Step 10.—When the regulator nut is tight, check the clearance between the mounting faces of the regulator and the hub, using a feeler gauge. To avoid leakage, this clearance should not exceed .002". See Figure 77.

Step 11.—Install the anti-icer tubes using two $\frac{7}{16}$" wrenches, one on the fitting in the regulator and one on the flare nut of the tubing. See Figure 68.

CAUTION

Care must be exercised to properly align the anti-icer tubes with the clamps so that the clamps do not crush the tubes when tightened.

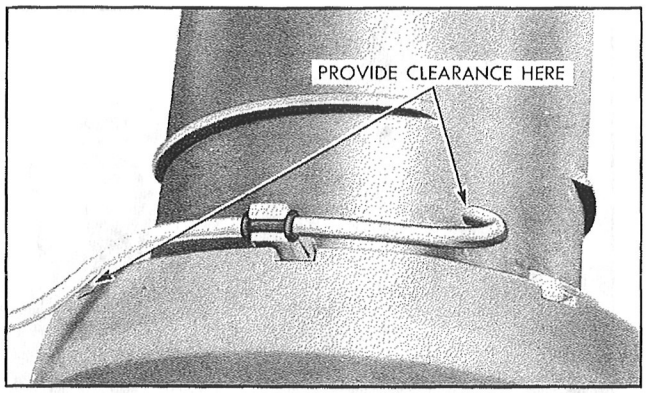

Figure 78—Assembly of Anti-icer Tubes

Step 12.—Tighten the anti-icer tube clamps, taking precautions to provide clearance between the tube and the hub socket, and between the end of the tube and the shank of the blade. See Figure 78. Safety the clamp screw with .032" wire.

b. BLADES.

(1) TOOLS AND EQUIPMENT FOR REMOVAL AND INSTALLATION OF BLADES.

8" Screwdriver
Diagonal Cutters
Blade Retaining Nut Wrench, Figure 66-4
30" x 1" Steel Bar
Cleaning Materials
½" Socket Wrench with Speed Handle
Grease, A.A.F. Specification 3581 AA (alternate 3581 B)
Thread Lubricant, A. N. Specification 3590

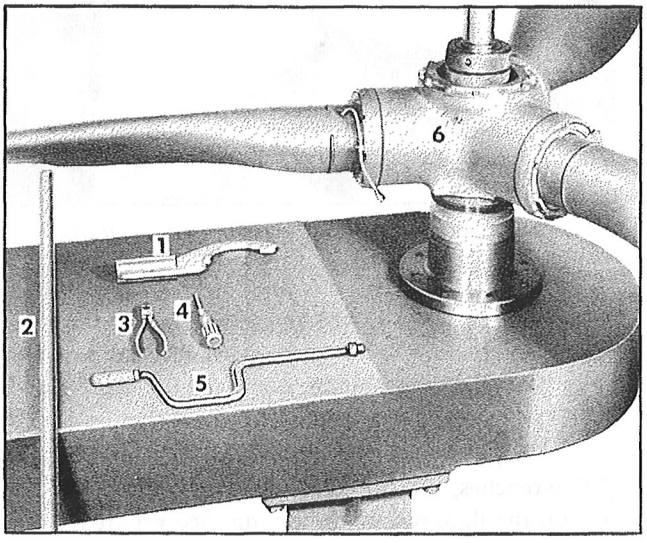

Figure 79—Removal of Blades from the Hub

1. Blade Retaining Nut Wrench, Figure 66-4
2. 30-in. by 1-in. Bar
3. Diagonal Cutters
4. 8-in. Screwdriver
5. ½-in. Socket Wrench with Speed Handle
6. Propeller on Stake

(2) PROCEDURE FOR BLADE REMOVAL AND DISASSEMBLY.

Step 1.—With the regulator removed or spinner bulkhead plates removed, mount the propeller on a stake with the master gear side up, as shown in Figure 79.

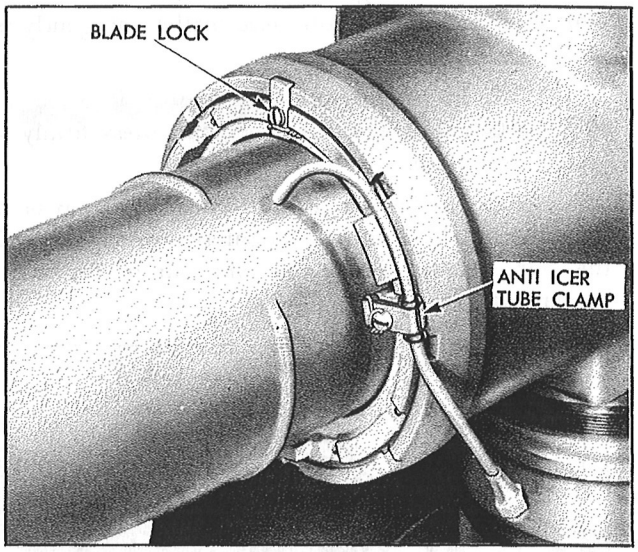

Figure 80—Blade Retaining Nut Lock

NOTE

The blade retaining nut is locked in the hub socket by a small lug secured in the blade retaining nut castellation that lines up with one of the hub socket castellations. See Figure 80. The anti-icer tube clamp and small balance weights are secured in other castellations of the blade retaining nut.

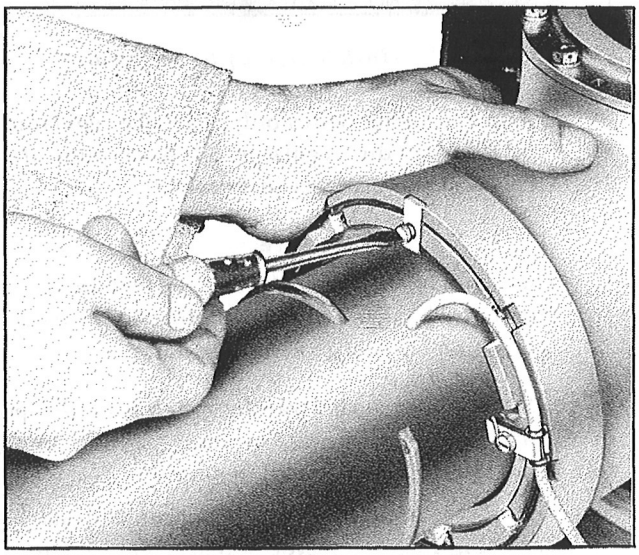

Figure 81—Removal of the Lock

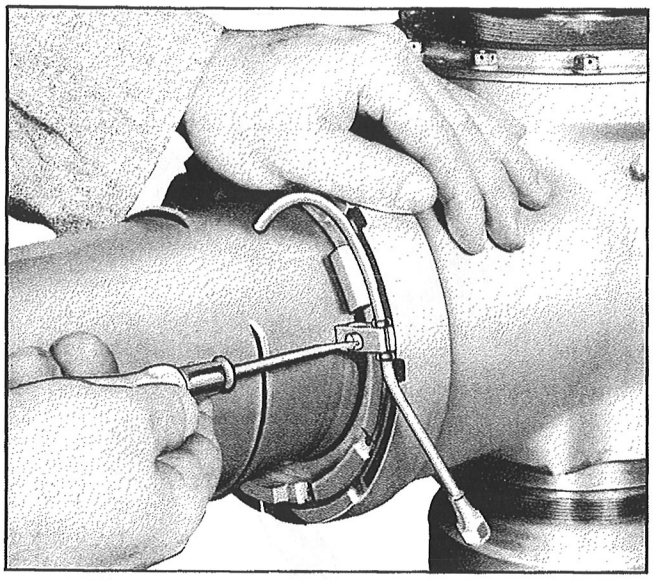

Figure 82—Removal of Anti-icer Tube Clamp

Step 2.—Cut the safety wire and remove the fillister head screw from the blade retaining nut lock using an 8″ screwdriver. See Figure 81.

NOTE

Mark the mating castellations of the blade retaining nut and the hub socket so that these two castellations may be aligned again if the same blade is to be reinstalled.

Step 3.—Remove the anti-icer tube and clamp together with any balance weights that may interfere with the removal of the blade retaining nut. See Figure 82. Mark the castellations from which each was removed.

NOTE

In certain cases where the castellations may happen to meet, the anti-icer tube clamp may also be used as the blade retaining nut lock.

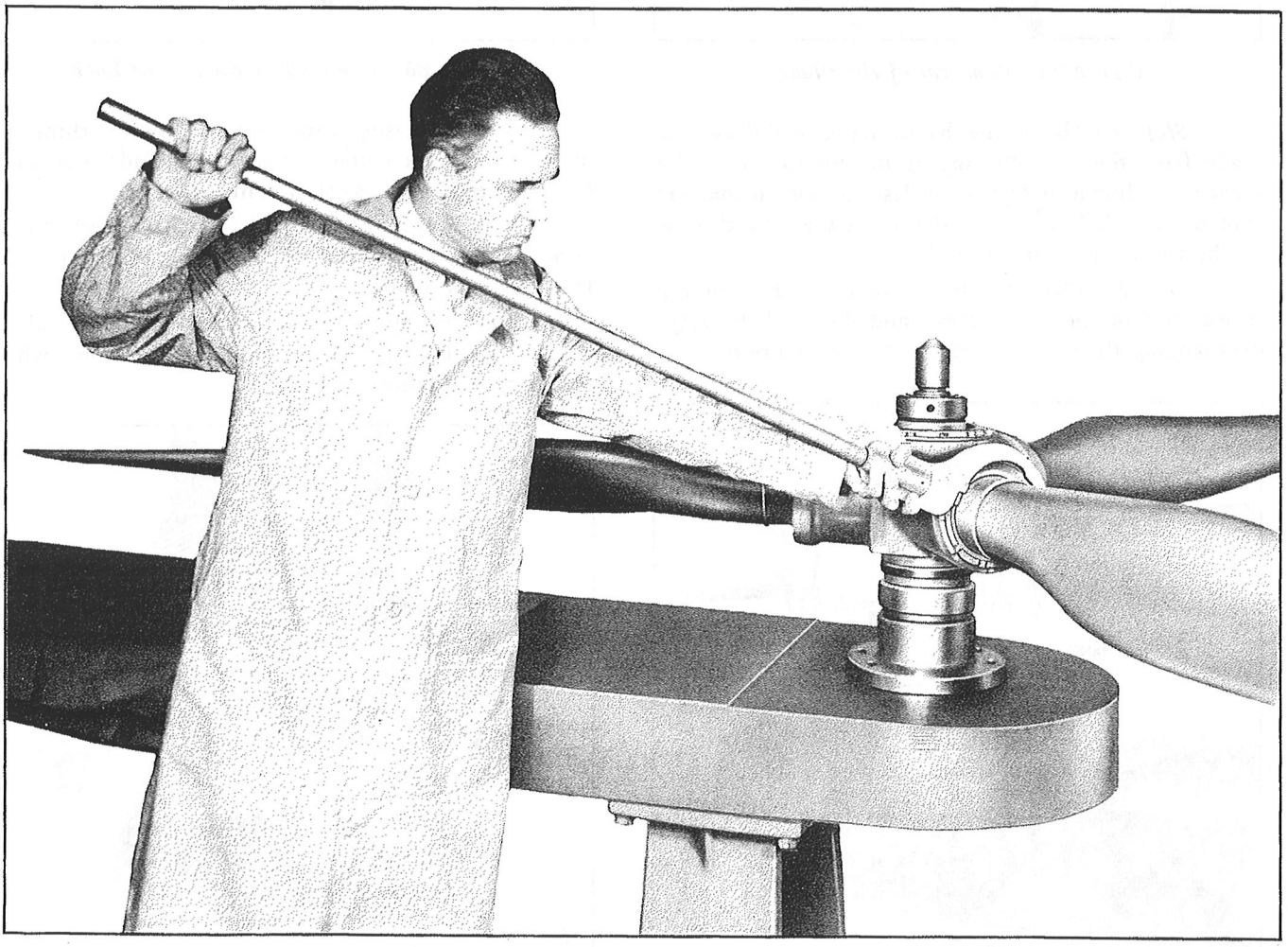

Figure 83—Removal of the Blade

Step 4.—Engage the Blade Retaining Nut Wrench, Figure 66-4, with one of the convenient castellations. As shown in Figure 83, turn the nut counterclockwise until free of the threads. Replace the balance weights and the lock lug in their respective castellations of the blade retaining nut.

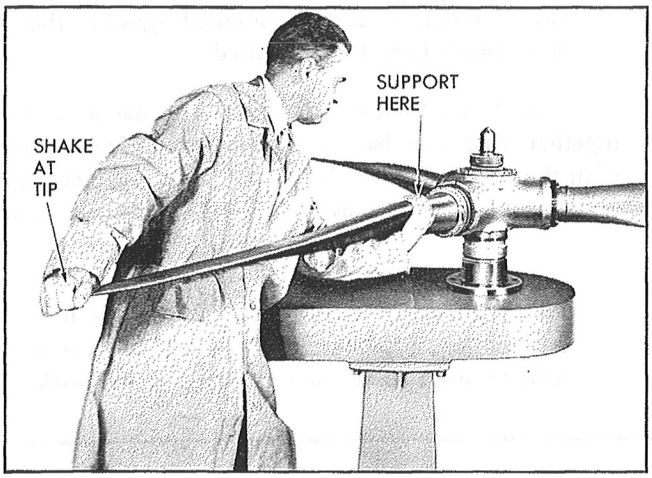

Figure 84—Removal of the Blade

Step 5.—Using the hands only, withdraw the blade from the hub, shaking at the tip to loosen the dowels, as shown in Figure 84. Use caution so that the root of the blade does not damage either the threads or the torque units in the hub.

Step 6.—Place the blade on a bench with the thrust face of the blade down and the stack bearings overhanging the edge of the bench. See Figure 85.

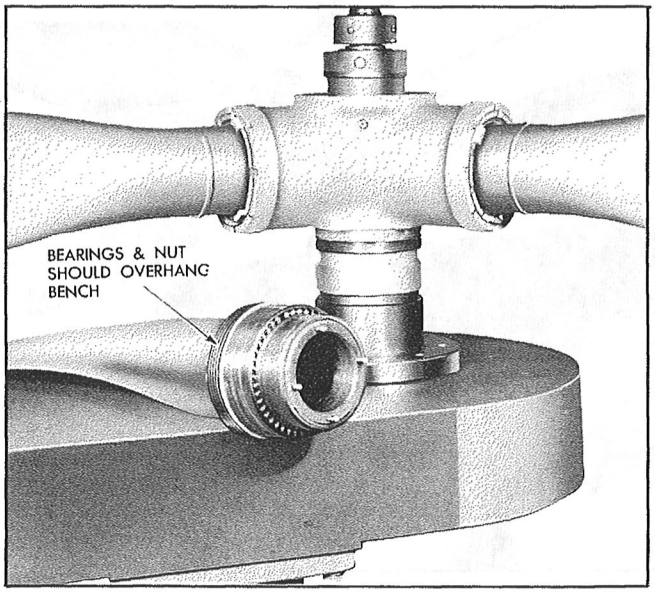

Figure 85—Lay Blade with Bearings Overhanging Bench

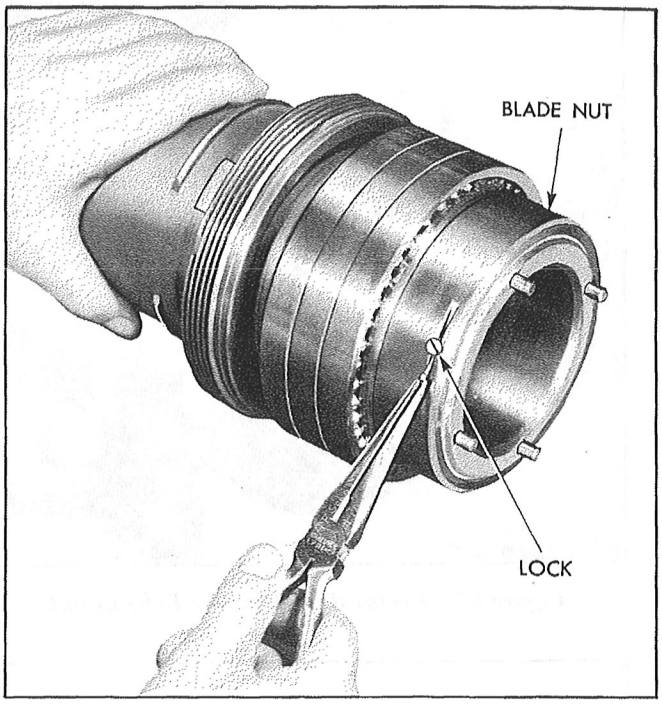

Figure 86—Removal of Blade Nut Lock

Step 7.—Using caution to avoid scratching the blade, remove the cotter key and brass blade lock screw from the blade nut, as shown in Figure 86.

Step 8.—Turn the blade nut counterclockwise, either by hand or using a strap wrench, until the nut is free from the blade.

Step 9.—Slide the stack bearings off the blade, tapping the bearings with a soft-faced hammer where necessary. See Figure 87.

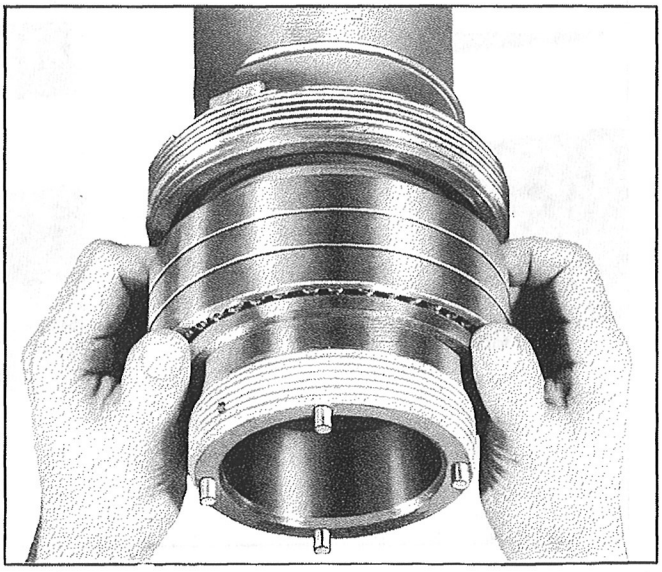

Figure 87—Removal of the Blade Bearings

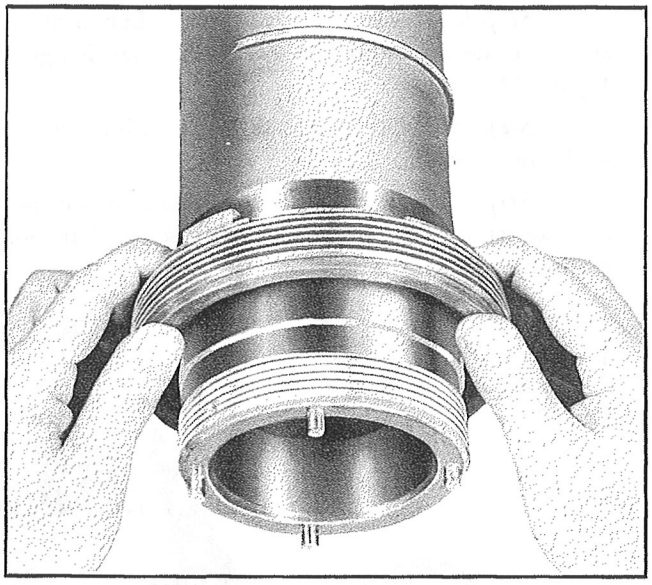

Figure 88—Removal of the Blade Retaining Nut

Step 10.—Slide the blade retaining nut from the blade, as shown in Figure 88, using caution to avoid damaging the blade retaining nut grease seal.

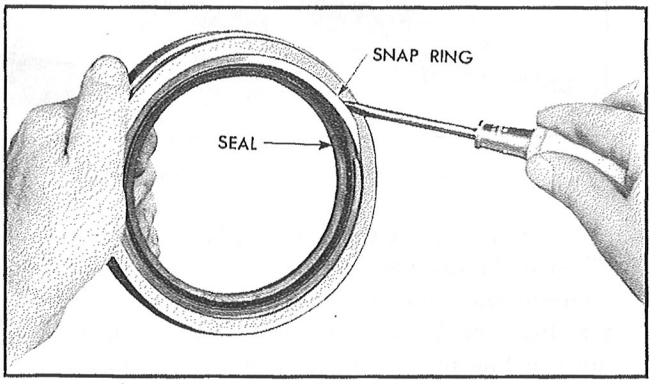

Figure 89—Removal of the Nut Grease Seal

Step 11.—The blade retaining nut seal may be replaced by removing the snap ring, as shown in Figure 89.

NOTE

The root of the blade is leaded to bring all blades to one master balance. *This lead should never be removed.* Balance washers are bolted into a cup in the root of the blade. In the event that blades are replaced, the balancing washers should be removed from the old blade and a like amount of washers attached to the new blade. See Figure 14.

(3) PROCEDURE FOR BLADE REASSEMBLY AND INSTALLATION.

Step 1.—Thoroughly clean, dry and inspect all parts.

Step 2.—Apply grease to the exterior of the root of the blade and slide the blade retaining nut into place with the castellations of the nut facing the tip of the blade. Use caution to avoid damaging the blade retaining nut grease seal.

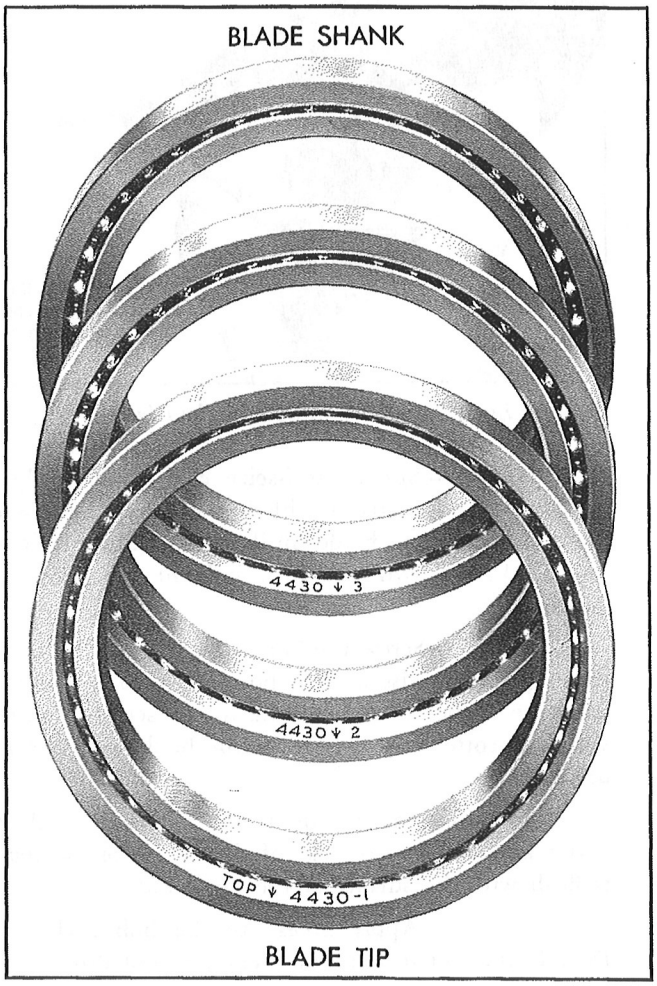

Figure 90—Identification of Blade Bearings

Step 3.—Grease the stack bearings, using a recommended lubricant and slide them on the blade in the order, number 1, then number 2, and then number 3 as marked on the outer race, with the outer race toward the blade retaining nut and the inner race facing the root of the blade. See Figure 90.

CAUTION

Stack bearings are ground and matched. They are not interchangeable individually but must

be used as an assembly and in the proper order. However, one stack bearing assembly may be interchanged with another stack bearing assembly.

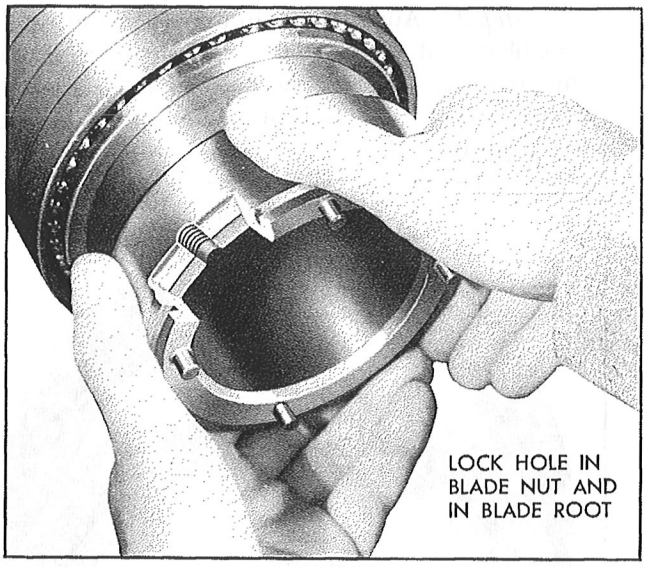

Figure 91—Installation of the Blade Nut

Step 4.—Spread anti-seize compound thinly on the blade nut threads and blade nut dowels. Screw the blade nut onto the blade until the locking hole in the nut is aligned with the lock hole in the blade. See Figure 91.

Step 5.—Screw the brass lock into the blade nut, turning it clockwise until it bottoms, then back up the screw until the cotter key hole in the screw is aligned with the cotter key groove in the blade nut. See Figure 86.

Step 6.—Secure the blade nut lock with the cotter key, bending the ear of the cotter key so that it is flush with the surface of the blade nut.

Step 7.—Apply grease to the hub socket and thread lubricant to the blade retaining nut threads.

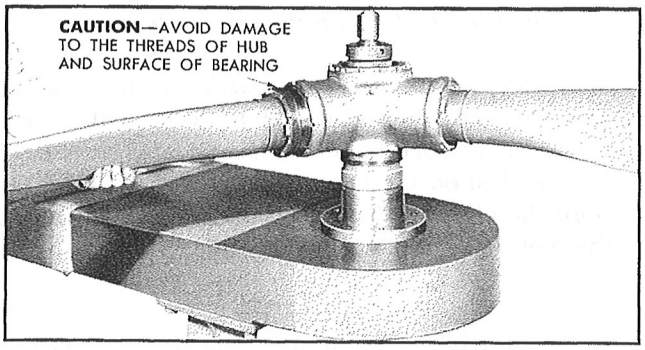

Figure 92—Installation of the Blade

Step 8.—Insert the blade in the hub socket and start the dowels into the blade cylinder flange. See Figure 92.

Step 9.—Slide the stack bearings into the place in the hub socket.

Step 10.—Start the blade retaining nut in the hub socket threads and turn clockwise until the blade retaining nut is snug.

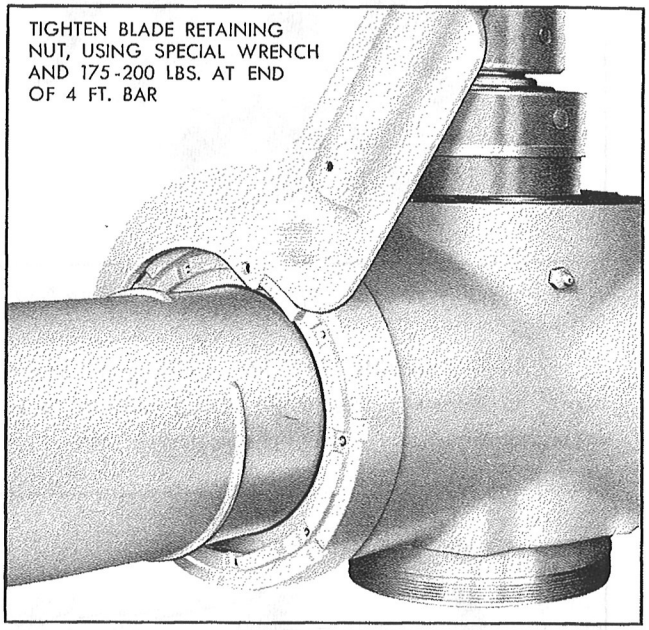

Figure 93—Installation of the Blade

Step 11.—Using the Blade Retaining Nut Wrench, Figure 66-4 and a 30″ bar, tighten the blade retaining nut, applying 175 to 200 pounds at the end of the bar, see Figure 93. Bring the marked castellations in line for the blade retaining nut lock.

CAUTION

If the blade retaining nut is turned past the marked castellations and the next castellation cannot be easily reached, do not back the blade retaining nut up to the marks. Remove the nut completely and retighten to the proper point.

Step 12.—Replace the blade retaining nut lock and screw, and safety with .032″ wire. See Figure 81.

Step 13.—Replace the balance weights, anti-icer tube and clamp. Safety with .032″ wire.

CAUTION

1. Care must be exercised to line up the anti-icer tubes with the clamps so that the clamps

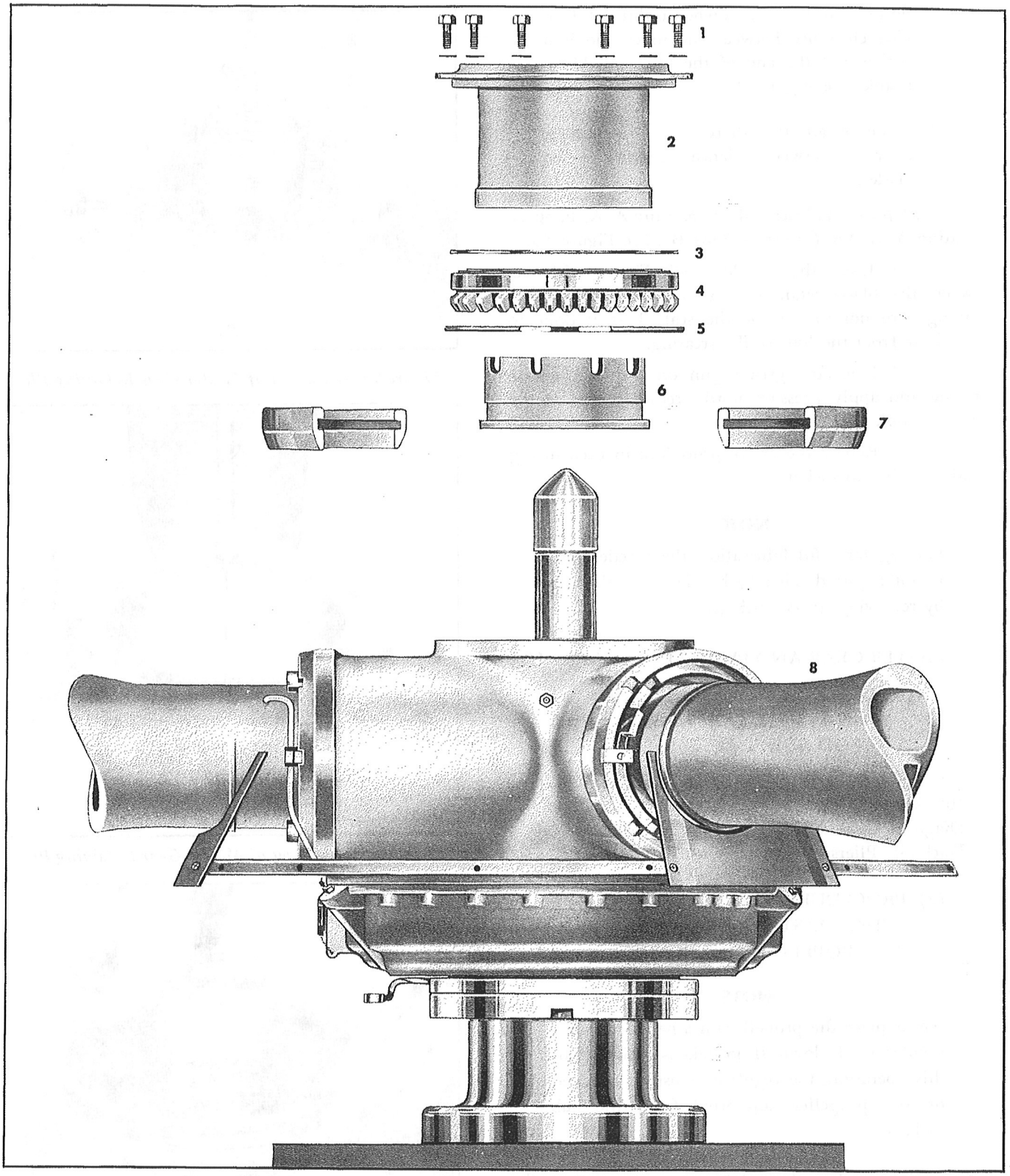

Figure 94—Master Gear, Propeller Shaft Nut, and Front Cone

1. Attaching Capscrews and Washers—9 required
2. Master Gear Retaining Plate
3. Shim
4. Master Gear Assembly
5. Lock Ring
6. Shaft Nut
7. Front Cone Halves
8. Propeller on Stake

do not crush the tubes when tightened. Provide clearance between the tubes and hub socket and the end of the tube and blade shank. See Figure 78.

2. Make certain that there is .003" minimum clearance between balance weights and the blade shank.

Step 14.—Lubricate the hub, using A. A. F. Specification 3581 AA (alternate 3581 B). See Figure 59.

1. Insert the Bleeder Tool, Figure 66-1, between the blade retaining nut and the blade shank, taking care not to damage the seal. This is done to bleed air from the hub while greasing.

2. Place the grease gun on the hub grease fitting and apply pressure until grease appears at the bleeder tool.

3. Repeat the above procedure in each fitting and at each hub socket.

NOTE

For regular refill lubrication, the bleeder tool is not required; air may be bled from the hub by removing grease fittings.

c. MASTER GEAR AND PROPELLER SHAFT NUT.

(1) TOOLS AND EQUIPMENT FOR REPLACEMENT OF MASTER GEAR AND SHAFT NUT.

$\frac{7}{16}$" Socket Wrench	.032" Brass Safety Wire
10" Screwdriver	Grease, A. A. F. Specification 3581 AA (alternate 3581 B)
Diagonal Cutters	
Duck-bill Pliers	

(2) PROCEDURE FOR REMOVAL OF THE MASTER GEAR AND THE PROPELLER SHAFT NUT.

NOTE

Never place the propeller on a bench with the regulator side down. If no stake is available for this operation, the regulator must be removed or the propeller supported from the hub sockets.

Step 1.—Cut the safety wire and remove the $\frac{1}{4}$" x 28 attaching capscrews from the master gear retaining plate, using a $\frac{7}{16}$" socket wrench, as shown in Figure 95.

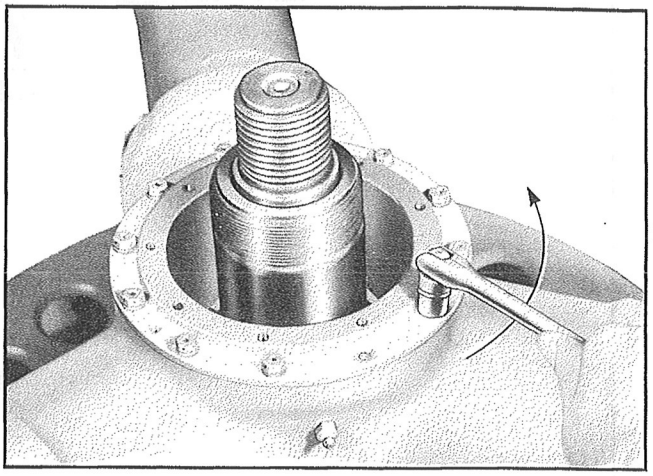

Figure 95—Removal of Master Gear Retaining Plate

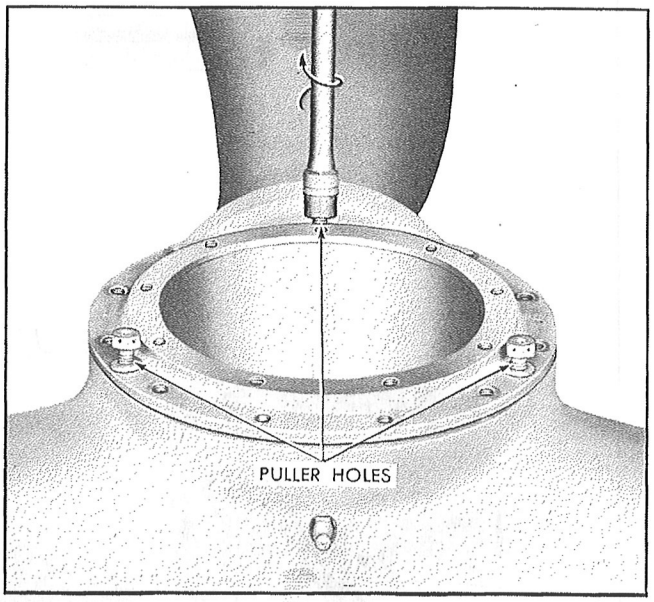

Figure 96—Removal of Master Gear Retaining Plate

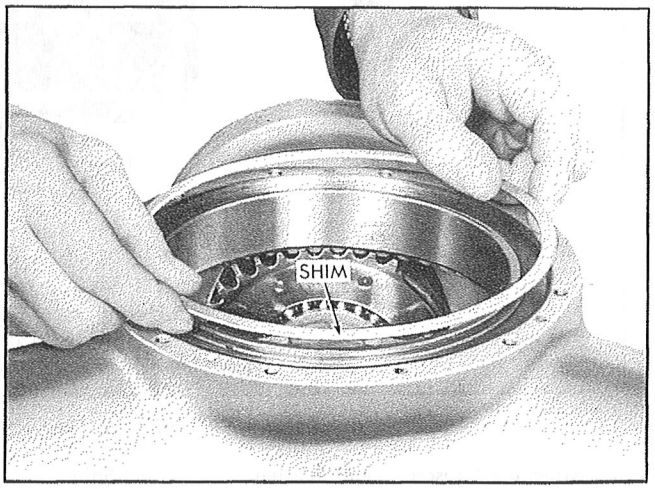

Figure 97—Removal of Shim