COUNTERWEIGHT PROPELLERS

SERVICE MANUAL

HAMILTON STANDARD PROPELLERS
Division of United Aircraft Corporation
EAST HARTFORD, CONNECTICUT

No. 110D

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SECTION I
INTRODUCTION

1. This Handbook is issued as the basic technical instructions for the equipment involved.

2. It includes a detailed description of parts, installation procedure, description of operation, service instructions, and overhaul instructions for all production models of the Counterweight type propeller.

3. The term "Counterweight" includes both the controllable and constant speed type of propeller. The controllable type is also known as the two-position. A detailed discussion of these different types is given in the appropriate sections of this Handbook.

4. This Handbook covers the 2B20, 2D30, 12D40, 2E40, 3D40, and 3E50 models. Because the operating principles and the major parts of these Counterweight propeller models are fundamentally the same, this Handbook is written on the most widely used model, the 2D30, and only the variations from this basic model are discussed for the other types.

5. The equipment involved is manufactured by the Hamilton Standard Propellers Division of United Aircraft Corporation, East Hartford, Connecticut, and by licensees of that Corporation.

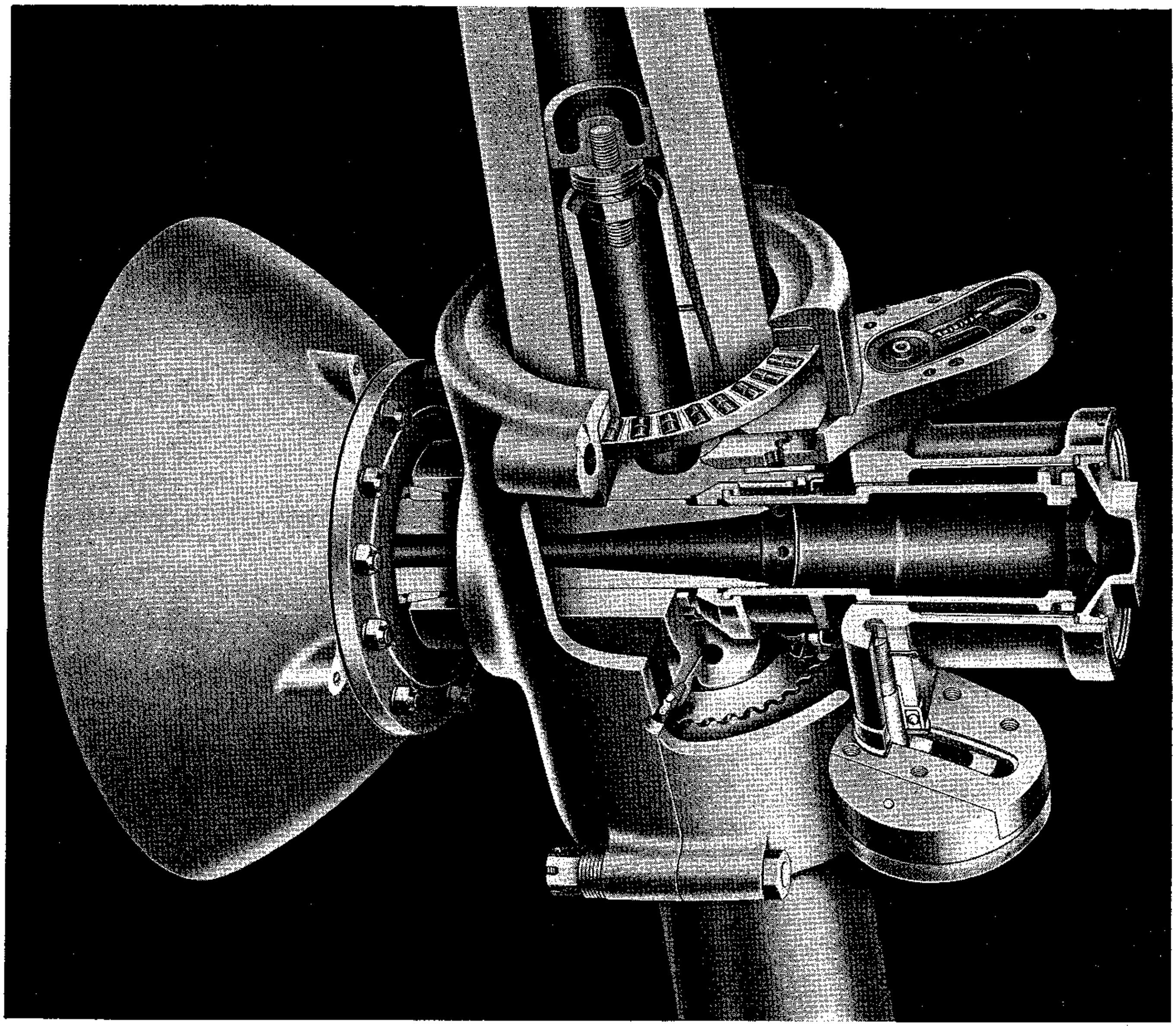


Figure 1 — Cutaway View of Counterweight Type Propeller

SECTION II
DESCRIPTION

1. GENERAL DESCRIPTION.

a. GENERAL.—The Counterweight type propeller is composed of two major assemblies, the hub assembly and the blade assembly. To clarify the discussions in this Handbook, the hub assembly has arbitrarily been subdivided into a hub group, a bracket & counterweight group, and a cylinder group. The blade assembly is subdivided into its component parts.

(1) HUB ASSEMBLY.

(*a*) HUB GROUP.—This group includes the spider, the barrel, the barrel bolts and nuts, the barrel support assemblies, the front and rear cones, the shim plate, spider shim, and grease retainer, as well as the front cone spacer and packing washer, hub snap ring, piston lock ring, and the phenolic spider ring. It should be noted that there is no assembly drawing number which includes these parts only.

(*b*) BRACKET & COUNTERWEIGHT GROUP.—The parts included in this group are the bracket, index pins, the counterweight, the counterweight screws, the counterweight bearing inner race, retainer assembly, outer race, and spacer, and the adjusting screw assembly, counterweight cap, and clevis pin.

(*c*) CYLINDER GROUP.—The piston, piston gaskets, and piston gasket nut are considered part of the cylinder group. The remaining parts are the cylinder assembly (which consists of the cylinder itself, the two liners, the counterweight thrust bearing shaft, and bushing), the counterweight thrust bearing assembly, the thrust washer, and the cylinder head, gasket, and lock ring. On propellers which include a spring return assembly, the assembly is considered part of the cylinder group.

(2) BLADE ASSEMBLY.—This assembly consists of the blade and thrust washers, the thrust bearing retainer assembly, the chafing ring, the balancing plug assembly, the bushing, the bushing screws, and the bushing drive pins.

b. BASIC OPERATING PRINCIPLES.—The Counterweight type propeller may be used to operate either as a controllable or constant speed propeller. With a controllable installation, the operator selects either the low blade angle or the high blade angle by a two-way valve which permits engine oil to flow into or drain from the propeller. If an engine driven governor is used, the propeller will operate as a constant speed installation, and engine speed will be maintained constant at any rpm setting within the operating range of the propeller. The governor supplies and controls the flow of oil to and from the propeller, thereby changing the blade angle to meet changes in flight and power conditions.

(1) As shown in figures 50, 51, and 52, the Counterweight type propeller from an operational standpoint consists of a piston (6) which is fixed to the propeller shaft, a cylinder (5) which rides on the piston and is connected to the counterweight brackets (7) by a ball-bearing and shaft system (8), and the brackets themselves which are fixed to the blades (9).

(2) Blade angle changes are accomplished by the use of two forces, one hydraulic and the other centrifugal. Oil forced into the piston-cylinder (6-5) arrangement is the hydraulic force which moves the cylinder (5) outboard. This motion is transmitted to the brackets (7) through the shaft and bearing group (8) and the brackets are moved inward. Since the brackets (7) are fixed to the butt end of the blades (9), the blades are rotated to a lower angle. If oil is allowed to drain from the cylinder, centrifugal force acting on the counterweights moves the brackets (7) outward, and the blades are rotated to a higher angle. The governor controls this action and allows the blades to move to a higher angle when the engine tends to overspeed, and to a lower angle when it tends to underspeed.

(3) If engine speed drops below the rpm for which the governor is set, the rotational speed of the engine driven governor fly-weights (2) decreases accordingly and the speeder spring (1) moves the pilot valve (3) downward. Oil is then supplied to the propeller cylinder (5) through the propeller-governor line (4) moving the propeller cylinder (5) in an outboard direction. This hydraulic force overrides the centrifugal force of the counterweights (7), and the brackets are moved inward. As a result, the blade angle is decreased and the propeller is returned to on-speed operation.

(4) If engine speed increases above the rpm for which the governor is set, the fly-weights (2) move outward against the force of the speeder spring (1) raising the pilot valve (3). This allows oil to drain from the propeller cylinder (5), through the propeller-governor line (4), and finally into the engine sump. The cylinder (5) is moved in an inboard direction by the counterweights (7) which are moved outward by centrifugal force. The blade angle is in-

creased and the propeller returns to on-speed operation. When all forces in the propeller and governor are balanced, the engine is operating on-speed and the governor pilot valve (3) is in a neutral position. Oil is neither supplied to nor drained from the propeller. The rpm setting of the governor can be changed by varying the compression in the speeder spring (1) which either increases or decreases the centrifugal force (and rpm) necessary to maintain the pilot valve (3) in a neutral position.

c. MODEL DESIGNATION SYSTEM.

(1) HUB ASSEMBLY.

(*a*) Counterweight propellers are identified by a model designation system which explains in part the type and use of the propeller. The numbers and letter group in front of the dash indicates the basic hub model, and the number group which follows the dash indicates the minor modifications incorporated in the basic model. In the model 2D30-247 propeller, the numbers and letter group preceding the dash indicates the following:

1. The first number, "2", is the number of blades in the propeller. Counterweight type propellers are made with either two or three blades.

2. The letter, "D", identifies the blade shank size. Counterweight propeller blade shank sizes are B, D, and E, which are approximately equivalent in shank diameter to SAE sizes 1, 1-1/2, and 2.

3. The two numbers immediately preceding the dash, "30" in this case, are the SAE propeller shaft spline size. Counterweight propellers are built in SAE Nos. 20, 30, 40, and 50 spline sizes.

Note

In addition, one Counterweight propeller model, the "12D40", contains the extra designation number "1" indicating one major change has been incorporated in the basic model.

(*b*) The numbers group following the dash identifies the minor modifications that have been incorporated in the basic model. In this example, the propeller is modified to a "-247" version. Propellers designed for right-hand rotation have odd "dash numbers", and those for left-hand rotation have even dash numbers. In each case an even dash number indicates that the propeller is the left-hand version of the propeller bearing the next lower odd dash number. By selecting the parts list (or by referring to the parts catalog) having the particular dash number marked on the propeller barrel, plus the parts list for the blade involved, it is possible to determine exactly the parts and assemblies by name and number which compose the complete propeller assembly.

Note

Direction of propeller rotation is determined by viewing the propeller from the slip stream, whereas direction of engine rotation is determined by viewing the engine shaft from the rear of the engine. Right-hand propellers turn clockwise, and left-hand propellers turn counterclockwise.

(2) BLADE ASSEMBLY.

(*a*) GENERAL DESIGNATIONS.—In addition to the hub model designation, the blades are identified by design numbers stamped on the circumference of the butt end of each blade. The blade designation system is similar to that used for the hub in that it describes in part the use and type of the unit. As an example, on a blade designated as a C6167A-12, the numbers and letters indicate the following:

1. The first letter, in this case "C", indicates that a molded rubber fairing has been added to the blade shank. Various styles of fairings are identified by changes in this letter designation.

2. The first number group, "6167", is the basic blade design.

3. The letter "A" which follows the basic blade design shows that this is a blade assembly. An assembly includes the bearing assembly, chafing ring, the bushing, the bushing drive pins, the bushing screws, and the balancing plug assembly. The blade assembly is sometimes considered to be the blade itself and the two thrust washers; however, when these parts alone are desired, the blade assembly indicated by the designation number should be specified minus the parts which are not wanted.

4. The first dash number group following the basic blade design number indicates the number of inches the propeller diameter is reduced from that of the basic design. In this example, the basic blade design diameter has been reduced 12 inches by shortening each blade 6 inches. If the basic blade design is used with no reduction in diameter, the complete designation would be C6167A-0.

(*b*) SPECIAL DESIGNATIONS.—To meet installation requirements, standard blade designs may be modified by telescoping or by special pitch distribution. The diameter of the propeller blade (as mounted in the hub) is modified either by telescoping or straight cut-off. In telescoping, the blade is trimmed down in width and thickness from the cut-off station to the widest station of the blade. In straight cut-off, only the cut-off station is modified. Figure 2 shows the two types of cut-offs.

1. TELESCOPE FROM CUT-OFF TO WIDEST STATION.—A blade which is modified by telescoping from the cut-off station to the widest sta-

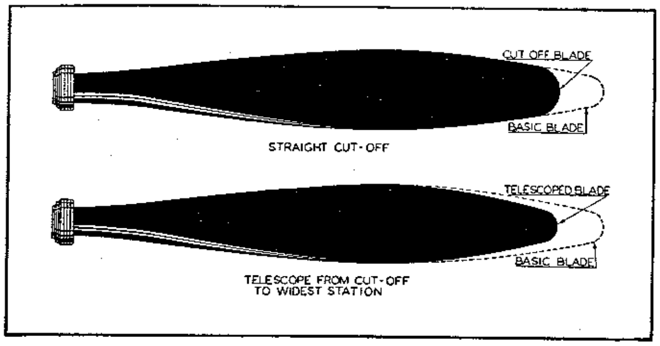


Figure 2 — Typical Blade Cut-Off Diagram

tion is identified by the letter "T" following the blade dash number; for example, 6167A-18T.

2. COMBINATION OF STRAIGHT CUT-OFF AND TELESCOPIC CUT-OFF.—When a blade is modified by a straight cut-off and then a telescope cut-off, it is identified by the letter "T" following a second dash number; as an example 6167A-6-12T. This shows the propeller diameter is reduced a total of 18 inches, telescoped 12 inches from a 6-inch straight cut-off. In this case, each blade has a straight cut-off of 3 inches and is telescoped 6 inches.

3. COMBINATION OF TELESCOPE CUT-OFF AND STRAIGHT CUT-OFF.—When a blade is modified by a combination of telescope cut-off and then straight cut-off, it is identified by the letter "T" following the first dash number; as an example, 6167A-12T-6. This indicates the propeller diameter is reduced a total of 18 inches; telescoped from the 12-inch cut-off station and then reduced an additional 6 inches by straight cut-off.

4. SPECIAL PITCH DISTRIBUTION.—A blade design which has a special pitch distribution is identified by the letter "A" following the first dash number; as an example, 6167A-12A. If this blade is also telescoped, the designation would be 6167A-12TA; if the diameter is reduced another 6 inches by straight cut-off, the designation would be 6167A-12TA-6.

2. DETAILED DESCRIPTION.

a. MODEL 2D30.—This model propeller has either a 10 or 15-degree total blade angle range. It has two "D" shank blades, and is built to fit on an SAE 30 propeller shaft. The model 2D30 is the most widely used, and therefore has been selected as the basic model in this Handbook.

(1) CRANKCASE BREATHING TYPE. (See figure 3.)

(*a*) HUB ASSEMBLY.—As previously described in paragraph 1.a. of this section, the Counterweight type hub assembly has arbitrarily been di-

Nomenclature for Figure 3

1 REAR CONE
2 BARREL ASSEMBLY
3 SPIDER
4 GREASE FITTING
5 SHIM PLATE DOWEL
6 SPIDER (PHENOLIC) RING
7 GREASE RETAINER ASSEMBLY
8 SPIDER SHIM
9 SHIM PLATE
10 BLADE BUSHING INDEX PIN
11 COUNTERWEIGHT BRACKET ASSEMBLY
12 COUNTERWEIGHT BRACKET
13 COUNTERWEIGHT (SMALL) DOWEL
14 COUNTERWEIGHT (LARGE) DOWEL
15 COUNTERWEIGHT
16 COUNTERWEIGHT (SMALL) SCREW
17 COUNTERWEIGHT (LARGE) SCREW
18 WELCH PLUG
19 BARREL SUPPORT ASSEMBLY
20 SCREW
21 WASHER
22 BALANCING (LEAD) WASHER
23 NUT
24 BARREL (PHENOLIC) SUPPORT
25 BARREL BOLT
26 WASHER
27 BARREL BOLT NUT
28 COTTER PIN
29 CYLINDER ASSEMBLY
30 CYLINDER (STEEL) LINER
31 CYLINDER (PHENOLIC) LINER
32 COUNTERWEIGHT BEARING SHAFT BUSHING
33 COUNTERWEIGHT BEARING SHAFT
34 COTTER PIN
35 PISTON
36 PISTON LOCK RING
37 SNAP RING
38 FRONT CONE SPACER
39 FRONT CONE PACKING WASHER
40 FRONT CONE
41 COTTER PIN
42 PISTON (INBOARD) GASKET
43 PISTON (OUTBOARD) GASKET
44 PISTON GASKET NUT
45 COTTER PIN
46 COUNTERWEIGHT THRUST BEARING ASSY.
47 THRUST WASHER
48 COUNTERWEIGHT BEARING (INNER) RACE
49 COUNTERWEIGHT BEARING RETAINER ASSEMBLY
50 COUNTERWEIGHT BEARING (OUTER) RACE
51 COUNTERWEIGHT BEARING RETAINER SPACER
52 COUNTERWEIGHT ADJUSTING SCREW ASSEMBLY
53 COUNTERWEIGHT ADJUSTING SCREW NUT
54 COUNTERWEIGHT CAP
55 CLEVIS PIN
56 CYLINDER HEAD GASKET
57 CYLINDER HEAD
58 CYLINDER HEAD LOCK RING
59 WELCH PLUG

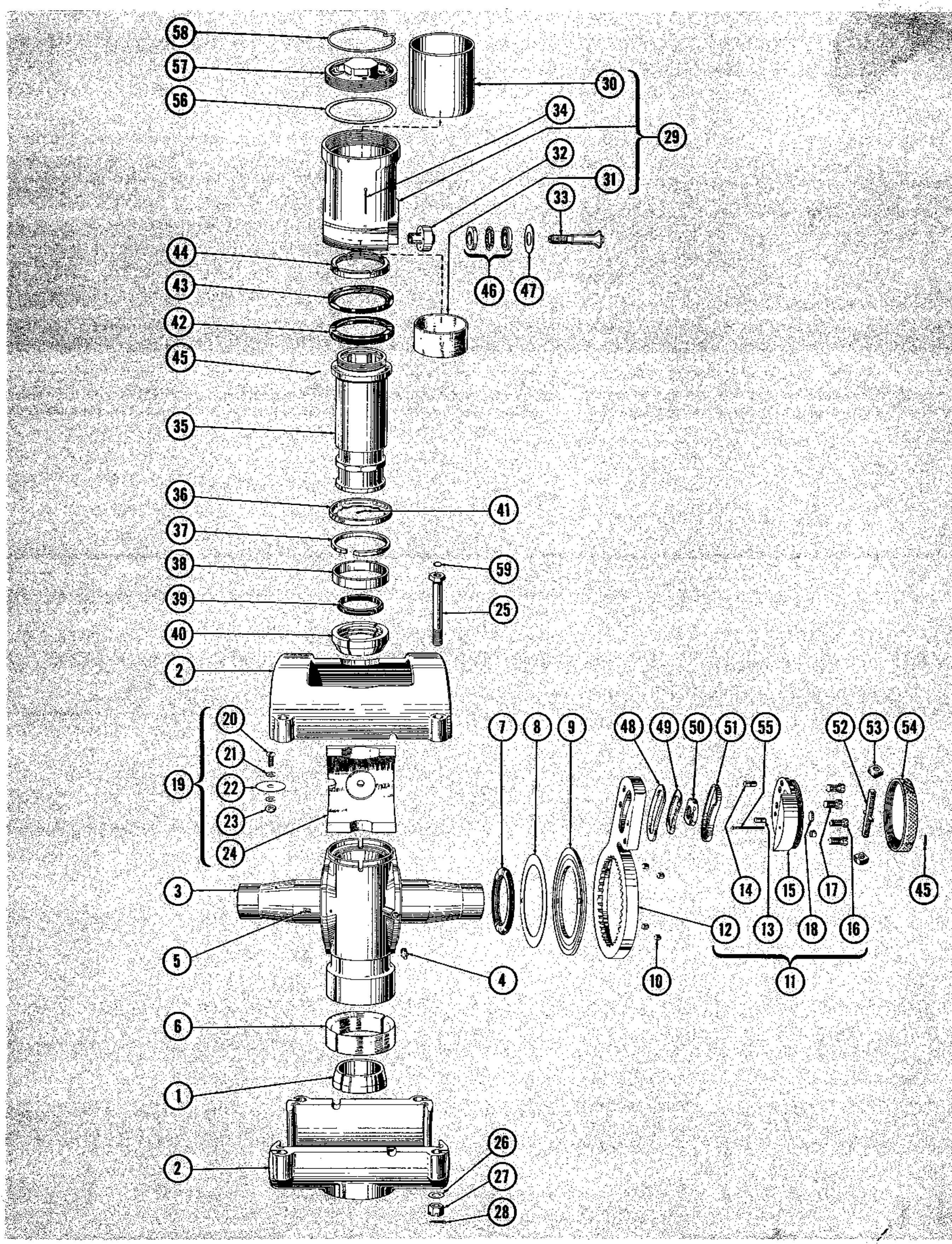


Figure 3 — Crankcase Breathing Type 2D30 Model

vided into a hub group, a bracket & counterweight group, and a cylinder group.

1. HUB GROUP.—The hub group consists of the spider, the barrel, and miscellaneous smaller parts. The spider may be considered the foundation for the entire propeller. It is made of heat-treated alloy steel, and is splined through the center with one raised segment omitted to accommodate the double spline on the propeller shaft. A cone seat is incorporated at each end of the splined portion. The front cone seat is at 30 degrees with the propeller axis, and the rear cone seat at 15 degrees. Arms which are integral with the spider body serve to locate the blades in the barrel. Each arm has two bearing surfaces which match with corresponding surfaces in the blade bushing. These bearings are lubricated through a small passage which extends from inside the hollow portion of the arm to a grease fitting located between the arms. A groove is provided just outboard of the front cone seat to hold the hub snap ring. The base of the spider includes a ledge which serves to hold the phenolic spider ring. The barrel is the casing which encloses the hub group and the butt ends of the blade assemblies. Since it is manufactured in half sections which are ground and balanced as a pair, the halves are not interchangeable and must be kept together throughout the service life of the propeller. Major damage to one half necessitates scrapping both halves. The halves are held together in an assembled propeller by four bolts and nuts which extend through bosses incorporated on each half near the parting surface. The centers of these bolts are hollow to provide for the lead wool used in final balancing of the propeller. After balancing, each bolt head is sealed with a welch plug, and the nuts are cottered to the bolts. The barrel (also made of a heat-treated alloy steel) carries the high centrifugal blade loads by means of the shoulders at each blade bore. The outboard barrel half has an opening through which the counterweight brackets extend to attach to the cylinder, and an opening in the inboard barrel half is provided for the spider. The barrel is located on the spider by phenolic supports. The inner surface of these supports fits curved sections between the spider arms, and the outer surface contacts the inside of the barrel. If required for vertical balance, washers are assembled on one barrel support, and held in place with a screw and a nut. A phenolic spider ring is installed around the base of the spider, and in conjunction with the barrel supports, this ring prevents metal-to-metal contact between the barrel and spider. The propeller is located on the propeller shaft by two cones. The steel front cone is cut in two sections which are serially numbered and must be used as a pair. A ledge on the cone fits over the base of the piston at installation holding that part in place, and a groove is provided below this ledge for the neoprene front cone packing washer which establishes the oil seal between the propeller piston and shaft. The bronze rear cone has a single split which allows it to be easily fitted over the propeller shaft, yet fit closely to the shaft when the propeller is installed. The hub snap ring is a split steel ring which is inserted into a groove in the outboard end of the spider bore. Another steel ring called the front cone spacer fits between the hub snap ring and the front cone, and takes up the clearance between these parts. As the piston is backed off the shaft threads during removal of the propeller, the spacer is forced against the hub snap ring by the front cone thereby starting the entire propeller off the shaft. The piston is fixed to the propeller shaft by a piston lock ring "L" shaped in cross section. The inner diameter incorporates notches that match and fit over the octagon on the piston. To lock the piston in place, cotter pins are inserted through holes in the vertical section of the lock ring and into matching holes in the spider. A self-lubricating shim plate and a solid brass shim are installed on each spider arm with the shim fitting against the spider arm face, and the plate between the shim and the blade bushing. Both are prevented from turning by a dowel in the spider arm face. The shims are made in thicknesses from .005 to .023 inch in increments of .001 inch, and are used during assembly to adjust the fit of the blade bearings. Spring-load leather grease retainers fit against the face of each spider arm. These retainers prevent leakage of the grease which lubricates the bearing surfaces between the spider arm and blade bushing.

2. BRACKET & COUNTERWEIGHT GROUP.—The counterweight bracket forms the connection between the blade and the cylinder. The inner circumference of the large circular end of the bracket has 40 semi-circular notches, and when installed on

Nomenclature for Figure 4

1 BLADE AND THRUST WASHERS
2 BLADE BALANCING PLUG ASSEMBLY
3 WASHER
4 BLADE BALANCING (THIN) WASHER
5 LOCK WASHER
6 NUT
7 BUSHING
8 BLADE BUSHING DRIVE PIN
9 BLADE BUSHING SCREW
10 BLADE CHAFING RING
11 BLADE THRUST BEARING RETAINER ASSEMBLY
12 BLADE THRUST BEARING ROLLER

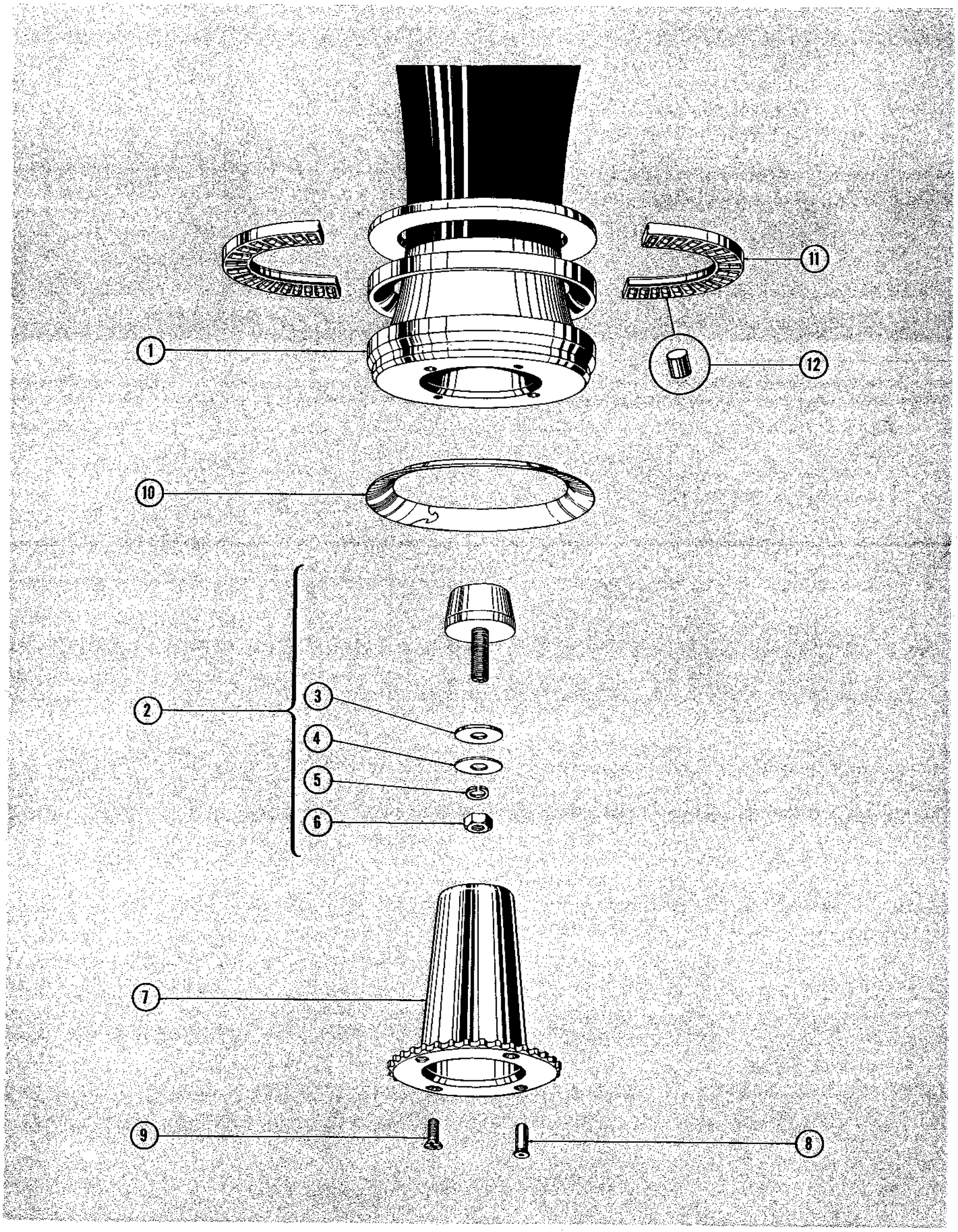


Figure 4 — Counterweight Type "D" Shank Blade Assembly

the blade, four of these notches 90 degrees apart line up with similar notches in the blade bushing to establish a particular high angle base setting. Steel index pins installed in the four aligned holes fix the bracket to the blade bushing. The opposite end of the bracket incorporates a cam slot in which the counterweight bearing shaft moves, and also various holes for the counterweight dowels and screws. The counterweight itself is stepped so that after assembly the thicker section aligns with the straight edge and fits flush with the inside surface of the bracket. The outer face of the counterweight is stamped with the angle graduations applicable to the particular range being used, and the base setting is stamped in a small lead insert near the slot. When the counterweight & bracket group are completely assembled, a slot in the counterweight holds the adjusting screw assembly consisting of the adjusting screw and a pin inserted through the adjusting screw. The pin prevents the screw from turning and changing the pitch setting. Two nuts, one on either end of the adjusting screw, can be moved independently up or down on the screw to change either the high or low blade angle setting. The counterweight bearing is composed of the long curved inner race, the retainer assembly, and the circular outer race. The inner race fits in the cam track of the counterweight bracket, and because of its curved design, it can be installed in only one position. One side of this race is slightly thicker than the other, and the retainer assembly is offset in a similar manner. This means that the retainer assembly can also be installed in but one position. The outer (or cap) race is also slightly curved, but due to its short length and the resultant possibility of improper installation, a curved line indicating the bracket cam slot outline is stamped on its outside face. A band of steel called the counterweight bearing spacer is fitted over the retainer assembly in the bracket cam slot to prevent misalignment of the bearing retainer during pitch changing operation. This spacer is not used on all models. After assembly, these parts are covered by a cap which is threaded onto the outer rim of the counterweight. The cap is locked by a clevis pin that is inserted through a hole in the back face of the counterweight. This pin extends just beyond the outer face of the cap where it is locked by a cotter pin.

3. CYLINDER GROUP.—The cylindrical steel piston is turned onto the propeller shaft threads at installation and serves to conduct the oil to the cylinder. The piston also acts as a locating guide for the cylinder. A flange on the inboard end of the piston fits into the front cone and in this way the piston acts as the propeller retaining nut. The flange on the outboard end locates the two gaskets which form the oil seal between the piston and the cylinder. The inboard

Nomenclature for Figure 5

1 REAR CONE
2 BARREL ASSEMBLY
3 SPIDER
4 GREASE FITTING
5 SHIM PLATE DOWEL
6 SPIDER (PHENOLIC) RING
7 GREASE RETAINER ASSEMBLY
8 SPIDER SHIM
9 SHIM PLATE
10 BLADE BUSHING INDEX PIN
11 COUNTERWEIGHT BRACKET ASSEMBLY
12 COUNTERWEIGHT BRACKET
13 COUNTERWEIGHT (SMALL) DOWEL
14 COUNTERWEIGHT (LARGE) DOWEL
15 COUNTERWEIGHT
16 COUNTERWEIGHT (SMALL) SCREW
17 COUNTERWEIGHT (LARGE) SCREW
18 WELCH PLUG
19 BARREL SUPPORT ASSEMBLY
20 SCREW
21 WASHER
22 BALANCING (LEAD) WASHER
23 NUT
24 BARREL (PHENOLIC) SUPPORT
25 BARREL BOLT
26 WASHER
27 BARREL BOLT NUT
28 COTTER PIN
29 CYLINDER ASSEMBLY
30 CYLINDER (STEEL) LINER
31 CYLINDER (PHENOLIC) LINER
32 COUNTERWEIGHT BEARING SHAFT BUSHING
33 COUNTERWEIGHT BEARING SHAFT
34 COTTER PIN
35 PISTON
36 OIL SUPPLY PIPE ASSEMBLY
37 PISTON LOCK RING
38 SNAP RING
39 FRONT CONE SPACER
40 FRONT CONE
41 COTTER PIN
42 PISTON (INBOARD) GASKET
43 PISTON (OUTBOARD) GASKET
44 PISTON GASKET NUT
45 OIL SUPPLY PIPE PACKING WASHER
46 OIL SUPPLY PIPE PACKING NUT
47 COUNTERWEIGHT THRUST BEARING ASSY.
48 THRUST WASHER
49 COUNTERWEIGHT BEARING (INNER) RACE
50 COUNTERWEIGHT BEARING RETAINER ASSY.
51 COUNTERWEIGHT BEARING (OUTER) RACE
52 COUNTERWEIGHT BEARING RETAINER SPACER
53 COUNTERWEIGHT ADJUSTING SCREW ASSY.
54 COUNTERWEIGHT ADJUSTING SCREW NUT
55 COUNTERWEIGHT CAP
56 CLEVIS PIN
57 COTTER PIN
58 CYLINDER HEAD GASKET
59 CYLINDER HEAD
60 CYLINDER HEAD LOCK RING
61 WELCH PLUG

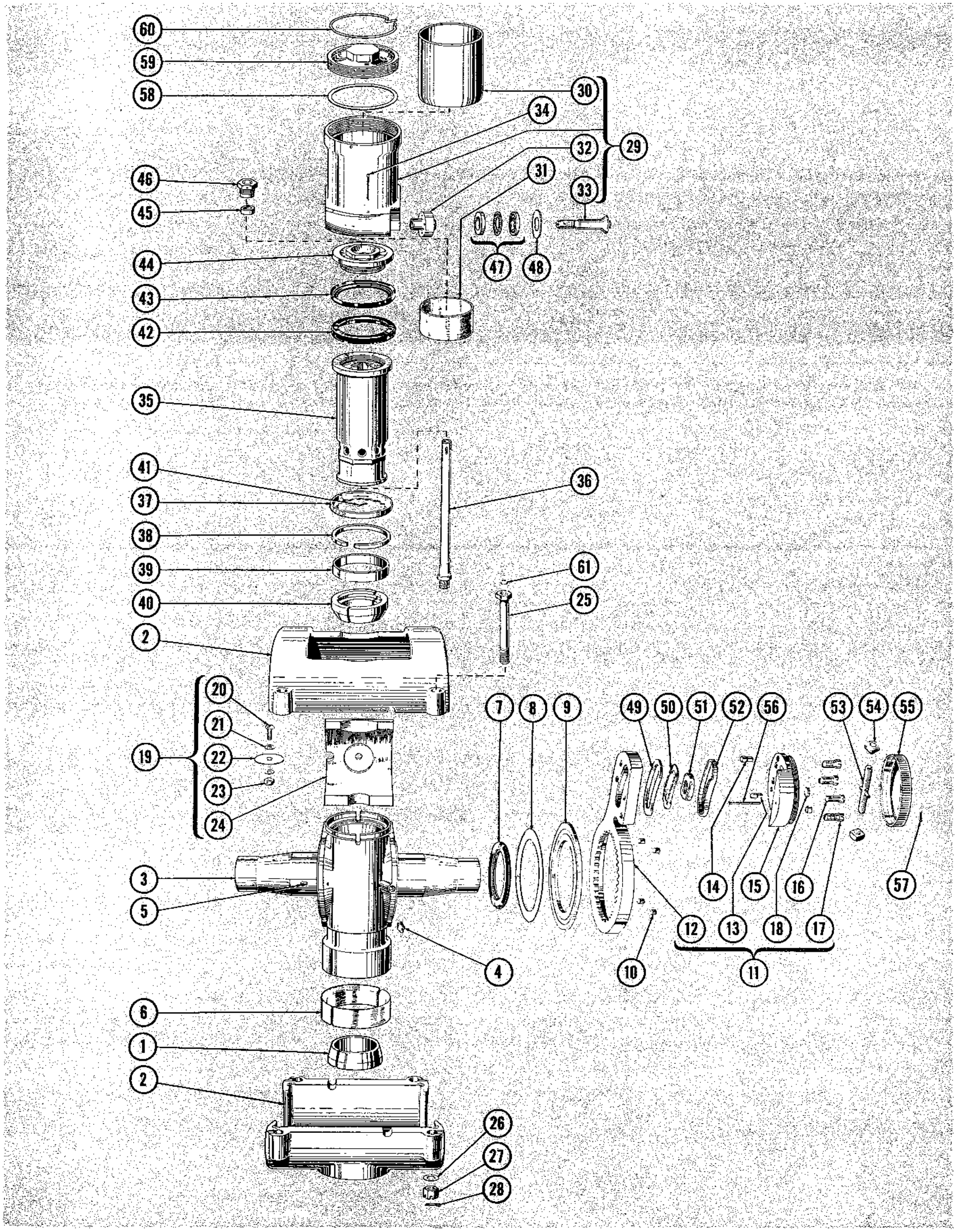


Figure 5 — Shaft Breathing Type 2D30 Model

gasket with a bevel on the OD of the lip is used as a guide, whereas the outboard gasket with a bevel on the ID of the lip fits against the liner in the cylinder and provides the oil seal. These gaskets are held in place by the piston gasket nut which is threaded onto the outboard end of the piston. The nut has four slots through one of which a locking cotter pin is inserted into a hole in the piston. The cylinder is made of aluminum, but a steel liner is inserted on the inside to provide a better wearing surface for the piston gaskets. The smaller bore at the inboard end of the cylinder incorporates a phenolic liner which prevents the piston from contacting and rubbing directly on the cylinder. The large flange on the base of the cylinder has threaded holes for the counterweight bearing shaft and a bore for each bushing. The shaft itself has a conical head which matches the outer race of the counterweight bearing, and the opposite end is threaded to fit into the cylinder. When the shaft is finally installed, it is held in place by a cotter pin which extends through a hole in the cylinder flange and the shaft. A bushing is installed in the cylinder to provide a bearing surface for the shaft, and it also acts as a container for the thrust bearing assembly. This bearing assembly consists of the inner race, the retainer assembly, and the outer race. The parts are circular, and the inner race is a light press fit on the counterweight bearing shaft bushing. At assembly, a bronze thrust washer is fitted against the outer race to provide a rolling contact between the bracket and the cylinder. The cylinder head is threaded into the cylinder with a copper-asbestos gasket between the two parts to make the assembly oil tight. The cylinder head is secured by a snap ring which rests in a groove in the head and has a tip portion which extends through holes in both the head and the cylinder. The center portion of the cylinder head has hexagonal flats to permit the use of a wrench during installation.

(*b*) BLADE ASSEMBLY. (See figure 4.)—Counterweight blades are made of aluminum alloy and heat-treated for high strength. The butt end of each blade incorporates a shoulder that is perpendicular to the shank center line; the thrust radius which takes the blade operating load is on the outboard face of the butt flange; and the inside face is flat to accommodate the blade bushing and the counterweight bracket. Before the butt end of the blade is upset in the forging operation, two hardened steel rings are installed to fit between the airfoil section and the butt flange. These thrust washers carry the centrifugal load from the blade to the barrel. The washer nearer the blade butt incorporates a radius to match the blade chafing ring radius, whereas the outer washer is flat on both sides. On blades which

Nomenclature for Figure 6

1 REAR CONE
2 BARREL ASSEMBLY
3 SPIDER
4 GREASE FITTING
5 SHIM PLATE DOWEL
6 SPIDER (PHENOLIC) RING
7 GREASE RETAINER ASSEMBLY
8 SPIDER SHIM
9 SHIM PLATE
10 COUNTERWEIGHT BRACKET ASSEMBLY
11 COUNTERWEIGHT BRACKET
12 COUNTERWEIGHT DOWEL
13 COUNTERWEIGHT
14 COUNTERWEIGHT SCREW LOCK WASHER
15 COUNTERWEIGHT SCREW
16 WELCH PLUG
17 BARREL SUPPORT ASSEMBLY
18 SCREW
19 WASHER
20 BALANCING (LEAD) WASHER
21 NUT
22 BARREL (PHENOLIC) SUPPORT
23 BARREL BOLT
24 BARREL BOLT NUT
25 COTTER PIN
26 CYLINDER ASSEMBLY
27 CYLINDER (STEEL) LINER
28 CYLINDER (PHENOLIC) LINER
29 COUNTERWEIGHT BEARING SHAFT BUSHING
30 COUNTERWEIGHT BEARING SHAFT
31 COTTER PIN
32 PISTON
33 PISTON LOCK RING
34 SNAP RING
35 FRONT CONE PACKING WASHER
36 FRONT CONE
37 COTTER PIN
38 PISTON (INBOARD) GASKET
39 PISTON (OUTBOARD) GASKET
40 PISTON GASKET NUT
41 COTTER PIN
42 THRUST WASHER
43 COUNTERWEIGHT BEARING (INNER) RACE
44 COUNTERWEIGHT BEARING RETAINER ASSEMBLY
45 COUNTERWEIGHT BEARING (OUTER) RACE
46 COUNTERWEIGHT ADJUSTING SCREW ASSEMBLY
47 COUNTERWEIGHT ADJUSTING SCREW NUT
48 COUNTERWEIGHT CAP
49 CLEVIS PIN
50 CYLINDER HEAD GASKET
51 CYLINDER HEAD
52 CYLINDER HEAD LOCK RING

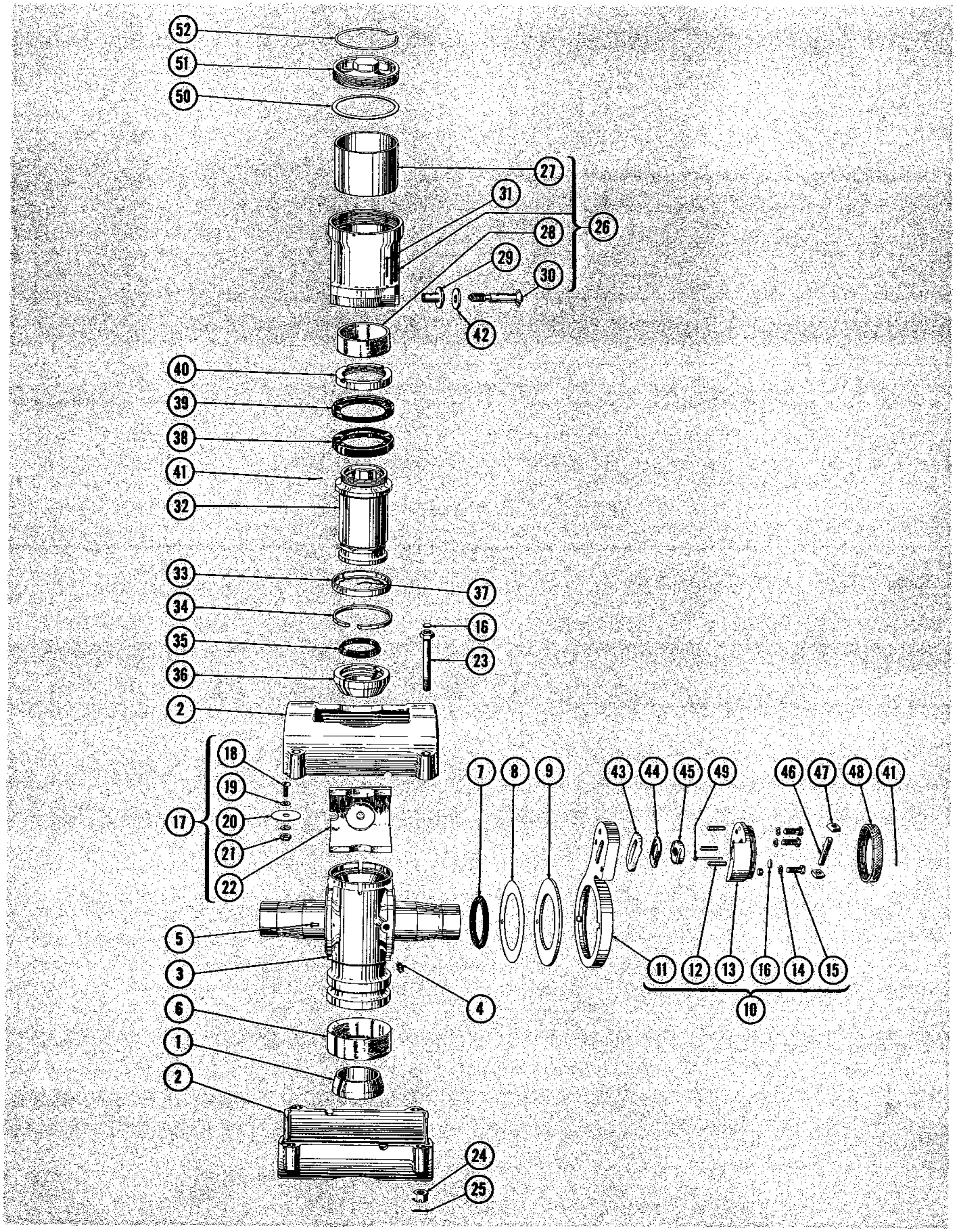


Figure 6 — Crankcase Breathing Type 2B20 Model

do not use chafing rings, the radius of the beveled thrust washer matches and fits directly against the blade butt fillet. Two halves of a roller-type thrust bearing retainer assembly fit between the washers and provide a means for the blade to turn in the barrel. A portion of the blade shank is hollow to provide for the bushing and balancing plug assembly. The bushing is made of aluminum-bronze alloy. The outside tapered surface of the bushing matches the blade taper bore, and the inside incorporates two bearing surfaces which correspond to the bearings on the spider arm. At assembly, the bushing is shrunk into the blade taper bore so that the bushing flange contacts the blade butt face. The outer circumference of the flange incorporates 36 semi-circular notches, four of which will align with similar notches in the counterweight bracket to establish a particular blade angle base setting. Two drive pins and two screws inserted through the bushing flange secure it into the blade. Each blade is fitted with an aluminum plug which is wedged into the blade bore at a point just beyond the outer end of the blade bushing. This plug has a steel stud on which washers may be added to obtain initial blade balance. The balancing washers are secured in place by a lock washer and a nut. Balancing plugs made to a later design may be withdrawn from the blade without first removing the bushing. A phenolic chafing ring on the blade fits between the blade butt fillet and the beveled thrust washer. This ring prevents chafing of the metal washer against the aluminum blade, and also serves to minimize stress concentration. Earlier chafing rings had a straight sided split, while the newer ones have an interlocking type joint.

(2) SHAFT BREATHING TYPE. (See figure 5.)—On some installations, the breather gases from the engine are vented through the shaft which makes necessary certain changes in the propeller. A small steel pipe is threaded into the propeller shaft and extends through the outboard end of the piston. It is sealed at the outboard piston end by a washer which fits around this oil supply pipe between the piston gasket nut and oil supply pipe packing nut. On a shaft breathing installation, the piston is modified to incorporate internal threads at the piston gasket ledge. The piston gasket nut is disc shaped with a threaded extension at the bottom to fit into the piston, and a threaded hole in the center for the oil supply pipe, packing washer, and nut. Several holes are added through the piston wall just outboard of the octagonal flange. Since oil does not contact the front cone, the neoprene front cone packing washer is not used and the cone itself is modified accordingly. With these parts installed, breather gases can escape to atmosphere through the holes near the base of the piston. At the same time, the propeller can be operated and maintained oil tight by the oil supply pipe and packing washer arrangement.

b. MODEL 2B20.—The 2B20 model is basically a smaller version of the 2D30 propeller previously described in paragraph 2.a. of this section. The maximum total blade angle range may be either 8 or 15 degrees in a 2B20 model. As indicated in the model designation, this type propeller has two "B" shank blades, and is designed to fit an SAE No. 20 propeller shaft. It is the smallest model of the Counterweight type propellers.

(1) CRANKCASE BREATHING TYPE. (See figure 6.)

(*a*) HUB ASSEMBLY.—The hub assembly parts used in 2B20 models are basically the same as those in the 2D30 described in paragraph 2.a.(1)(a) of this section with slight variations made in the shape and size of the parts to conform with the smaller size of the propeller.

1. HUB GROUP.—The 2B20 model does not use a front cone spacer nor barrel bolt washers. All dash numbers previous to –225 incorporated a shorter spider, whereas models –225 and above may or may not use a spider which is one inch longer. Spider shims are made in thicknesses from .008 to .020 inch in increments of .001 inch.

2. BRACKET & COUNTERWEIGHT GROUP.—The inner circumference of the large end of the counterweight bracket has two rectangular slots 180 degrees apart. At assembly, two steel keys fix the bracket to the blade butt and also provide a method for changing the base angle setting of the propeller. One end of the key, the indexing portion, fits into the slot in the counterweight bracket; the other end of the key fits into a corresponding slot in the blade butt and blade bushing, and is held to the

Nomenclature for Figure 7

1 BLADE AND THRUST WASHERS
2 BLADE BALANCING PLUG ASSEMBLY
3 WASHER
4 BLADE BALANCING (THIN) WASHER
5 LOCK WASHER
6 NUT
7 BUSHING
8 BLADE KEY
9 BLADE BUSHING SCREW
10 BLADE THRUST BEARING RETAINER ASSEMBLY
11 BLADE THRUST BEARING ROLLER

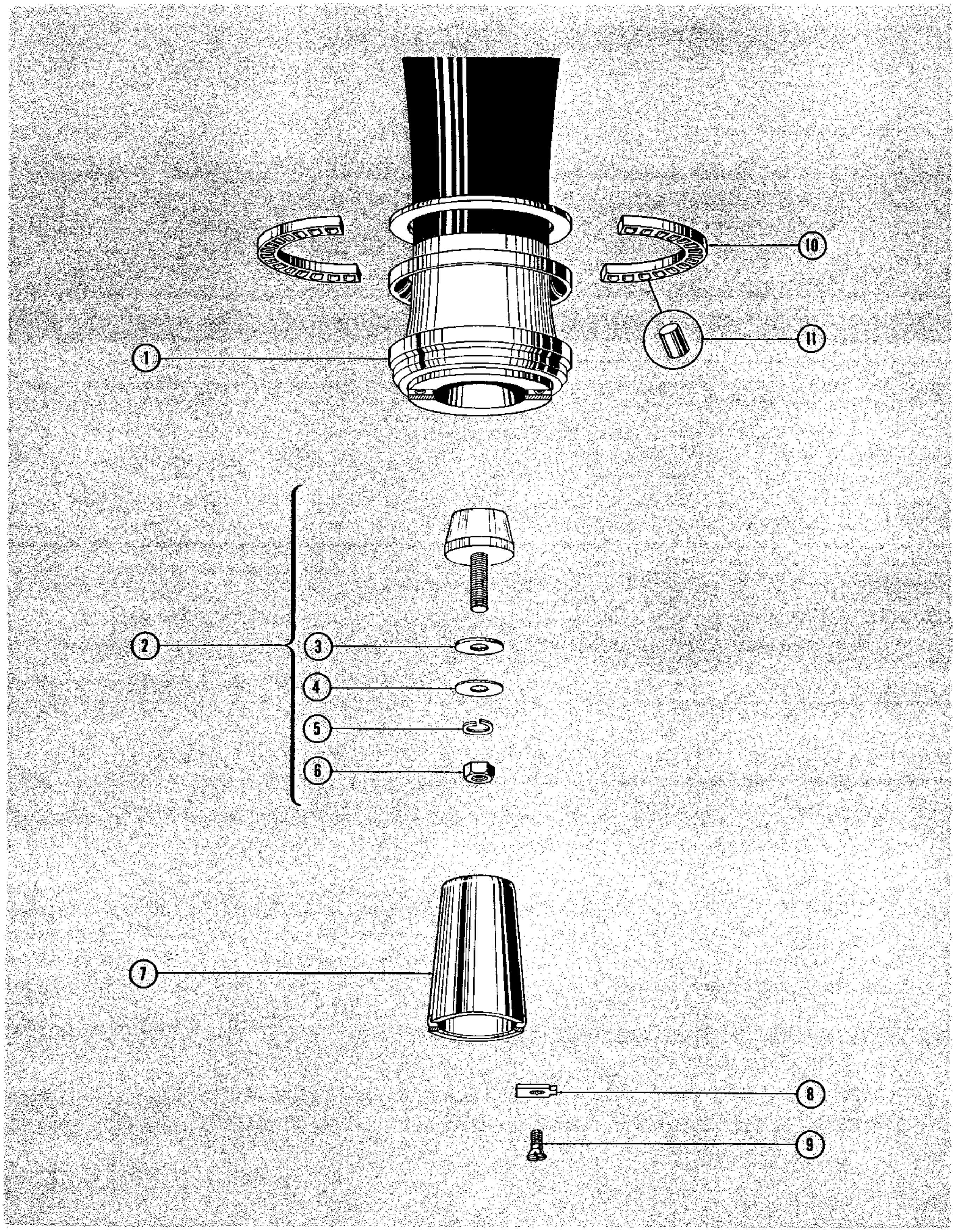


Figure 7 — Counterweight Type "B" Shank Blade Assembly

blade by a screw. One of the blade keys, No. 50140, is a neutral key and gives just one base setting of 23 degrees. Other keys are available which permit different blade angle settings, depending upon the way they are installed. One side of each key is marked plus and the other side minus the number of degrees the indexing portion of the key varies from the body portion. By turning the key over at installation, the centerline of the indexing portion is shifted either above or below the centerline of the body portion, and with the exception of the neutral key, this makes possible two base settings for each key. The bracket & counterweight group in a model 2B20 propeller does not include counterweight bearing retainer spacers, and the bearing retainer assemblies and races are flat as compared with the offset type used in the model 2D30. The counterweight screws are secured in place by lock washers instead of safety wire, and the 2B20 uses three screws of the same size rather than four screws of two different sizes.

3. CYLINDER GROUP.—Early models of the 2B20 propeller incorporated bearing shaft bushings made of bronze, and no bearing assemblies or thrust washers. On newer models, the bushing is made of steel, and a thrust washer is incorporated at assembly between the bushing and the counterweight bracket. The 2B20 piston is shorter than the 2D30, and this feature eliminates the need for a front cone spacer.

(*b*) BLADE ASSEMBLY. (See figure 7.)—The "B" shank blade is quite similar to the "D" shank except that it does not use a chafing ring, and the bushing has no flange. The large end of the bushing, which incorporates two rectangular slots 180 degrees apart that match the body portion of the blade index keys, is installed flush with the blade butt. The bushing is secured in place when the index keys are attached to the blade by screws.

(2) SHAFT BREATHING TYPE. (See figure 8.)—The parts used in the 2B20 to adapt the propeller for a shaft breathing installation are the same with slight variations in size as those needed in the 2D30. These parts consist of the oil supply pipe assembly, and the packing nut and packing which form the oil seal between the pipe and the piston at the piston gasket nut. The front cone packing washer is not used on shaft breathing installations.

c. MODEL 12D40. (See figure 9.)—The 12D40 model is basically a larger version of the 2D30 propeller previously described in paragraph 2.a. of this section. The maximum total blade angle range may be either 11 or 16 degrees in a 12D40 model. As indicated in the model designation, this type propeller is the same as the 2D30 except that it is designed to fit an

Nomenclature for Figure 8

1 REAR CONE
2 BARREL ASSEMBLY
3 SPIDER
4 GREASE FITTING
5 SHIM PLATE DOWEL
6 SPIDER (PHENOLIC) RING
7 GREASE RETAINER ASSEMBLY
8 SPIDER SHIM
9 SHIM PLATE
10 COUNTERWEIGHT BRACKET ASSEMBLY
11 COUNTERWEIGHT BRACKET
12 COUNTERWEIGHT DOWEL
13 COUNTERWEIGHT
14 COUNTERWEIGHT SCREW LOCK WASHER
15 COUNTERWEIGHT SCREW
16 WELCH PLUG
17 BARREL SUPPORT ASSEMBLY
18 SCREW
19 WASHER
20 BALANCING (LEAD) WASHER
21 NUT
22 BARREL (PHENOLIC) SUPPORT
23 BARREL BOLT
24 BARREL BOLT NUT
25 COTTER PIN
26 CYLINDER ASSEMBLY
27 CYLINDER (STEEL) LINER
28 CYLINDER (PHENOLIC) LINER
29 COUNTERWEIGHT BEARING SHAFT BUSHING
30 COUNTERWEIGHT BEARING SHAFT
31 COTTER PIN
32 PISTON
33 OIL SUPPLY PIPE ASSEMBLY
34 PISTON LOCK RING
35 SNAP RING
36 FRONT CONE
37 COTTER PIN
38 PISTON (INBOARD) GASKET
39 PISTON (OUTBOARD) GASKET
40 PISTON GASKET NUT
41 OIL SUPPLY PIPE PACKING WASHER
42 OIL SUPPLY PIPE PACKING NUT
43 COUNTERWEIGHT BEARING (INNER) RACE
44 COUNTERWEIGHT BEARING RETAINER ASSEMBLY
45 COUNTERWEIGHT BEARING (OUTER) RACE
46 COUNTERWEIGHT ADJUSTING SCREW ASSEMBLY
47 COUNTERWEIGHT ADJUSTING SCREW NUT
48 COUNTERWEIGHT CAP
49 CLEVIS PIN
50 COTTER PIN
51 CYLINDER HEAD GASKET
52 CYLINDER HEAD
53 CYLINDER HEAD LOCK RING

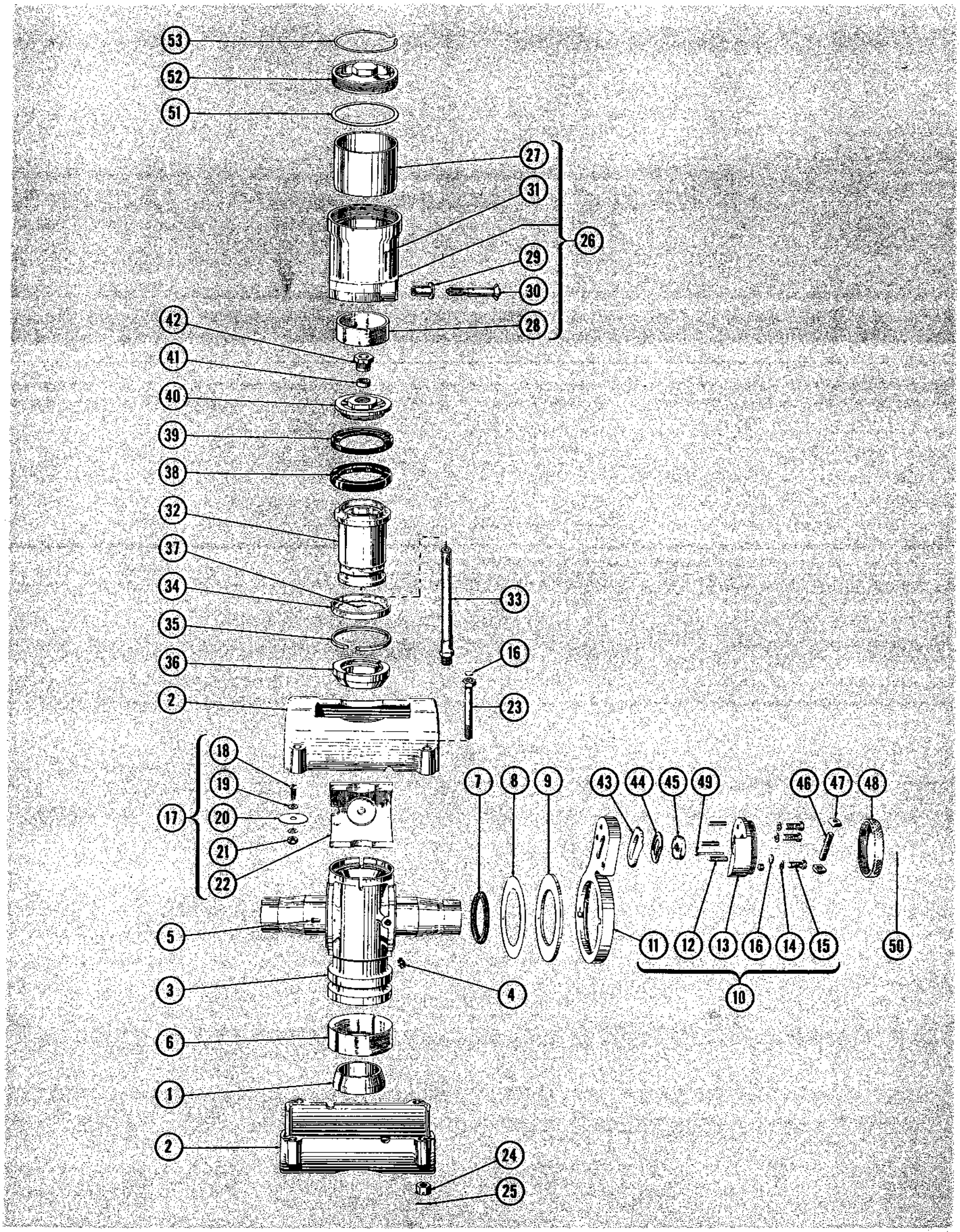


Figure 8 — Shaft Breathing Type 2B20 Model

SAE No. 40 propeller shaft. To date, the 12D40 has been used only on crankcase breathing installations.

d. MODEL 2E40.—The model 2E40 is also very similar to the 2D30 model; however, it incorporates "E" shank blades, and is designed for an SAE No. 40 propeller shaft. The maximum total blade angle range may be either 10 or 20 degrees. The major difference between a 2E40 and a 2D30 is that the former may incorporate a spring return assembly.

(1) PROPELLERS WITHOUT SPRING RETURN ASSEMBLY. (See figure 10.)

(*a*) HUB ASSEMBLY.

1. HUB GROUP.—The difference between the 2E40 hub group and that group in the 2D30 is that the 2E40 does not use a front cone packing washer or piston lock ring. The front cone packing washer is not needed since the piston is made oiltight at the inboard end by a packing and nut which fit around the oil supply pipe as explained in paragraph 2.d.(1)(a)*3.* of this section. The piston is locked by the spring puller bolt and vernier lock plate arrangement described in this same paragraph. The propeller can be adapted for a shaft breathing installation by the use of an oil supply pipe, or a crankcase breathing installation by the use of a shaft oil plug. The oil supply pipe is a short tube threaded on one end to fit into the propeller shaft. This arrangement permits oil to flow through the pipe and into the propeller piston, but at the same time crankcase breather gases are vented to atmosphere through the holes in the piston wall. On crankcase breathing installations, an oil plug is installed in the propeller shaft. This plug incorporates chevron packings which establish the oil seal between the plug and propeller shaft. It is secured by four screws inserted through locking holes in the shaft, and the short oil supply pipe of the plug carries the oil into the propeller piston. With either an oil supply pipe or plug, an oil seal is made at the piston by the oil supply pipe packing and nut previously described. Barrel supports for the model 2E40 propeller do not incorporate the vertical balancing washers used in later 2D30 models.

2. BRACKET & COUNTERWEIGHT GROUP.—Except for the differences in size and the fact that the counterweight screws are secured by lock washers rather than safety wire, the parts in the bracket & counterweight group are the same in the 2E40 as in the 2D30.

3. CYLINDER GROUP.—The piston in the model 2E40 can be used both on shaft and crankcase breathing engines. The inboard end just beyond the breather holes incorporates a false bottom. This bottom has an opening in the center which is flanged and internally threaded to accommodate the piston oil seal

Nomenclature for Figure 9

1 REAR CONE
2 BARREL ASSEMBLY
3 SPIDER
4 GREASE FITTING
5 SHIM PLATE DOWEL
6 SPIDER (PHENOLIC) RING
7 GREASE RETAINER ASSEMBLY
8 SPIDER SHIM
9 SHIM PLATE
10 BLADE BUSHING INDEX PIN
11 COUNTERWEIGHT BRACKET ASSEMBLY
12 COUNTERWEIGHT BRACKET
13 COUNTERWEIGHT (SMALL) DOWEL
14 COUNTERWEIGHT (LARGE) DOWEL
15 COUNTERWEIGHT
16 COUNTERWEIGHT (SMALL) SCREW
17 COUNTERWEIGHT (LARGE) SCREW
18 WELCH PLUG
19 BARREL SUPPORT ASSEMBLY
20 SCREW
21 WASHER
22 BALANCING (LEAD) WASHER
23 NUT
24 BARREL (PHENOLIC) SUPPORT
25 BARREL BOLT
26 WASHER
27 BARREL BOLT NUT
28 COTTER PIN
29 CYLINDER ASSEMBLY
30 CYLINDER (STEEL) LINER
31 CYLINDER (PHENOLIC) LINER
32 COUNTERWEIGHT BEARING SHAFT BUSHING
33 COUNTERWEIGHT BEARING SHAFT
34 COTTER PIN
35 PISTON
36 PISTON LOCK RING
37 SNAP RING
38 FRONT CONE SPACER
39 FRONT CONE PACKING WASHER
40 FRONT CONE
41 COTTER PIN
42 PISTON (INBOARD) GASKET
43 PISTON (OUTBOARD) GASKET
44 PISTON GASKET NUT
45 COTTER PIN
46 COUNTERWEIGHT THRUST BEARING ASSY.
47 THRUST WASHER
48 COUNTERWEIGHT BEARING (INNER) RACE
49 COUNTERWEIGHT BEARING RETAINER ASSEMBLY
50 COUNTERWEIGHT BEARING (OUTER) RACE
51 COUNTERWEIGHT BEARING RETAINER SPACER
52 COUNTERWEIGHT ADJUSTING SCREW ASSEMBLY
53 COUNTERWEIGHT ADJUSTING SCREW NUT
54 COUNTERWEIGHT CAP
55 CLEVIS PIN
56 CYLINDER HEAD GASKET
57 CYLINDER HEAD
58 CYLINDER HEAD LOCK RING
59 WELCH PLUG

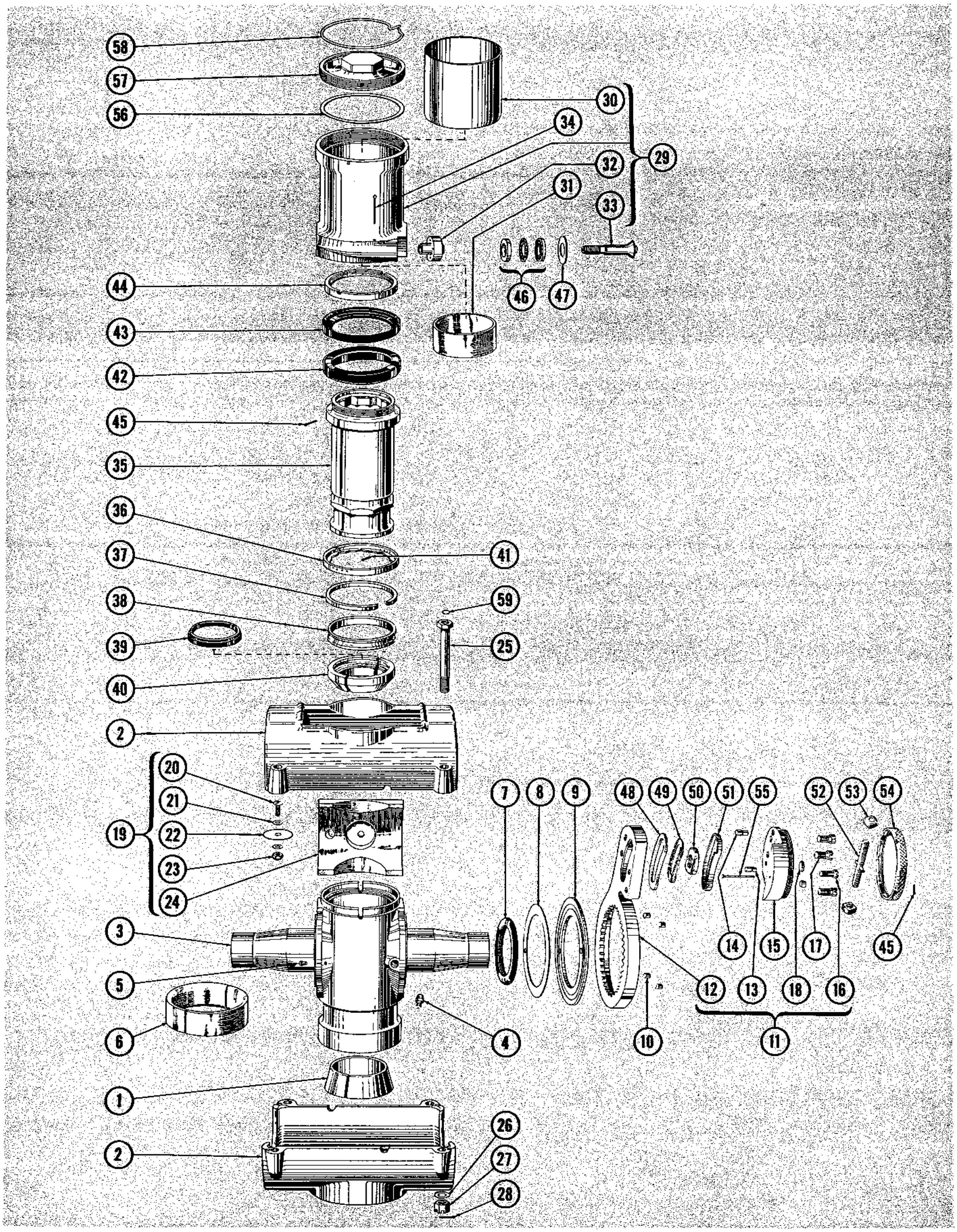


Figure 9 — Crankcase Breathing Type 12D40 Model

and nut. This arrangement establishes the oil seal between the oil supply pipe and the piston, and yet permits breather gases to escape to atmosphere through the holes in the piston wall on shaft breathing installations. The outboard end of the piston incorporates a shoulder to support the piston gaskets, and is threaded to fit the cup shaped piston gasket nut. The center portion of this nut is splined to match the splines on the spring puller bolt. At assembly, the spring puller bolt and spring are installed through the piston gasket nut, and the spring is retained by a circular washer that is attached to the bolt by a pin. The cylinder head used in a model 2E40 is also cup shaped, with a splined hole through the center portion to accommodate the vernier lock plate. This lock plate is a circular washer splined on both the inner and outer periphery. The outside splines match those in the cylinder head, and the splines on the inside of the lock plate match those on the spring puller bolt. In this way, the entire propeller is locked on the propeller shaft since the piston gasket nut is fixed with respect to the spring puller bolt, by virtue of the splines; the spring puller bolt is fixed with respect to the cylinder head, when the vernier lock plate is installed; and the cylinder head in turn is fixed to the cylinder by a lock ring. A copper asbestos gasket is used between the cylinder head and the cylinder. A small snap ring is installed in a groove on the outboard end of the vernier lock plate to facilitate its removal. The assembly is completed by a clamp nut gasket, clamp nut, and lock ring which are fitted into the cylinder head above the vernier lock plate. The clamp nut threads onto the end of the spring puller bolt.

(*b*) BLADE ASSEMBLY. (See figure 11.)—Except for differences in the size of various parts, the "E" shank blade assembly is the same as the "D" shank previously described.

(2) PROPELLERS WITH SPRING RETURN ASSEMBLY. (See figure 12.)—A spring return assembly is incorporated in 2E40 models which have a maximum blade angle range of 20 degrees. This assembly provides the additional force toward high pitch made necessary by the greater angular travel of the counterweights and the slope of the counterweight cam tracks. The spring return assembly consists of two coaxial springs, wound in opposite directions, which are installed inboard of the piston gasket nut and around the spring puller bolt. A steel disc called the spring puller plate fits over the bottom of the spring puller bolt and acts as a base for the springs. A nut is attached to the bottom threaded portion of the spring puller bolt to hold the spring puller plate, and this nut is safetied by a cotter pin. A hollow cylinder which locates the inner spring is made integral with the spring puller plate, and small raised

Nomenclature for Figure 10

1 REAR CONE
2 BARREL ASSEMBLY
3 SPIDER
4 GREASE FITTING
5 SHIM PLATE DOWEL
6 SPIDER (PHENOLIC) RING
7 GREASE RETAINER ASSEMBLY
8 SPIDER SHIM
9 SHIM PLATE
10 BLADE BUSHING INDEX PIN
11 COUNTERWEIGHT BRACKET ASSEMBLY
12 COUNTERWEIGHT BRACKET
13 COUNTERWEIGHT (LARGE) DOWEL
14 COUNTERWEIGHT (SMALL) DOWEL
15 COUNTERWEIGHT
16 CWT. SCREW LOCK (SMALL) WASHER
17 CWT. SCREW LOCK (LARGE) WASHER
18 COUNTERWEIGHT (SMALL) SCREW
19 COUNTERWEIGHT (LARGE) SCREW
20 WELCH PLUG
21 BARREL (PHENOLIC) SUPPORT
22 BARREL BOLT
23 WASHER
24 BARREL BOLT NUT
25 COTTER PIN
26 CYLINDER ASSEMBLY
27 CYLINDER (STEEL) LINER
28 CYLINDER (PHENOLIC) LINER
29 COUNTERWEIGHT BEARING SHAFT BUSHING
30 COUNTERWEIGHT BEARING SHAFT
31 COTTER PIN
32 PISTON
33 PISTON OIL SEAL
34 PISTON OIL SEAL NUT
35 COTTER PIN
36 SNAP RING
37 FRONT CONE SPACER
38 FRONT CONE
39 PISTON (INBOARD) GASKET
40 PISTON (OUTBOARD) GASKET
41 SPRING PULLER BOLT ASSEMBLY
42 PULLER BOLT SPRING
43 PISTON GASKET NUT
44 COUNTERWEIGHT THRUST BEARING ASSY.
45 THRUST WASHER
46 COUNTERWEIGHT BEARING (INNER) RACE
47 COUNTERWEIGHT BEARING RETAINER ASSY.
48 COUNTERWEIGHT BEARING (OUTER) RACE
49 COUNTERWEIGHT BEARING RETAINER SPACER
50 COUNTERWEIGHT ADJUSTING SCREW ASSY.
51 COUNTERWEIGHT ADJUSTING SCREW NUT
52 COUNTERWEIGHT CAP
53 CLEVIS PIN
54 CYLINDER HEAD GASKET
55 CYLINDER HEAD
56 CYLINDER HEAD LOCK RING
57 VERNIER LOCK PLATE
58 VERNIER LOCK PLATE STOP RING
59 CYLINDER HEAD CLAMP NUT GASKET
60 CYLINDER HEAD CLAMP NUT
61 CYLINDER HEAD CLAMP NUT LOCK RING
62 WELCH PLUG

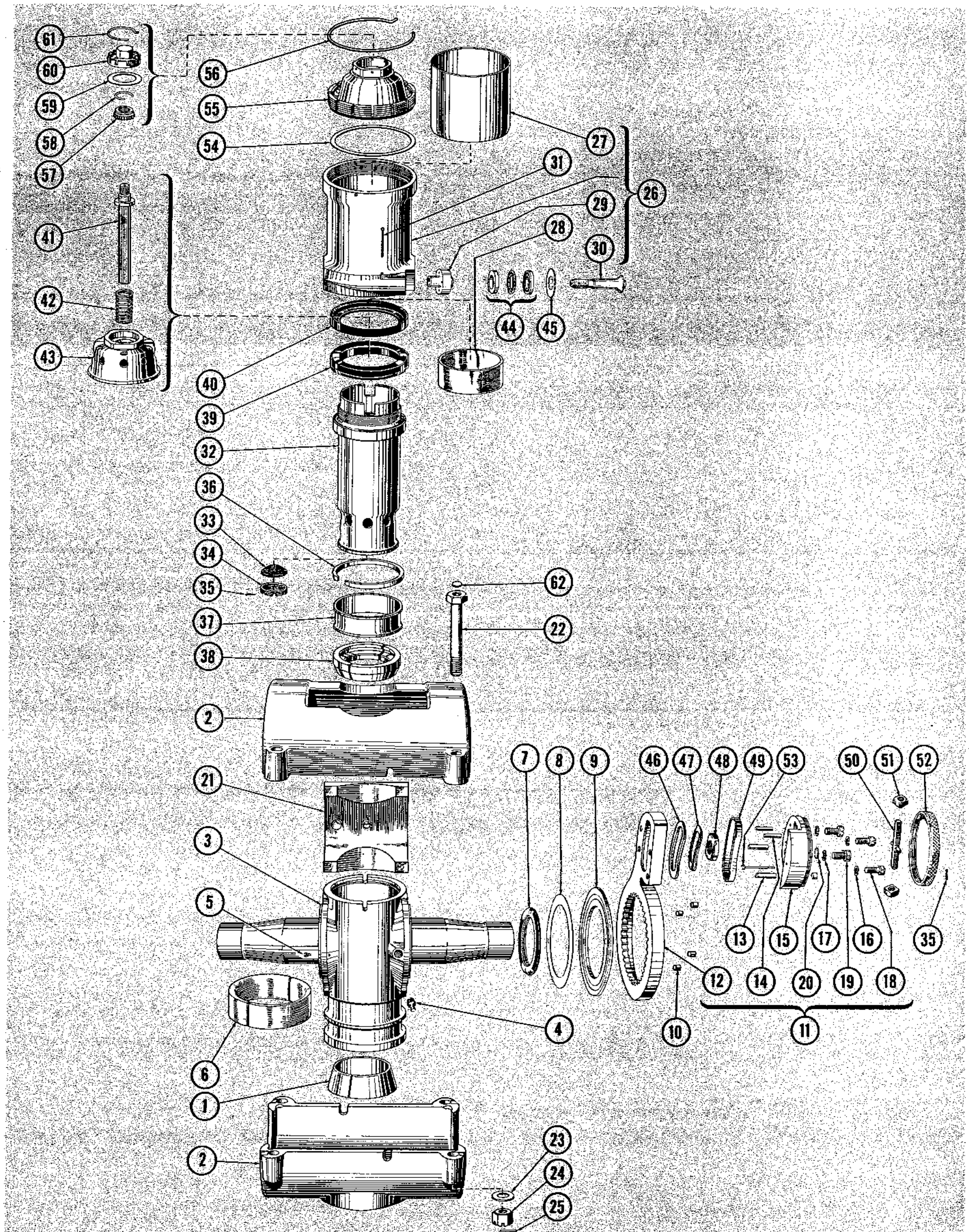


Figure 10 — Model 2E40 Without Spring Return Assembly

"V" sections in the bottom of the plate serve to separate the two springs. A small spring is included on the spring puller bolt to fit between the bolt washer and the piston gasket nut. This spring positions the bolt so that the vernier lock plate can be easily installed at installation of the spring return unit. At installation, the spring return assembly fits inside the piston with the spring puller plate just above the shelf near the inboard end of the piston.

e. MODEL 3D40.—The 3D40 model is the 3-bladed version of the model 2D30 propeller previously described in paragraph 2.a. of this section. It incorporates three "D" shank blades, is designed to fit an SAE No. 40 propeller shaft, and the maximum total blade angle range is 10, 15 or 20 degrees.

(1) PROPELLERS WITHOUT SPRING RETURN ASSEMBLY. (See figure 13.)

(*a*) HUB ASSEMBLY.

1. HUB GROUP.—The barrel supports in most 3D40 models incorporate a cylindrical key which is held in place by a rivet. At assembly, this key fits into a matching groove on the spider barrel support seat, and serves to locate the support with respect to the spider. Some earlier models did not incorporate barrel supports but instead had a phenolic chafing ring which was glued to the steel shim plate. This phenolic ring fitted snugly inside the barrel and took the place of the barrel supports now used. Only the early models of the 3D40 used a phenolic spider ring, piston lock ring, and front cone packing washer.

2. BRACKET & COUNTERWEIGHT GROUP.—The parts in this group are the same as the 2D30 except that the counterweight screws are secured by lock washers instead of safety wire. Besides this, some earlier models of the 3D40 did not incorporate counterweight bearing retainer spacers.

3. CYLINDER GROUP.—Parts in a 3D40 cylinder group are identical in form with those in the model 2E40 with the exception that provision is made for three bearing shafts rather than two; however, some earlier 3D40 models did not have thrust bearing assemblies or thrust washers.

(*b*) BLADE ASSEMBLY. (See figure 4.)—The model 3D40 propeller uses a regular "D" shank blade assembly which has previously been described.

(2) PROPELLERS WITH SPRING RETURN ASSEMBLY. (See figure 14.)—When the model 3D40 propeller has a blade angle range of 20 degrees, a spring return assembly is incorporated. The reason for this assembly and the parts which make it up are described in paragraph 2.d.(2) of this section.

f. MODEL 3E50.—The 3E50 model is the largest in the counterweight group, and it has a maximum total blade angle range of 10 or 20 degrees. It incorporates three "E" shank blades, and fits on an SAE No. 50 propeller shaft.

(1) PROPELLERS WITHOUT SPRING RETURN ASSEMBLY.

(*a*) HUB ASSEMBLY.

1. HUB GROUP.—With the exception of differences in number and size, the parts in the 3E50 model hub group are identical with those used in the 2E40 model previously described in paragraph 2.d.(1)(a)*1.* of this section.

2. BRACKET & COUNTERWEIGHT GROUP.—The parts used in a 3E50 model bracket & counterweight group are the same as those used in the 2E40 except that there are three counterweight bearing shafts and related assemblies instead of two.

3. CYLINDER GROUP.—Except for the fact that the piston is larger to fit on an SAE No. 50 propeller shaft, and that the cylinder head and piston gasket nut are flat rather than cup shaped, the 3E50 cylinder group is very similar to the 2E40.

(*b*) BLADE ASSEMBLY. (See figure 11.)—The 3E50 model incorporates an "E" shank blade which is identical, except for changes in size of the parts, to the "D" shank.

(2) PROPELLERS WITH SPRING RETURN ASSEMBLY. (See figure 15.)—When the model 3E50 propeller has a blade angle range of 20 degrees, a spring return assembly is incorporated. The reason for this assembly and the parts which make it up are described in paragraph 2.d.(2) of this section.

Nomenclature for Figure 11

1 BLADE AND THRUST WASHERS
2 BLADE BALANCING PLUG ASSEMBLY
3 WASHER
4 BLADE BALANCING (THIN) WASHER
5 LOCK WASHER
6 NUT
7 BUSHING
8 BLADE BUSHING DRIVE PIN
9 BLADE BUSHING SCREW
10 BLADE CHAFING RING
11 BLADE THRUST BEARING RETAINER ASSEMBLY
12 THRUST BEARING (LONG) ROLLER
13 THRUST BEARING (SHORT) ROLLER

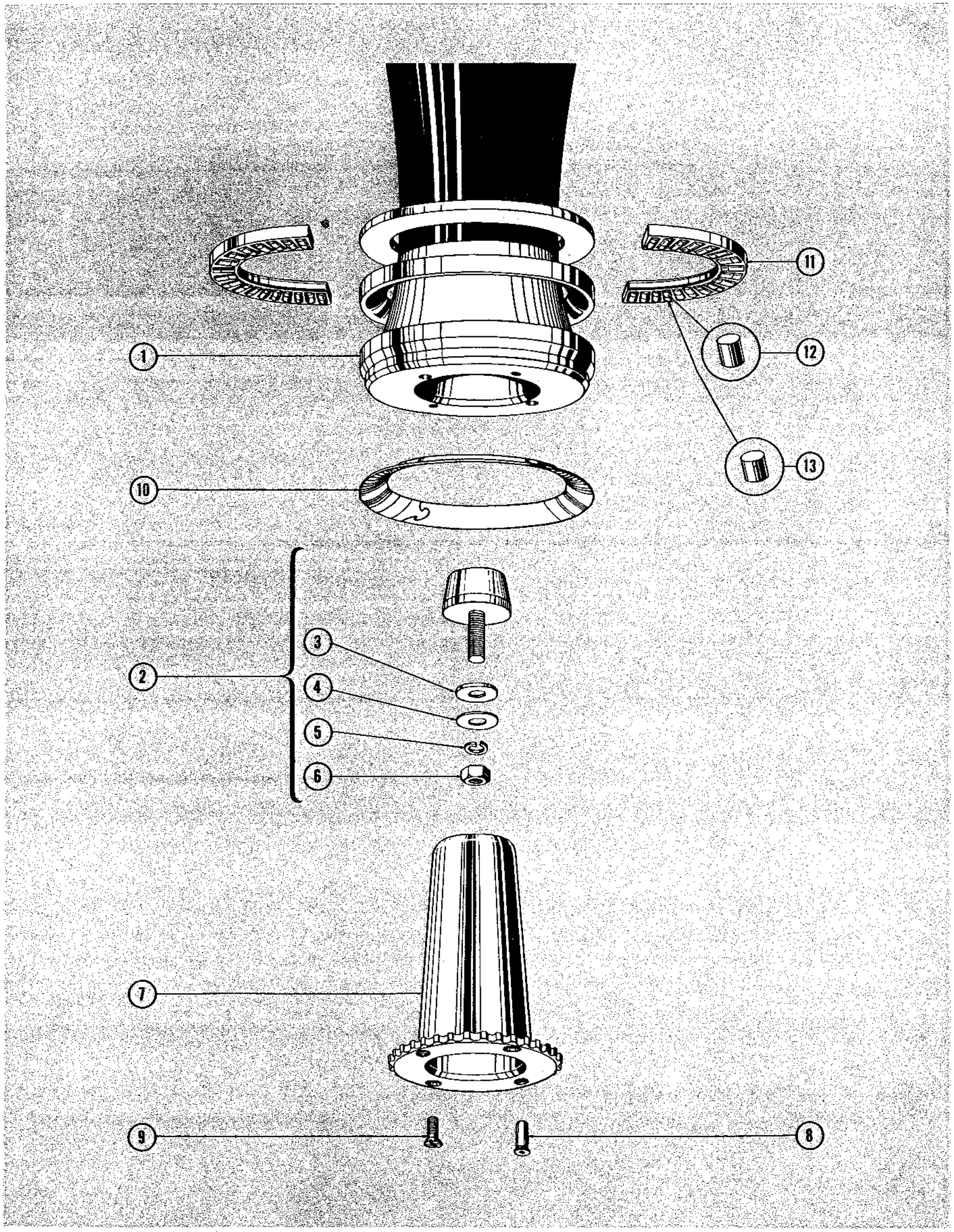


Figure 11 — Counterweight Type "E" Shank Blade Assembly

Nomenclature for Figure 12

1 REAR CONE
2 BARREL ASSEMBLY
3 SPIDER
4 GREASE FITTING
5 SHIM PLATE DOWEL
6 SPIDER (PHENOLIC) RING
7 GREASE RETAINER ASSEMBLY
8 SPIDER SHIM
9 SHIM PLATE
10 BLADE BUSHING INDEX PIN
11 COUNTERWEIGHT BRACKET ASSEMBLY
12 COUNTERWEIGHT BRACKET
13 COUNTERWEIGHT (LARGE) DOWEL
14 COUNTERWEIGHT (SMALL) DOWEL
15 COUNTERWEIGHT
16 COUNTERWEIGHT SCREW LOCK (SMALL) WASHER
17 COUNTERWEIGHT SCREW LOCK (LARGE) WASHER
18 COUNTERWEIGHT (SMALL) SCREW
19 COUNTERWEIGHT (LARGE) SCREW
20 WELCH PLUG
21 BARREL (PHENOLIC) SUPPORT
22 BARREL BOLT
23 WASHER
24 BARREL BOLT NUT
25 COTTER PIN
26 CYLINDER ASSEMBLY
27 CYLINDER (STEEL) LINER
28 CYLINDER (PHENOLIC) LINER
29 COUNTERWEIGHT BEARING SHAFT BUSHING
30 COUNTERWEIGHT BEARING SHAFT
31 COTTER PIN
32 PISTON
33 PISTON OIL SEAL
34 PISTON OIL SEAL NUT
35 COTTER PIN
36 SNAP RING
37 FRONT CONE SPACER
38 FRONT CONE
39 PISTON (INBOARD) GASKET
40 PISTON (OUTBOARD) GASKET
41 SPRING PULLER BOLT ASSEMBLY
42 PULLER BOLT SPRING
43 PISTON GASKET NUT
44 INNER SPRING
45 OUTER SPRING
46 SPRING PULLER PLATE
47 SPRING PULLER BOLT NUT
48 COTTER PIN
49 COUNTERWEIGHT THRUST BEARING ASSY.
50 THRUST WASHER
51 COUNTERWEIGHT BEARING (INNER) RACE
52 COUNTERWEIGHT BEARING RETAINER ASSY.
53 COUNTERWEIGHT BEARING (OUTER) RACE
54 COUNTERWEIGHT BEARING RETAINER SPACER
55 COUNTERWEIGHT ADJUSTING SCREW ASSY.
56 COUNTERWEIGHT ADJUSTING SCREW NUT
57 COUNTERWEIGHT CAP
58 CLEVIS PIN
59 CYLINDER HEAD GASKET
60 CYLINDER HEAD
61 CYLINDER HEAD LOCK RING
62 VERNIER LOCK PLATE
63 VERNIER LOCK PLATE STOP RING
64 CYLINDER HEAD CLAMP NUT GASKET
65 CYLINDER HEAD CLAMP NUT
66 CYLINDER HEAD CLAMP NUT LOCK RING

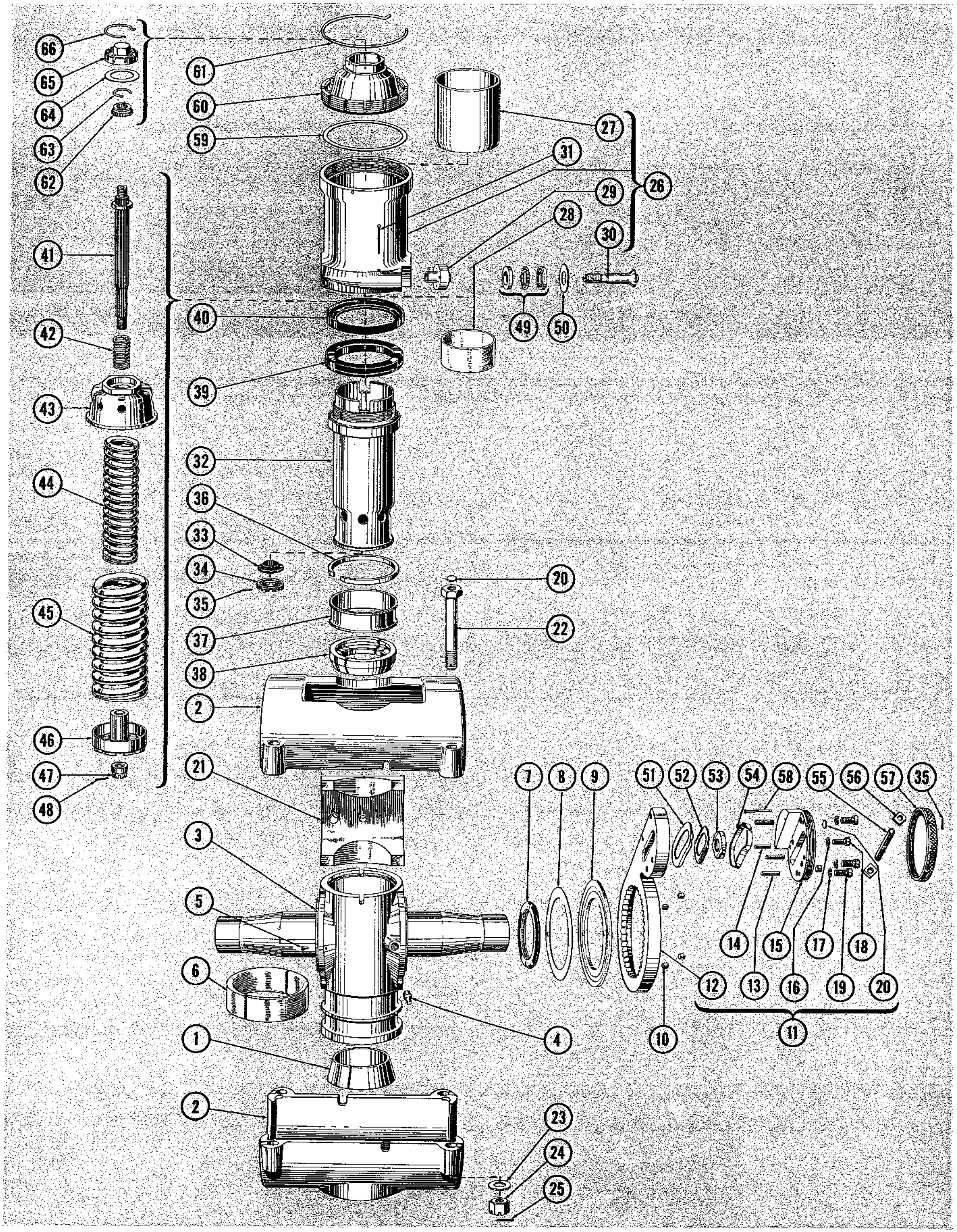


Figure 12 — Model 2E40 With Spring Return Assembly

Nomenclature for Figure 13

1 REAR CONE
2 BARREL ASSEMBLY
3 SPIDER
4 GREASE FITTING
5 SHIM PLATE DOWEL
6 GREASE RETAINER ASSEMBLY
7 SPIDER SHIM
8 SHIM PLATE
9 BLADE BUSHING INDEX PIN
10 COUNTERWEIGHT BRACKET ASSEMBLY
11 COUNTERWEIGHT BRACKET
12 COUNTERWEIGHT (SMALL) DOWEL
13 COUNTERWEIGHT (LARGE) DOWEL
14 COUNTERWEIGHT
15 COUNTERWEIGHT (SMALL) SCREW
16 COUNTERWEIGHT (LARGE) SCREW
17 WELCH PLUG
18 BARREL SUPPORT ASSEMBLY
19 BARREL BOLT
20 WASHER
21 BARREL BOLT NUT
22 COTTER PIN
23 CYLINDER ASSEMBLY
24 CYLINDER (STEEL) LINER
25 CYLINDER (PHENOLIC) LINER
26 COUNTERWEIGHT BEARING SHAFT BUSHING
27 COUNTERWEIGHT BEARING SHAFT
28 COTTER PIN
29 PISTON
30 PISTON OIL SEAL
31 PISTON OIL SEAL NUT
32 COTTER PIN
33 SNAP RING
34 FRONT CONE SPACER
35 FRONT CONE
36 PISTON (INBOARD) GASKET
37 PISTON (OUTBOARD) GASKET
38 SPRING PULLER BOLT ASSEMBLY
39 PULLER BOLT SPRING
40 PISTON GASKET NUT
41 COUNTERWEIGHT THRUST BEARING ASSY.
42 THRUST WASHER
43 COUNTERWEIGHT BEARING (INNER) RACE
44 COUNTERWEIGHT BEARING RETAINER ASSY.
45 COUNTERWEIGHT BEARING (OUTER) RACE
46 COUNTERWEIGHT BEARING RETAINER SPACER
47 COUNTERWEIGHT ADJUSTING SCREW ASSY.
48 COUNTERWEIGHT ADJUSTING SCREW NUT
49 COUNTERWEIGHT CAP
50 CLEVIS PIN
51 CYLINDER HEAD GASKET
52 CYLINDER HEAD
53 CYLINDER HEAD LOCK RING
54 VERNIER LOCK PLATE
55 VERNIER LOCK PLATE STOP RING
56 CYLINDER HEAD CLAMP NUT GASKET
57 CYLINDER HEAD CLAMP NUT
58 CYLINDER HEAD CLAMP NUT LOCK RING
59 WELCH PLUG

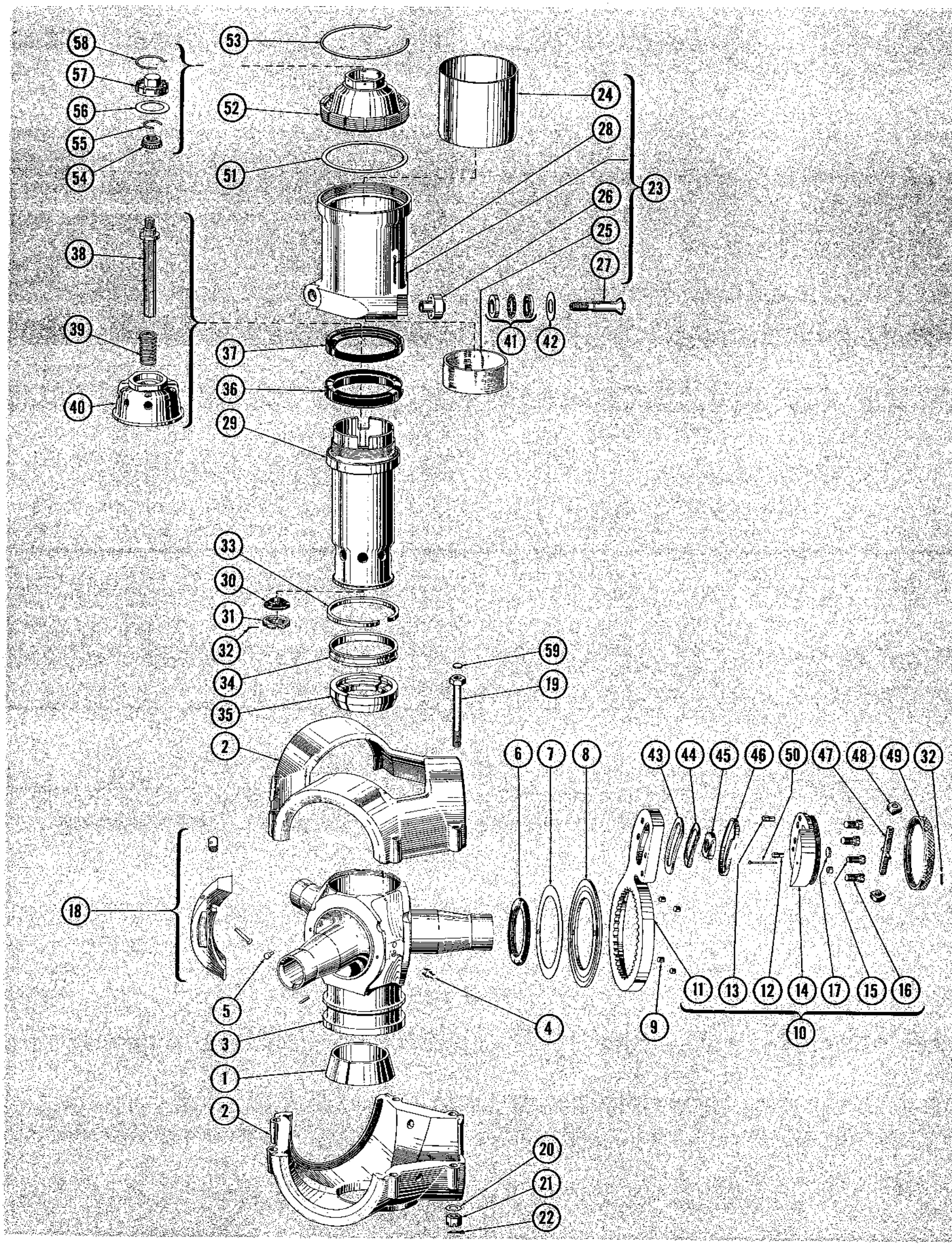


Figure 13 — Model 3D40 Without Spring Return Assembly

Nomenclature for Figure 14

1	REAR CONE	33	FRONT CONE SPACER
2	BARREL ASSEMBLY	34	FRONT CONE
3	SPIDER	35	PISTON (INBOARD) GASKET
4	GREASE FITTING	36	PISTON (OUTBOARD) GASKET
5	SHIM PLATE DOWEL	37	SPRING PULLER BOLT ASSEMBLY
6	GREASE RETAINER ASSEMBLY	38	PULLER BOLT SPRING
7	SPIDER SHIM	39	PISTON GASKET NUT
8	SHIM PLATE	40	INNER SPRING
9	BLADE BUSHING INDEX PIN	41	OUTER SPRING
10	COUNTERWEIGHT BRACKET ASSEMBLY	42	SPRING PULLER PLATE
11	COUNTERWEIGHT BRACKET	43	SPRING PULLER BOLT NUT
12	COUNTERWEIGHT DOWEL	44	COUNTERWEIGHT THRUST BEARING ASSY.
13	COUNTERWEIGHT	45	THRUST WASHER
14	COUNTERWEIGHT (SMALL) SCREW	46	COUNTERWEIGHT BEARING (INNER) RACE
15	COUNTERWEIGHT (LARGE) SCREW	47	COUNTERWEIGHT BEARING RETAINER ASSY.
16	WELCH PLUG	48	COUNTERWEIGHT BEARING (OUTER) RACE
17	BARREL SUPPORT ASSEMBLY	49	COUNTERWEIGHT BEARING RETAINER SPACER
18	BARREL BOLT	50	COUNTERWEIGHT ADJUSTING SCREW ASSY.
19	WASHER	51	COUNTERWEIGHT ADJUSTING SCREW NUT
20	BARREL BOLT NUT	52	COUNTERWEIGHT CAP
21	COTTER PIN	53	CLEVIS PIN
22	CYLINDER ASSEMBLY	54	CYLINDER HEAD GASKET
23	CYLINDER (STEEL) LINER	55	CYLINDER HEAD
24	CYLINDER (PHENOLIC) LINER	56	CYLINDER HEAD LOCK RING
25	COUNTERWEIGHT BEARING SHAFT BUSHING	57	VERNIER LOCK PLATE
26	COUNTERWEIGHT BEARING SHAFT	58	VERNIER LOCK PLATE STOP RING
27	COTTER PIN	59	CYLINDER HEAD CLAMP NUT GASKET
28	PISTON	60	CYLINDER HEAD CLAMP NUT
29	PISTON OIL SEAL	61	CYLINDER HEAD CLAMP NUT LOCK RING
30	PISTON OIL SEAL NUT	62	WELCH PLUG
31	COTTER PIN		
32	SNAP RING		

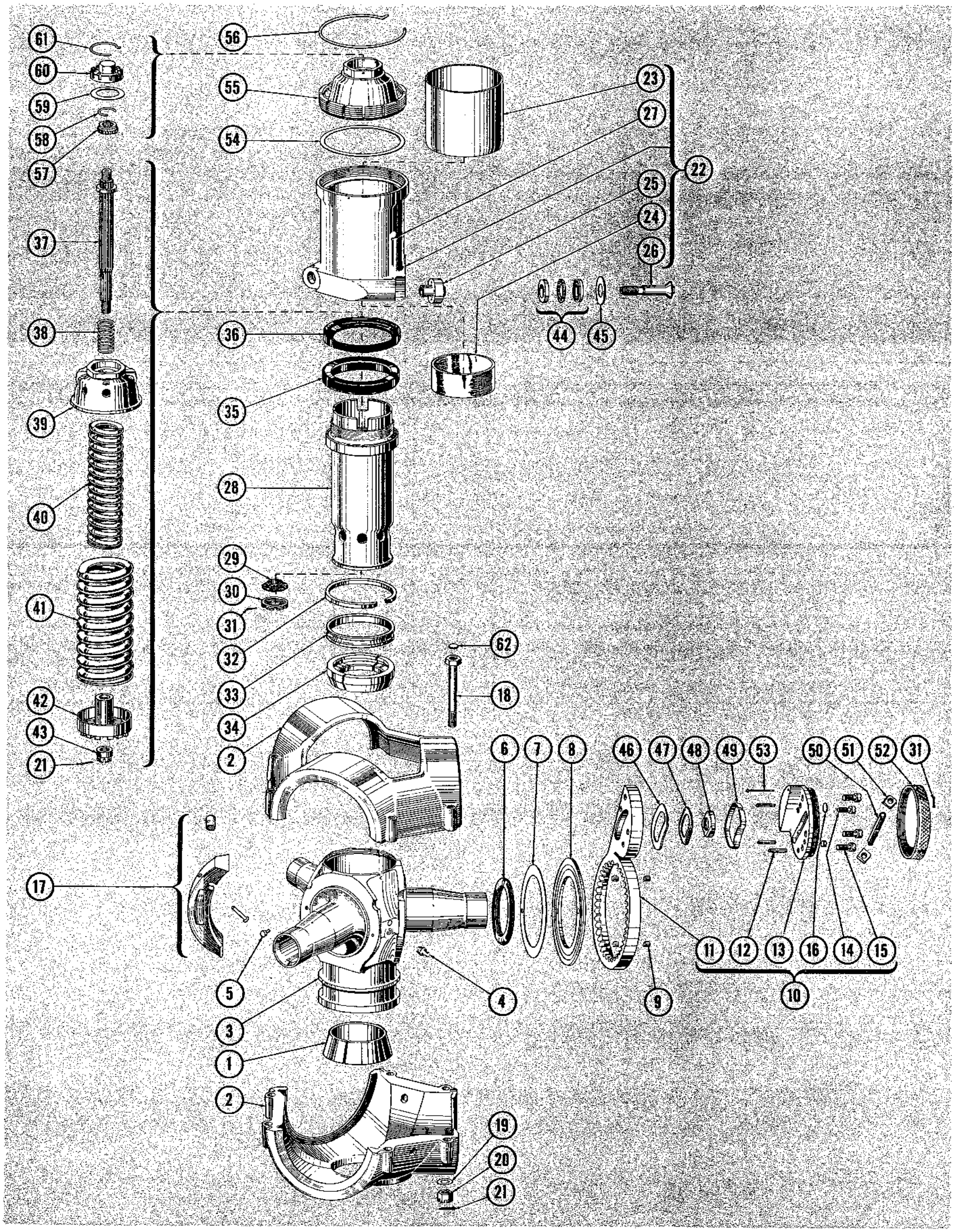


Figure 14 — Model 3D40 With Spring Return Assembly

Nomenclature for Figure 15

1 REAR CONE
2 BARREL ASSEMBLY
3 SPIDER
4 GREASE FITTING
5 SHIM PLATE DOWEL
6 GREASE RETAINER ASSEMBLY
7 SPIDER SHIM
8 SHIM PLATE
9 BLADE BUSHING INDEX PIN
10 COUNTERWEIGHT BRACKET ASSEMBLY
11 COUNTERWEIGHT BRACKET
12 COUNTERWEIGHT (LARGE) DOWEL
13 COUNTERWEIGHT (SMALL) DOWEL
14 COUNTERWEIGHT
15 COUNTERWEIGHT SCREW LOCK (SMALL) WASHER
16 COUNTERWEIGHT SCREW LOCK (LARGE) WASHER
17 COUNTERWEIGHT (SMALL) SCREW
18 COUNTERWEIGHT (LARGE) SCREW
19 WELCH PLUG
20 BARREL SUPPORT ASSEMBLY
21 BARREL BOLT
22 WASHER
23 BARREL BOLT NUT
24 COTTER PIN
25 CYLINDER ASSEMBLY
26 CYLINDER (STEEL) LINER
27 CYLINDER (PHENOLIC) LINER
28 COUNTERWEIGHT BEARING SHAFT BUSHING
29 COUNTERWEIGHT BEARING SHAFT
30 COUNTERWEIGHT BEARING SHAFT CLEVIS PIN
31 COTTER PIN
32 PISTON
33 PISTON OIL SEAL
34 PISTON OIL SEAL NUT
35 SNAP RING
36 FRONT CONE
37 PISTON (INBOARD) GASKET
38 PISTON (OUTBOARD) GASKET
39 SPRING PULLER BOLT ASSEMBLY
40 PULLER BOLT SPRING
41 PISTON GASKET NUT
42 INNER SPRING
43 OUTER SPRING
44 SPRING PULLER PLATE
45 SPRING PULLER BOLT NUT
46 COTTER PIN
47 COUNTERWEIGHT THRUST BEARING ASSY.
48 THRUST WASHER
49 COUNTERWEIGHT BEARING (INNER) RACE
50 COUNTERWEIGHT BEARING RETAINER ASSY.
51 COUNTERWEIGHT BEARING (OUTER) RACE
52 COUNTERWEIGHT BEARING RETAINER SPACER
53 COUNTERWEIGHT ADJUSTING SCREW ASSY.
54 COUNTERWEIGHT ADJUSTING SCREW NUT
55 COUNTERWEIGHT CAP
56 CLEVIS PIN
57 CYLINDER HEAD GASKET
58 CYLINDER HEAD
59 CYLINDER HEAD LOCK RING
60 VERNIER LOCK PLATE
61 VERNIER LOCK PLATE STOP RING
62 CYLINDER HEAD CLAMP NUT GASKET
63 CYLINDER HEAD CLAMP NUT
64 CYLINDER HEAD CLAMP NUT LOCK RING

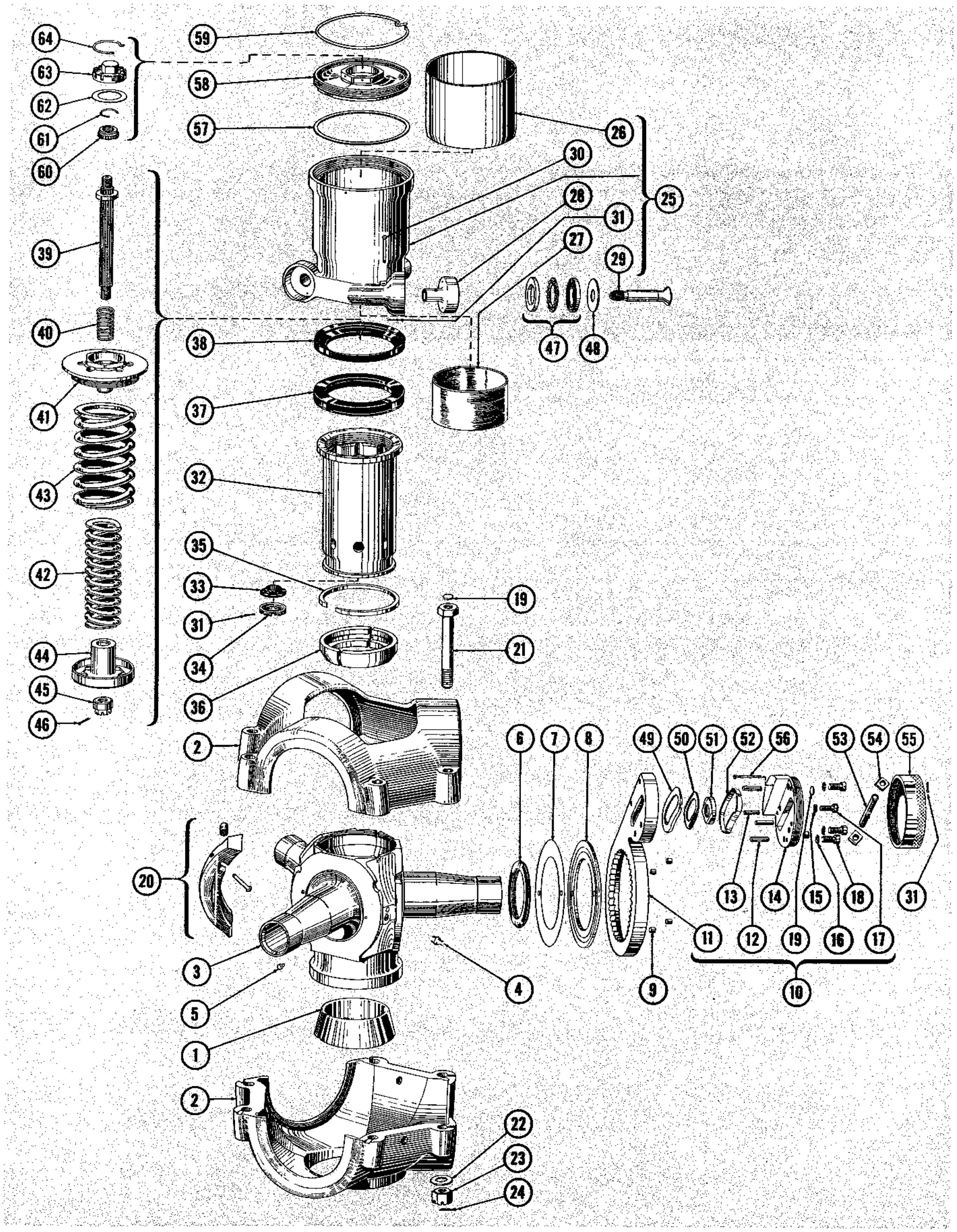


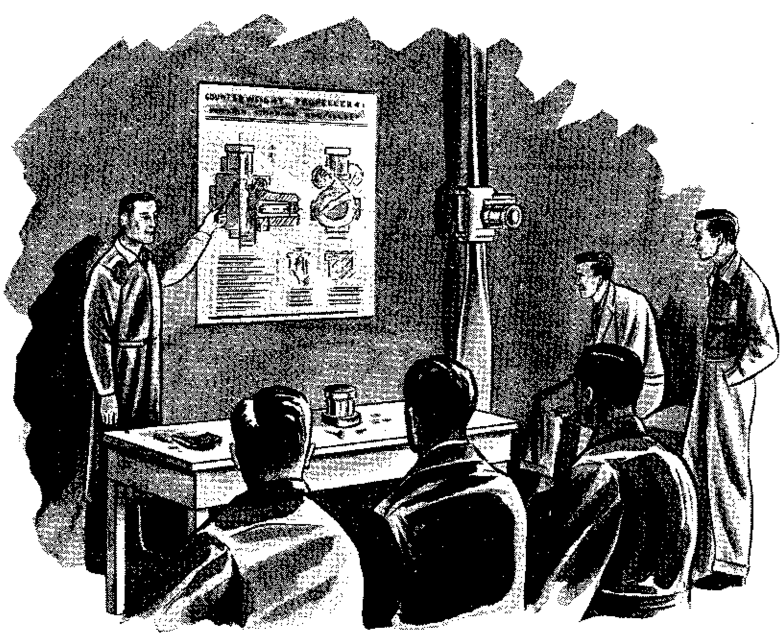
Figure 15 — Model 3E50 With Spring Return Assembly

g. MODEL VARIATION SUMMARY.—Listed in this model variation summary are the changes in parts and characteristics which distinguish one model Counterweight type propeller from another. Whenever possible, each model is compared with another to point out the similarity.

Propeller Model	Bracket Range (Degrees)	Cwt. Cap Weight (Lbs.)	Clevis Pin (Cwt. Cap)	Cwt. Thrust Bearing Assy.	Crankcase (C) or Shaft Breathing (S)	Oil Pipe or Shaft Plug	Front Cone Packing Washer	Crankcase (C) or Shaft Breathing (S) Piston	Spring Return Assy.	Barrel Support Balance Washers	Spider Ring	Remarks
2B20-209	8	0.38	AN392-47	no	S	pipe	no	S	no	yes	yes	
2B20-213	15	0.38	AN392-47	no	S	pipe	no	S	no	yes	yes	Same as -209 except has 15-degree range.
2B20-223	15	0.38	AN392-47	no	C	neither	yes	C	no	yes	yes	Same as -213 except is crankcase breather.
2B20-225	15	1.59	AN392-63	no	C	neither	yes	C	no	yes	yes	Same as -223 except has heavier counterweight caps and spider is one inch longer.
2B20-229	15	0.38	AN392-47	no	C	neither	yes	C	no	yes	yes	Same as -223 except spider is one inch longer.
2B20-241	15	0.70	AN392-51	no	C	neither	yes	C	no	yes	yes	Same as -229 except has heavier counterweight caps.
2B20-249	15	0.25	AN392-51	no	C	neither	yes	C	no	yes	yes	Same as -241 except has lighter counterweight caps.
2B20-251	15	0.38	AN392-47	no	S	pipe	no	S	no	yes	yes	Same as -213 except spider is one inch longer.
2B20-317	15	0.38	AN392-47	no	C	neither	yes	C	no	yes	yes	Same as -229 except cylinder has thrust washers and steel cylinder bushings.
2B20-329	15	0.70	AN392-51	no	C	neither	yes	C	no	yes	yes	Same as -317 except has heavier counterweight caps.
2B20-337	15	0.25	AN392-51	no	C	neither	yes	C	no	yes	yes	Same as -329 except has lighter counterweight caps.
2D30-29	10	0.23	AN392-45	no	C	neither	yes	C	no	no	yes	
2D30-207	10	0.23	AN392-45	yes	S	pipe	no	S	no	no	yes	Same as -29 except is shaft breather and has barrel supports and counterweight thrust bearings.
2D30-209	15	0.23	AN392-45	yes	C	neither	yes	C	no	no	yes	Same as -207 except has 15-degree range and is crankcase breather.
2D30-227	10	0.23	AN392-45	yes	C	neither	yes	C	no	yes	yes	Same as -209 except has 10-degree range and vertical balancing washers.
2D30-233	10	0.23	AN392-45	yes	S	pipe	no	S	no	yes	yes	Same as -227 except is shaft breather.
2D30-235	15	0.23	AN392-45	yes	C	neither	yes	C	no	yes	yes	Same as -209 except has vertical balancing washers, and slightly different counterweight bearing parts.

Propeller Model	Bracket Range (Degrees)	Cwt. Cap Weight (Lbs.)	Clevis Pin (Cwt. Cap)	Cwt. Thrust Bearing Assy.	Crankcase (C) or Shaft Breathing (S)	Oil Pipe or Shaft Plug	Front Cone Packing Washer	Crankcase (C) or Shaft Breathing (S) Piston	Spring Return Assy.	Barrel Support Balance Washers	Spider Ring	Remarks
2D30-237	15	0.63	AN392-45	yes	C	neither	yes	C	no	yes	yes	Same as -235 except has heavier counterweight caps.
2D30-243	15	0.23	AN392-45	yes	S	pipe	no	S	no	yes	yes	Same as -235 except is shaft breather.
2D30-247	15	1.40	AN392-51	yes	C	neither	yes	C	no	yes	yes	Same as -235 except has heavier counterweight caps.
2D30-249	15	0.63	AN392-45	yes	C	neither	yes	C	no	yes	yes	
2D30-259	10	0.63	AN392-23	yes	C	neither	yes	C	no	yes	yes	Same as -237 except has 10-degree range.
2D30-261	15	2.56	52458	yes	C	neither	yes	C	no	yes	yes	Same as -249 except has heavier counterweight caps.
12D40-201	16	0.63	AN392-45	yes	C	neither	yes	C	no	no	yes	
12D40-211	16	0.63	AN392-45	yes	C	neither	yes	C	no	yes	yes	Same as -201 except has vertical balancing washers and, slightly different counterweight bearing parts.
12D40-217	11	0.23	AN392-45	yes	C	neither	yes	C	no	yes	yes	Same as -211 except has 11-degree range and lighter counterweight caps.
2E40-201	10	1.40	AN392-51	yes	either	either	no	both	no	no	yes	
2E40-209	10	1.40	AN392-51	yes	either	either	no	both	no	no	yes	Same as -201 except for minor differences in counterweight bearing parts.
2E40-213	20	0.63	AN392-45	yes	either	either	no	both	yes	no	yes	Same as -209 except has 20-degree range, spring return assembly, and lighter counterweight caps.
3D40-57	10	0.23	AN392-45	no	C	neither	yes	C	no	no	yes	
3D40-209	15	0.63	AN392-45	yes	either	either	no	both	no	no	no	
3D40-213	20	0.23	AN392-45	yes	either	either	no	both	yes	no	no	Same as -209 except has 20-degree range, lighter counterweight caps, and spring return assembly.
3D40-225	10	0.23	AN392-45	yes	either	either	no	both	no	no	no	Same as -213 except has 10-degree range and no spring return assembly.
3D40-227	20	1.40	AN392-51	yes	either	either	no	both	yes	no	no	Same as -213 except has heavier counterweight caps.
3D40-231	15	0.63	AN392-45	yes	either	either	no	both	no	no	no	Same as -225 except has 15-degree range and heavier counterweight caps.
3D40-235	20	0.23	AN392-45	yes	either	either	no	both	yes	no	no	Same as -227 except has lighter counterweight caps.
3D40-267	20	1.40	AN392-51	yes	either	either	no	both	yes	no	no	
3D40-271	20	0.63	AN392-45	yes	either	either	no	both	yes	no	no	Same as -235 except has heavier counterweight caps.
3E50-61	10	1.40	AN392-51	no	C	neither	yes	C	no	no	yes	

Propeller Model	Bracket Range (Degrees)	Cwt. Cap Weight (Lbs.)	Clevis Pin (Cwt. Cap)	Cwt. Thrust Bearing Assy.	Crankcase (C) or Shaft Breathing (S)	Oil Pipe or Shaft Plug	Front Cone Packing Washer	Crankcase (C) or Shaft Breathing (S) Piston	Spring Return Assy.	Barrel Support Balance Washers	Spider Ring	Remarks
3E50-65	10	3.15	50193	no	S	pipe	no	S	no	no	yes	Same as -61 except is shaft breather, and has heavier counterweight caps.
3E50-201	20	4.85	52991	yes	either	either	no	both	yes	no	no	
3E50-203	20	3.15	50193	yes	either	either	no	both	yes	no	no	Same as -201 except has lighter counterweight caps.
3E50-219	20	3.15	50193	yes	S	pipe	no	both	yes	no	no	Same as -203 except has oil supply pipe.
3E50-253	20	3.15	AN392-65	yes	either	either	no	both	yes	no	no	
3E50-319	20	4.85	54263	yes	either	either	no	both	yes	no	no	Same as -203 except has heavier counterweight caps.
3E50-345	20	3.15	AN392-65	yes	either	either	no	both	yes	no	no	Same as -319 except has lighter counterweight caps.



SECTION III
INSTALLATION

1. GENERAL PREINSTALLATION CHECKS.

a. Before installing the propeller, all parts which are accessible without disassembly should be visually examined for damage and checked for proper fit. All corrosion and all raised edges of nicks, burrs, galling, and scoring on joining surfaces of attaching parts should be carefully stoned down and these parts thoroughly cleaned with non-leaded gasoline or carbon tetrachloride. Clean the splines and both cone seats of the spider and coat them with clean engine oil. Washing of propellers prior to installation in order to remove corrosion preventive compounds to Specification No. AN-VV-C-576a-1 is not necessary since these compounds have no ill effect on the engine oil or any other parts. Blades should be carefully checked for nicks, cuts, etc. before the propeller is installed. See section V for minor blade repair procedures.

CAUTION

Carefully remove all small metal particles after any stoning or dressing of propeller parts. If carbon tetrachloride is used for cleaning, make certain all traces are removed and the parts thoroughly dried. In order to protect any synthetic rubber seals and packings, aromatic fuels should not be used for cleaning propeller parts.

b. Inspect the propeller shaft, threads, and splines for corrosion, nicks, burrs, or similar damage. Carefully remove any such damage with a fine stone and polish with crocus cloth. Wash the inside and outside of the shaft with gasoline, allow it to dry thoroughly, and then apply a light coat of clean engine oil. The shaft threads should be coated with thread lubricant to Specification No. AN-C-53-1 or clean engine oil. Remove the screw plug (if installed) from the propeller shaft.

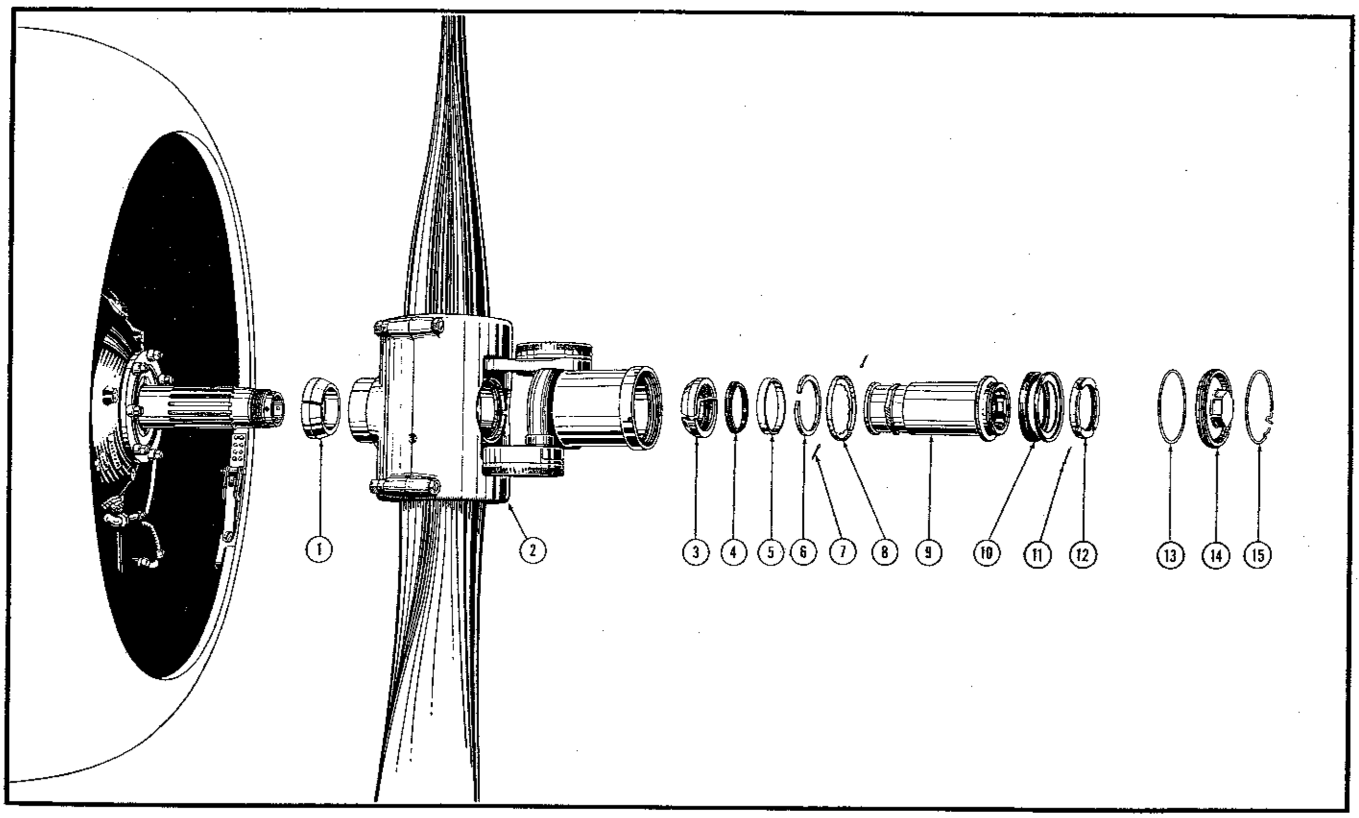


Figure 16 — Propeller Extended Off Propeller Shaft

1 REAR CONE
2 HUB & BLADES ASSEMBLY
3 FRONT CONE
4 FRONT CONE PACKING WASHER
5 FRONT CONE SPACER
6 HUB SNAP RING
7 COTTER PIN
8 PISTON LOCK RING
9 PISTON
10 PISTON GASKETS
11 COTTER PIN
12 PISTON GASKET NUT
13 CYLINDER HEAD GASKET
14 CYLINDER HEAD
15 CYLINDER HEAD LOCK RING

2. MODEL 2D30.

a. INSTALLATION PROCEDURE.—This installation procedure is written so that only the service tools described in paragraph 1. of section V and commonly used commercial tools are required. No other tools are needed to install the propeller.

(1) PROPELLERS FOR CRANKCASE BREATHING ENGINES.

(*a*) Install the rear cone spacer, if used, and the rear cone on the propeller shaft, and move them back against the engine thrust nut. Cover the shaft threads with a thread protector or wrap the threads with tape if a suitable protector is not available.

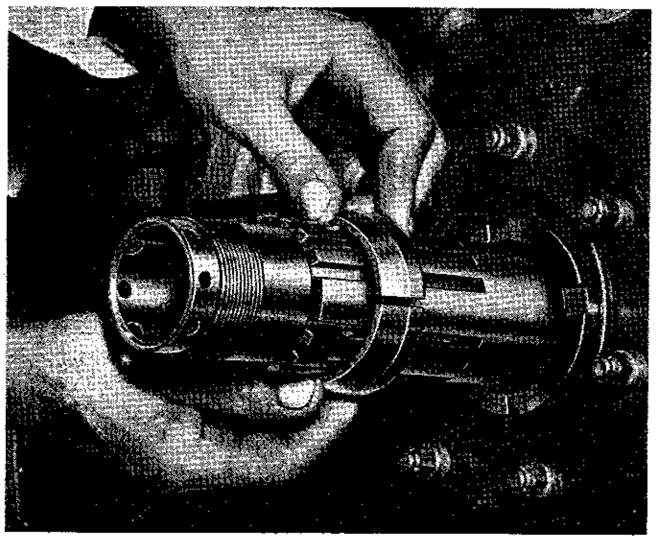


Figure 17 — Installing Rear Cone on Propeller Shaft

(*b*) Remove the cylinder head lock ring and the cylinder head if they are installed in the propeller. Attach a hoisting sling to the propeller blades and lift the assembly so the blank spline in the propeller spider is in line with the wide spline of the propeller shaft. Install the propeller on the shaft, using care not to damage the threads and the splines of the shaft or spider, and slide it back against the rear cone.

Note

On most new engines, oil and corrision preventives are flushed from the cylinders prior to installation of the engine on the aircraft. However, in case this has not been done and the engine is allowed to stand idle for an appreciable time after propeller installation and before engine run-up, the portion of the cylinders wiped clean of protective by rotating the propeller shaft during installation may corrode. In such cases, attach a single hoisting sling to the blade in line with the blank spline of the spider so that at installation the propeller will line up with the engine shaft wide spline (usually left in the top position).

(*c*) Using a blade turning device on each blade, turn the blades to a position near the low angle setting of the propeller. The blades should be at approximately the same angle in order to keep the cylinder from being cocked. Care should be used during this operation to move both blades at the same time and not to pull the propeller off the shaft. Remove the thread protector or tape from the shaft threads.

(*d*) Coat the shaft threads of the piston with thread lubricant conforming to Specification No. AN-C-53-1 or clean engine oil, and insert the piston through the cylinder. Place the piston lock ring over the inboard end of the piston with the end having the large inside diameter facing the cylinder. Install the

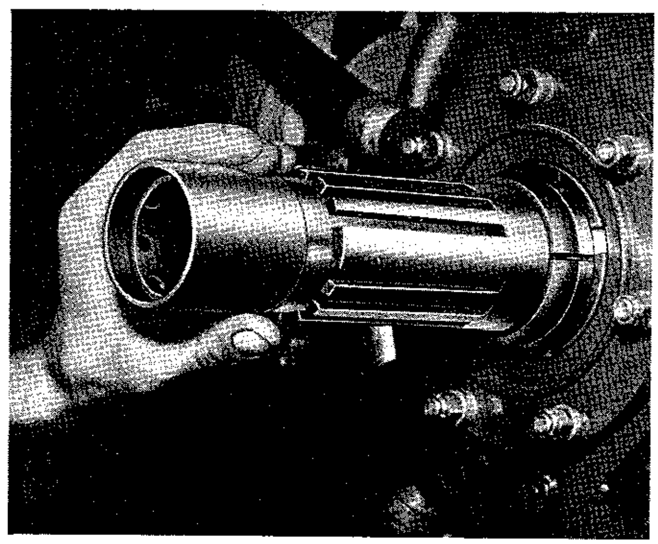


Figure 18 — Covering Shaft With Thread Protector

hub snap ring and the front cone spacer in that order over the end of the piston and push them out against the lock ring. Lightly coat the front cone packing

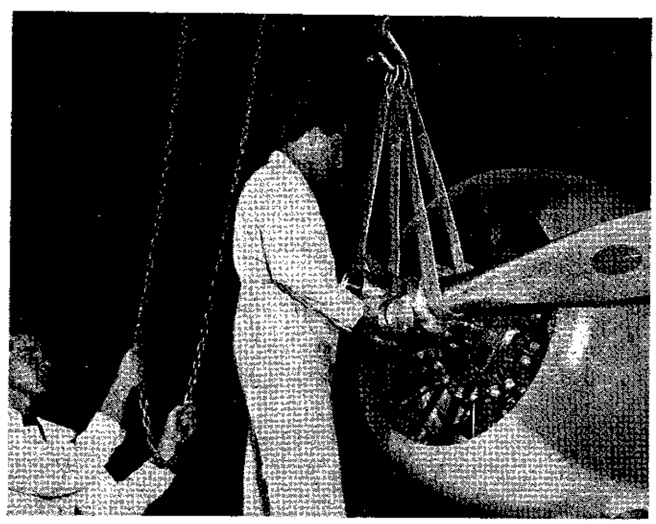


Figure 19 — Installing Propeller on Shaft

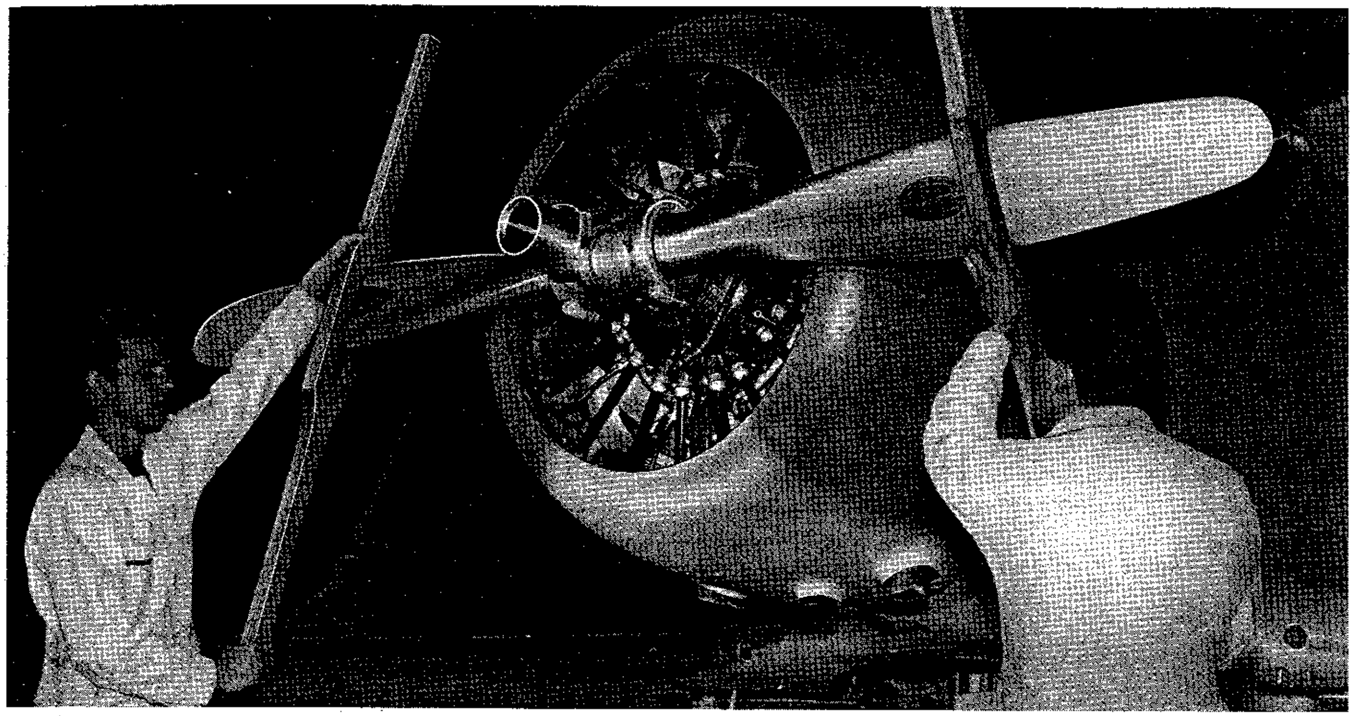


Figure 20 — Turning Blades to Low Angle

washer and front cone with clean engine oil and place the beveled end of the packing washer against the beveled inboard end of the piston. Check the pair numbers stamped on the two front cone halves for agreement and then assemble the cone halves around the piston flange. Fit the packing washer into its position in the inside groove of the front cone. Make sure that the packing washer is properly seated against the piston and in the front cone groove.

(*e*) Slide the piston and front cone assembly into the spider until it contacts the shaft threads. Carefully align the piston and shaft threads and screw the piston onto the shaft using a short bar with the proper installation wrench listed in section V, paragraph 1. In no case should force be used to tighten the piston if there is any indication of binding or if the threads are not properly engaged since this may cause serious damage to the threads.

(*f*) If the piston does not turn freely onto the shaft, the following checks should be made. Make sure the blades are not set at different angles, thus causing the cylinder and piston to be cocked out of line with the propeller shaft. Check the front cone packing washer to insure that it is properly seated and inspect the piston and shaft threads for damage. In extreme cases where it is impossible to start the piston on the shaft by any of these means, the counterweights and counterweight bearing shafts should be removed. When removing the adjusting screw assemblies, do not disturb the position of the adjusting nuts. (For procedure, see section VI, paragraph 2.) This will completely free the cylinder and piston and allow the piston to be more easily started onto the propeller shaft. After the piston has been tightened, place the counterweight thrust bearing assemblies and thrust washers into the cylinder bushings. Assemble the counterweight bearing assemblies into the bracket slots and screw the bearing shafts into the cylinder. Line up the cotter pin holes in the shafts with those in the cylinder bosses and install the cotter pins. Place the counterweight bearing retainer spacers into the bracket slots and assemble the counterweights. Install

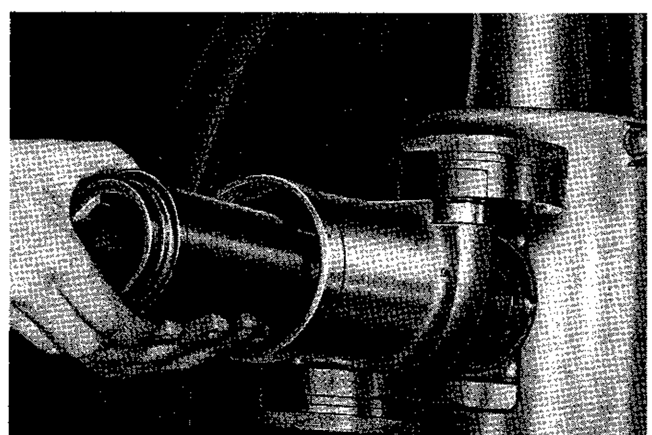


Figure 21 — Inserting Piston Through Cylinder

the adjusting screw assemblies making sure the adjusting nuts are in their proper position on the screws. Tighten the counterweight caps onto the counterweights and install the clevis pins and cotter pins. During the reassembly of the foregoing parts, care should be used to install the parts so that their position numbers correspond with the bracket numbers.

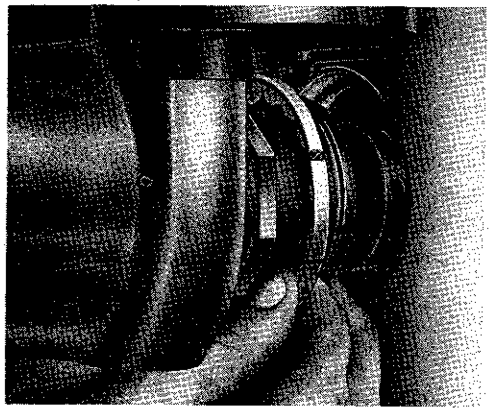


Figure 22 — Positioning Piston Lock Ring

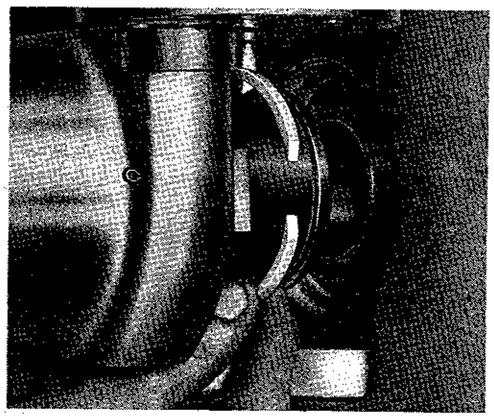


Figure 23 — Positioning Hub Snap Ring

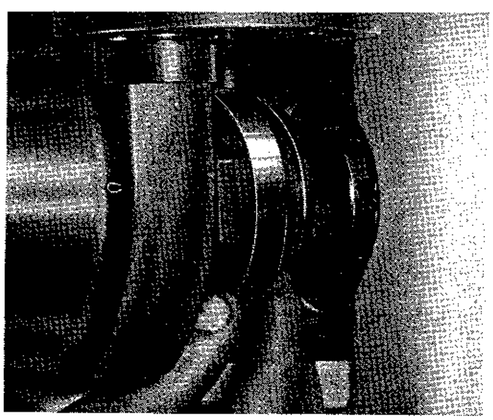


Figure 24 — Positioning Front Cone Spacer

(*g*) Finish tightening the piston by applying a force of 180 pounds at the end of a four-foot bar installed into the installation wrench. To make sure the piston is fully tightened, strike the bar once close to the wrench with a hammer weighing about 2-1/2 pounds while the 180-pound force is being applied.

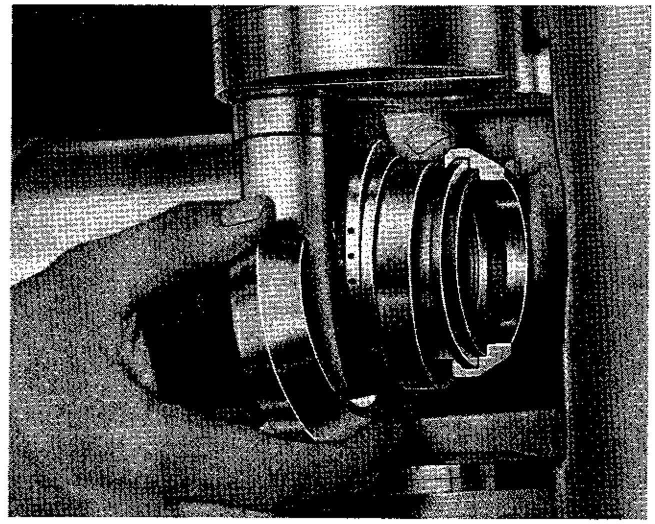
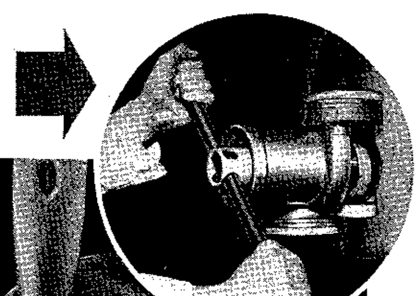


Figure 25 — Installing Front Cone Packing Washer and Cone

(*h*) Move the front cone spacer into the spider and against the front cone. Compress the hub snap ring and install it into the snap ring groove in the spider. Position the piston lock ring in the top of the spider around the octagon portion of the piston so that the two cotter pin holes in the outboard end of the spider line up with two of the eight cotter pin holes in the lock ring. By indexing the lock ring around the piston it is always possible to find a position in which the two cotter pin holes in the spider line up with two of the lock ring holes without any further tightening of the piston. Safety the lock ring to the spider with a cotter pin in each of the two sets of aligned holes. The cotter pins should be installed

Figure 26 — Starting Piston onto Propeller Shaft



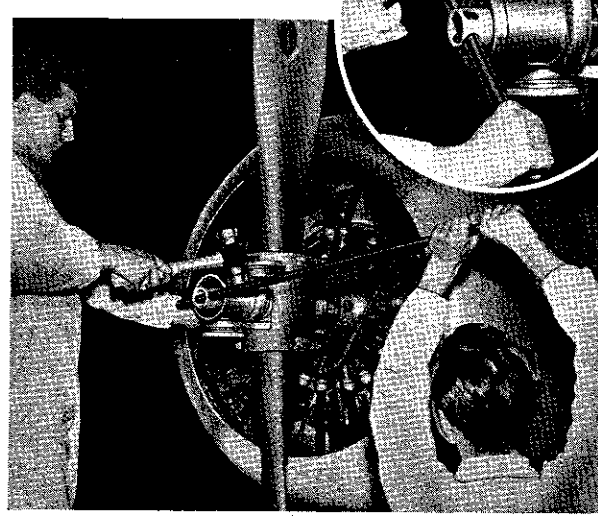


Figure 27 — Final Tightening of Propeller Piston

with the heads facing toward the piston. In order to install the cotters in this position, it will be necessary to first bend them slightly to clear the side of the piston.

(*i*) Using a blade turning device on each blade, turn the blades to the full high pitch position. Install the inboard piston gasket on the piston, with the chamfered end facing toward the spider, and seat it on the piston shoulder. Place the outboard piston gasket onto the piston and against the inboard gasket with the sealing lips facing away from the spider. The inboard and outboard gaskets should not be confused and be installed in the wrong sequence. The inboard gasket is not designed to be an oil seal but simply a guide for the cylinder and can be identified by the 45-degree chamfer on the edge of the outside diameter and on the small inside diameter. The outboard gasket acts as an oil seal and can be identified by the single 45-degree chamfer on the edge of the larger inner diameter. See figures 31 and 32.

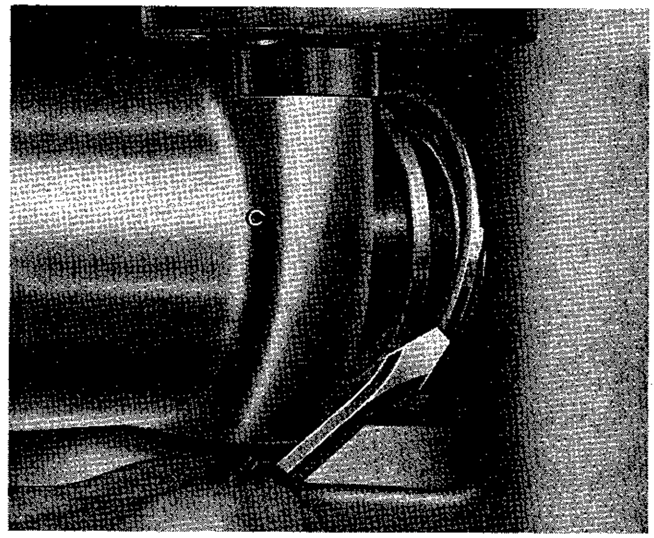


Figure 29 — Installing Hub Snap Ring in Spider

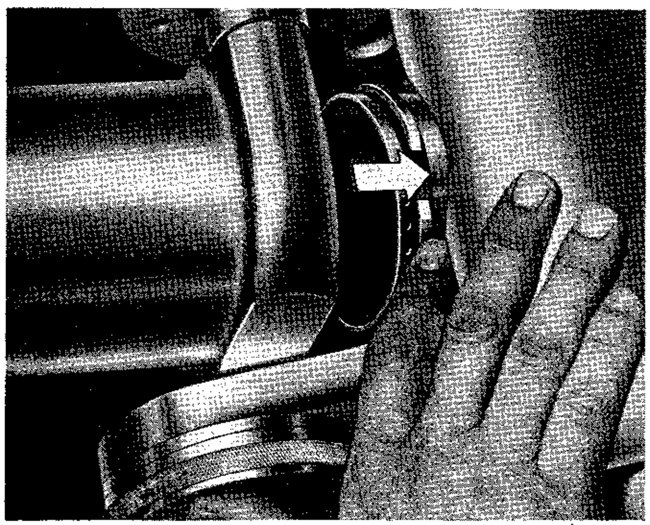


Figure 28 — Moving Front Cone Spacer into Position

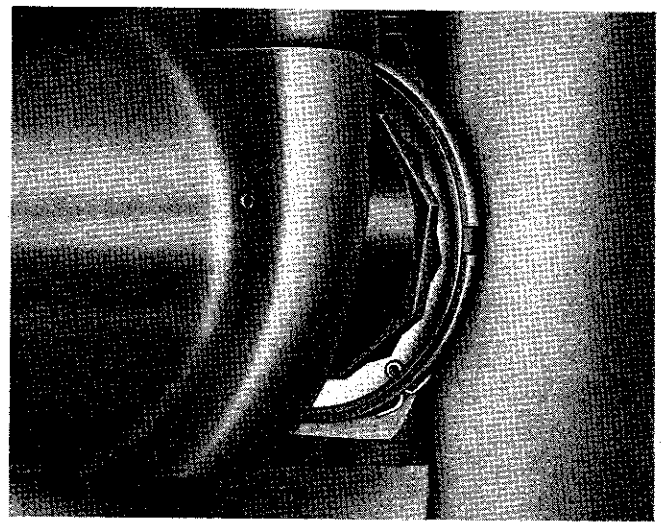


Figure 30 — Piston Lock Ring Installed and Cottered

WARNING

Under no circumstances should the piston gaskets be soaked in oil. Preoiling can soften the portion of the gasket under the retaining nut sufficiently to cause failure of the gasket and serious oil leakage from the propeller. Gaskets that have been preoiled or are otherwise not in satisfactory condition are to be replaced.

(*j*) Install and tighten the piston gasket nut firmly with the installation wrench listed in section V, paragraph 1. and a short bar 1-1/2 to 2 feet long. Line up one of the cotter pin slots in the nut with a cotter pin hole in the piston, and install the cotter pin with the head pointing away from the piston.

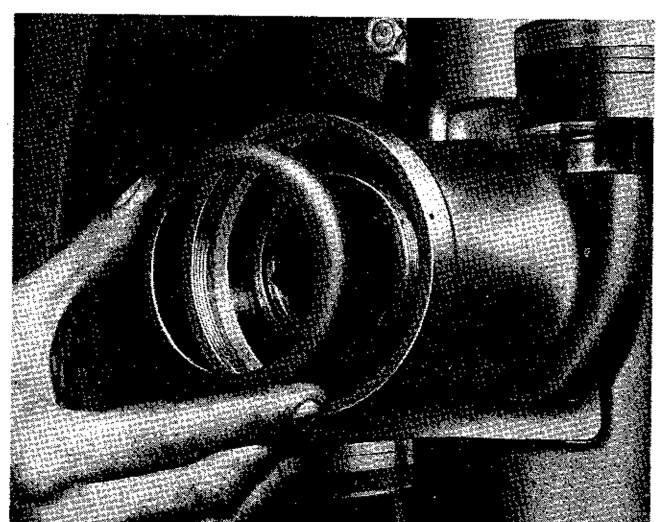


Figure 31 — Installing Piston Inboard Gasket

(*k*) Place the cylinder head gasket onto its seat in the end of the cylinder using grease, if necessary, to hold it in place. The gasket should be installed with the split face against the cylinder seat. Screw the cylinder head into the cylinder and tighten it firmly with the proper installation wrench and a 1-1/2 to 2-foot bar. Line up one of the locking holes in the cylinder head with a locking hole in the cylinder. Install the cylinder head lock ring and snap it into position in the groove in the cylinder head.

(*l*) Upon completion of the installation, all visible cotter pins and lock rings should be checked.

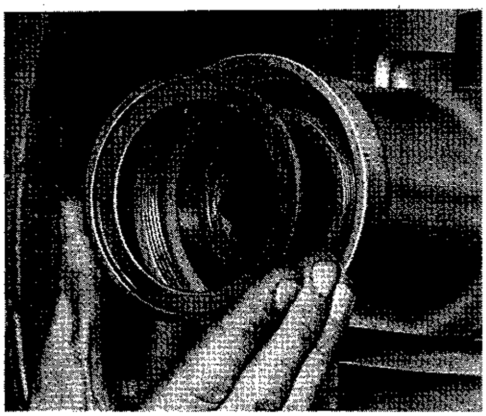


Figure 32 — Installing Piston Outboard Gasket

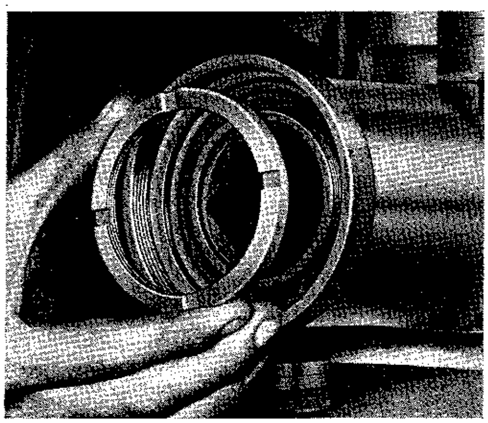


Figure 33 — Installing Piston Gasket Nut

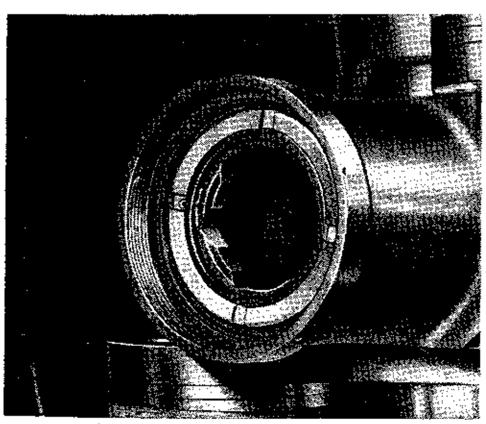


Figure 34 — Piston Gasket Nut Tightened and Cottered

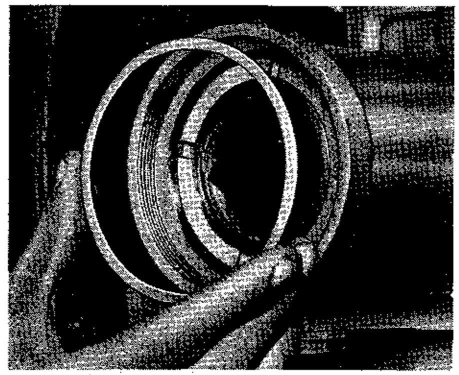


Figure 35 — Inserting Cylinder Head Gasket

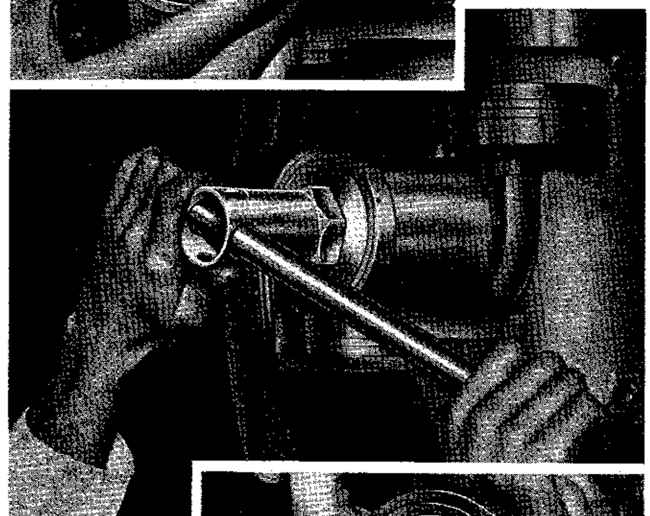


Figure 36 — Tightening Cylinder Head

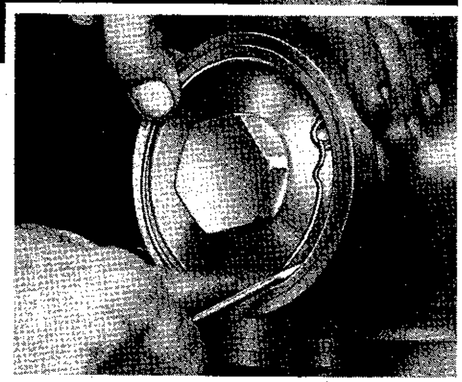


Figure 37 — Installing Head Lock Ring

(2) PROPELLERS FOR SHAFT BREATHING ENGINES.

(*a*) Install the rear cone spacer, if used, and the rear cone on the propeller shaft and move them back against the engine thrust nut. Cover the shaft threads with a thread protector or wrap the threads with tape, if a suitable protector is not available.

(*b*) Install the oil supply pipe assembly and the oil supply pipe gasket, if used, into the propeller shaft. Tighten the supply pipe snugly but not excessively since this may damage the internal oil pipe in the propeller shaft. Lock the oil supply pipe with safety wire.

(*c*) Remove the cylinder head lock ring and the cylinder head if they are installed in the propeller. Insert the front cone spacer into the bore above the front cone seat of the spider and install the hub snap ring into the spider snap ring groove. Place the piston lock ring in the bore in the outboard end of the spider with the end having the large inside diameter facing toward the cylinder.

(*d*) Attach a hoisting sling to the propeller blades and lift the assembly so the blank spline in the propeller spider is in line with the wide spline of the propeller shaft. Install the propeller on the shaft using care not to damage the shaft threads and the splines of the shaft or spider, and then slide it back against the rear cone.

(*e*) Using a blade turning device on each blade, turn the blades to a position near the low angle setting of the propeller. The blades should be at approximately the same angle in order to keep the cylinder from being cocked. Care should be used during this operation to move both blades at the same time and not to pull the propeller off the shaft since there is nothing locking the propeller to the shaft at this time. Remove the thread protector or tape from the shaft threads.

(*f*) Remove the piston lock ring, hub snap ring, and front cone spacer from their positions in the spider and let them hang on the oil supply pipe. Coat the shaft threads of the piston with thread lubricant conforming to Specification No. AN-C-53-1 or clean engine oil and insert the piston through the cylinder. Place the piston lock ring, hub snap ring, and front cone spacer, in that order, over the end of the piston and slide them toward the outboard end of the piston. Assemble the two front cone halves around the piston flange first making sure that the pair numbers stamped on the cone halves are identical.

(*g*) Slide the piston and front cone assembly into the spider until it contacts the shaft threads. Carefully align the piston and shaft threads and screw the piston onto the shaft using a short bar with the proper installation wrench listed in section V, paragraph 1. In no case should force be used to tighten the piston if there is any indication of binding or if the threads are not properly engaged since this may cause serious damage to the threads.

(*h*) If the piston does not turn freely onto the shaft, make sure the blades are not set at different angles thus causing the cylinder and piston to be cocked out of line with the propeller shaft. Also check the piston and shaft threads for damage. In extreme cases where it is impossible to start the piston on the shaft by any other means, the counterweights and counterweight bearing shafts should be removed. When removing the adjusting screw assemblies, do not disturb the position of the adjusting nuts. (For procedure, see section VI, paragraph 2.) This will completely free the cylinder and piston and allow the piston to be properly started onto the propeller shaft. After the piston has been tightened, place the counterweight thrust bearing assemblies and thrust washers into the cylinder bushings. Assemble the counterweight bearing assemblies into the bracket slots and screw the bearing shafts into the cylinder. Line up the cotter pin holes in the shafts with those in the cylinder bosses and install the cotter pins. Place the counterweight bearing retainer spacers into the bracket slots

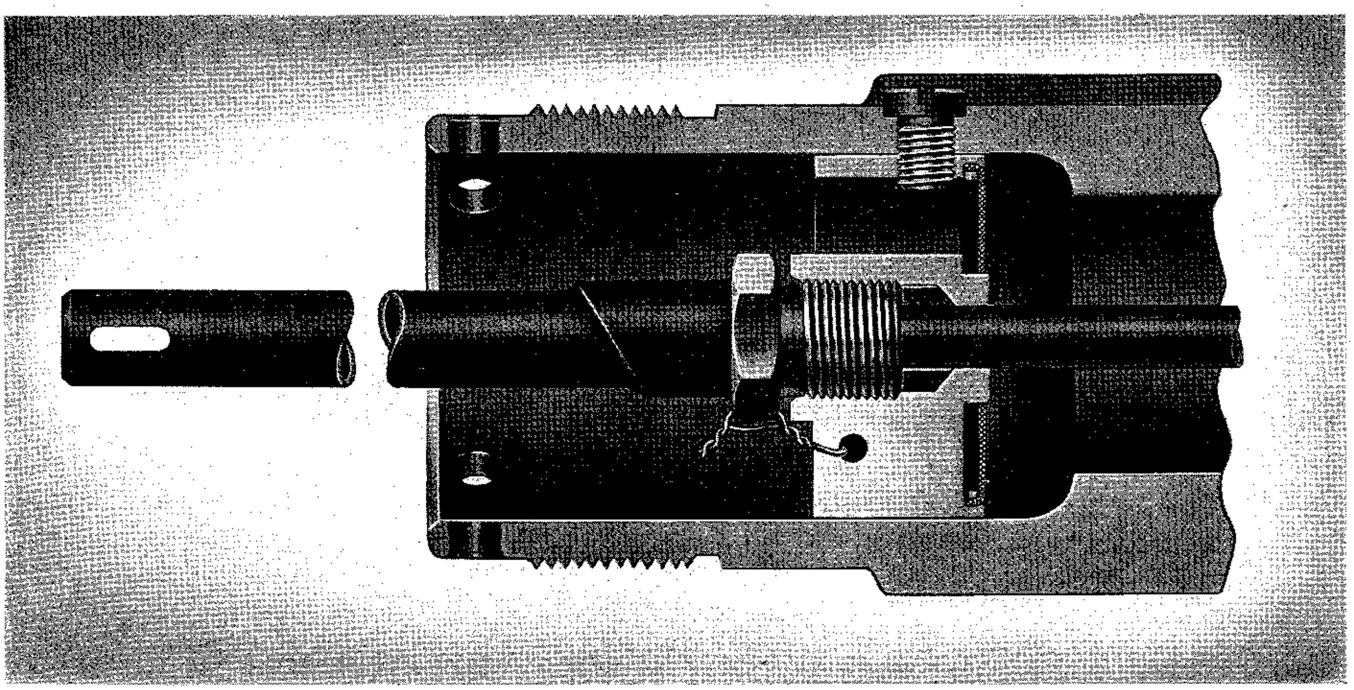


Figure 38 — Oil Supply Pipe Installed in Propeller Shaft

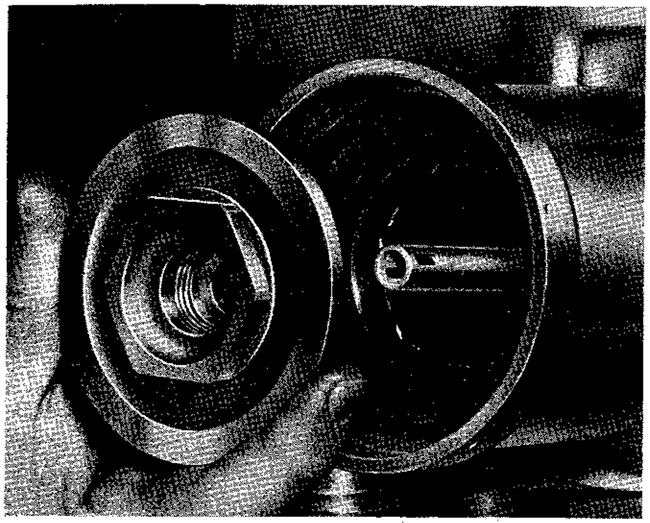


Figure 39 — Installing Shaft Breathing Type Piston Gasket Nut

and assemble the counterweights. Install the adjusting screw assemblies making sure the adjusting nuts are in their proper position on the screws. Tighten the counterweight caps onto the counterweights and install the clevis pins and cotter pins. During the reassembly of the foregoing parts, care should be used to install the parts so that their position numbers correspond with the bracket position numbers.

(*i*) Finish tightening the piston by applying a force of 180 pounds at the end of a four-foot bar installed into the installation wrench. To make sure the piston is fully tightened, strike the bar once close to the wrench with a hammer weighing about 2-1/2 pounds while the 180-pound force is being applied. The proper installation wrench for the model 2D30 propeller is listed in paragraph 1. of section V.

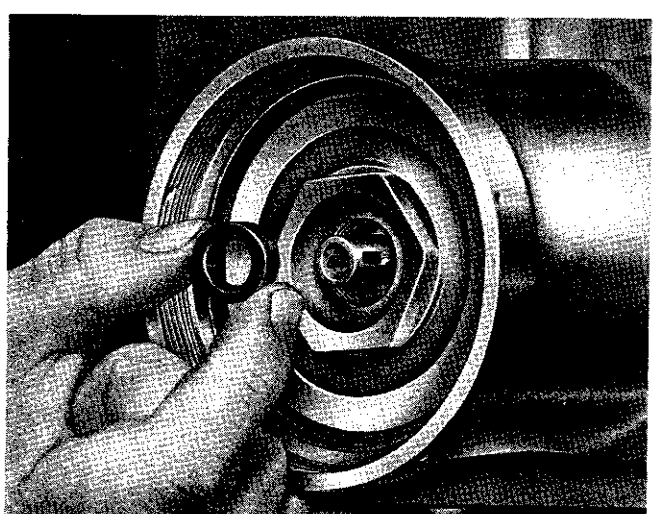


Figure 40 — Installing Oil Supply Pipe Packing Washer

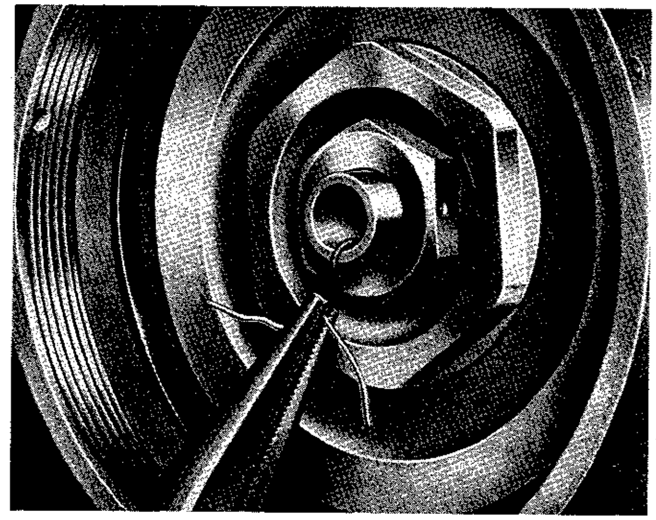


Figure 41 — Locking Oil Supply Pipe Packing Nut

(*j*) Move the front cone spacer into the spider against the front cone. Compress the hub snap ring and install it into the snap ring groove in the spider. Position the piston lock ring in the top of the spider around the octagon portion of the piston so that the two cotter pin holes in the outboard end of the spider line up with two of the eight cotter pin holes in the lock ring. By indexing the lock ring around the piston, it is always possible to find a position in which the two cotter pin holes in the spider line up with two of the lock ring holes without any further tightening of the piston. Safety the lock ring to the spider with a cotter pin in each of the two sets of aligned holes. The cotter pins should be installed with the heads facing toward the piston. In order to install the cotters in this position, it will be necessary to first bend them slightly to clear the side of the piston.

(*k*) Using a blade turning device on each blade, turn the blades to the full high pitch position. Install the inboard piston gasket on the piston, with the chamfered end facing toward the spider, and seat it on the piston shoulder. Place the outboard piston gasket onto the inboard gasket with the sealing lips facing away from the spider. The inboard and outboard gaskets should not be confused and be installed in the wrong sequence. The inboard gasket is not designed to be an oil seal but simply a guide for the cylinder and can be identified by the 45-degree chamfer on the edge of the outside diameter and on the small inside diameter. The outboard gasket acts as an oil seal and can be identified by the single 45-degree chamfer on the edge of the larger inner diameter.

(*l*) Install and tighten the piston gasket nut firmly with the installation wrench shown in section V, paragraph 1. and a short bar 1-1/2 to 2 feet long.

WARNING

Under no circumstances should the piston gaskets be soaked in oil. Preoiling can soften the portion of the gasket under the retaining nut sufficiently to cause failure of the gasket and serious oil leakage from the propeller. Gaskets that have been preoiled or are otherwise not in satisfactory condition are to be replaced.

(*m*) Install the oil supply pipe packing washer over the end of the pipe and push it into position in the bore of the piston gasket nut. Tighten the oil supply pipe packing nut firmly into place and line up one of the locking holes in the nut with one of the locking slots in the pipe. Safety the nut to the supply pipe with safety wire.

(*n*) Place the cylinder head gasket onto its seat in the end of the cylinder using grease, if necessary, to hold it in place. The gasket should be installed with the split face against the cylinder seat. Screw the cylinder head into the cylinder and tighten it firmly with the proper installation wrench and a 1-1/2 to 2-foot bar. Line up one of the locking holes in the cylinder head with a locking hole in the cylinder. Install the cylinder head lock ring and snap it into position in the groove in the cylinder head.

(*o*) Upon completion of the installation, all visible cotter pins and lock rings should be checked.

b. ADJUSTMENTS.—Following completion of the propeller installation, move the blades into the full low pitch position by means of blade turning devices. Check the low blade angle setting by means of a universal bubble type protractor located at the proper blade reference station. Move the blades into the full high pitch position and check the high blade angle setting. The high blade angles should be within 0.1 degree of the specified setting for the propeller. The low blade angles should be within 0.3 degree of the specified setting and within 0.2 degree of each other. The correct high and low angle settings of the propeller may be found in applicable technical publications, and the propeller should have been set to those angles at overhaul. If, however, due to slight reductions in diameter resulting from blade repair the blade angle settings are not correct, remove the counterweight caps and check the position of the adjusting screw nuts. Adjust the nuts as required until the blade angles correspond to the proper setting within the allowable tolerance. When adjusting the nuts, it is important that the nut at the high angle end of each adjusting screw be placed as closely to the same distance from the end of the counterweight slot as is possible and still maintain the blade angles within the blade angle tolerance. This likewise applies to the nut at the low angle end of the slot. Following this procedure will insure that the bearing shafts contact the nuts at the same time, and will prevent the cylinder from cocking during operation. After the proper blade angles have been obtained, reinstall the counterweight caps and safety them by means of clevis pins and cotter pins.

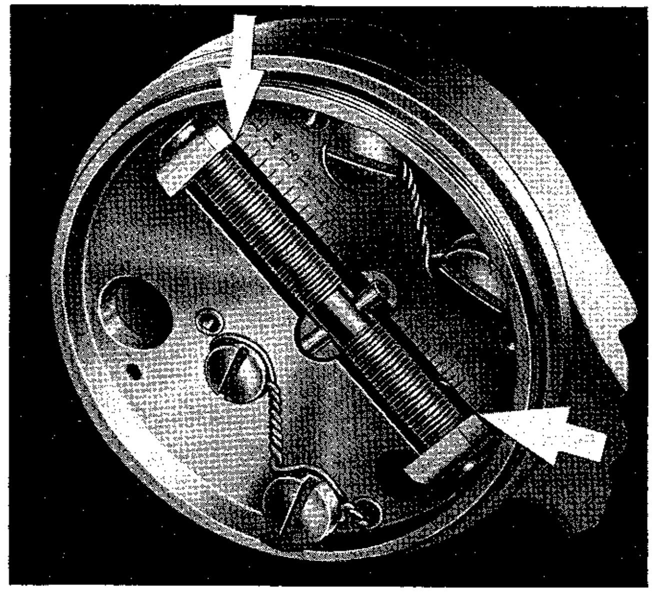


Figure 42 — Check Setting of Counterweight Adjusting Screw Nuts

c. REMOVAL PROCEDURE.—In general, the procedure for removing the propeller is the reverse of the installation procedure.

(1) By means of a blade turning device, move the blades into the high pitch position. Remove the cylinder head lock ring and unscrew the cylinder head. Take the cylinder head gasket out of the cylinder.

(2) On propellers for shaft breathing engines, remove the safety wire from the oil supply pipe packing nut. Unscrew the packing nut and the piston gasket nut, and remove the outboard piston gasket. On propellers for crankcase breathing engines, remove the cotter pin, unscrew the piston gasket nut, and take out the outboard piston gasket.

(3) Move the blades to a position near the low angle setting of the propeller and remove the two cotter pins from the piston lock ring. Slide the lock ring away from the spider.

(4) Attach a hoisting sling to the propeller blades and, using the proper wrench and bar, unscrew the piston completely off the propeller shaft threads. As the piston is unscrewed, the front cone spacer contacts the hub snap ring thus partially backing the propeller off the shaft with the piston.

(5) Disengage the hub snap ring from the spider. Remove the front cone (and the front cone packing washer in the case of propellers for crankcase breathing engines), front cone spacer, hub snap ring, and piston lock ring from the piston. Take the piston out of the cylinder.

(6) Cover the propeller shaft threads with a thread protector or wrap the threads with tape if a suitable protector is not available. Slide the propeller carefully off the shaft using care not to damage the shaft threads and the splines of the shaft or spider. In the case of propellers for shaft breathing engines, also be careful not to damage the oil supply pipe.

(7) On propellers for shaft breathing engines, remove the safety wire from the inboard end of the oil supply pipe, and then carefully unscrew the pipe.

(8) If another propeller is not to be installed immediately, clean, oil, and cover the propeller shaft. If the propeller is to be stored for any length of time, all metal surfaces of the propeller should be protected against corrosion by applying a coat of corrosion preventive compound to Specification No. AN-VV-C-576a-1.

3. MODEL 2B20.

Model 2B20 propellers do not incorporate front cone spacers; otherwise, the installation, adjustment, and removal procedures are the same as those described for the model 2D30 propeller in paragraphs 2.a., b., and c. of this section.

4. MODEL 12D40.

The installation, adjustment, and removal procedures for the model 12D40 propeller are identical with the model 2D30 propeller described in paragraphs 2.a., b., and c. of this section.

5. MODEL 2E40.

a. INSTALLATION PROCEDURE.

(1) PROPELLERS WITHOUT SPRING RETURN ASSEMBLY.

(*a*) Install the rear cone spacer (if used) and the rear cone on the propeller shaft.

(*b*) If the engine is the crankcase breathing type, the following installation procedure is necessary. After making sure that the ends of each of the chevron packings are staggered approximately 90 degrees, the assembled propeller shaft oil plug is placed in the open end of the propeller shaft and secured by four screws which are inserted through the locking holes of the propeller shaft. Next, turn the "hex" base of the oil pipe in a counterclockwise direction. The chevron packing will be expanded forming an oil-

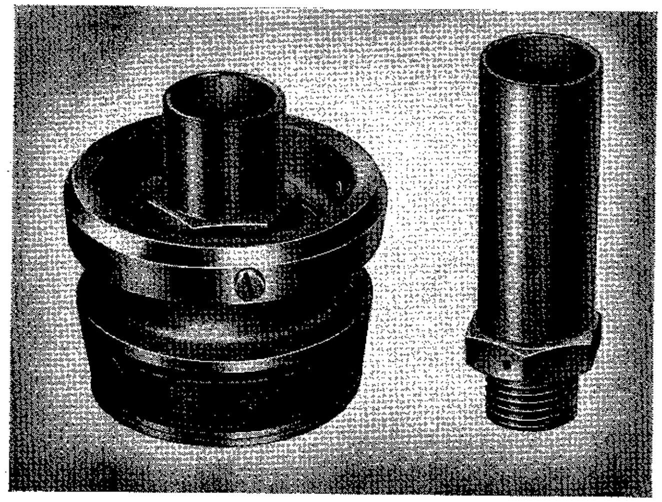


Figure 43 — Shaft Plug and Short Oil Pipe

tight seal. The pipe is then secured to one of the (four) screws by means of safety wire.

(*c*) If the engine is the shaft breathing type, the following procedure is necessary. Install the oil supply pipe gasket (if one is required) over the oil supply pipe threads, and turn the oil supply pipe into the oil plug or "Y" connection inside the propeller shaft. Secure the oil supply pipe by means of safety wire.

(*d*) Apply thread lubricant to Specification No. AN-C-53-1 or clean engine oil to the shaft threads. Then, cover the shaft threads with a thread protector, or wrap them with tape.

(*e*) After removing the cylinder head and cylinder head lock ring, attach a hoisting sling and raise the propeller with the blank spline of the spider in line with the propeller shaft wide spline. Carefully install the propeller on the shaft, and move it back against the rear cone.

Note

On most new engines, oil and corrosion preventives are flushed from the cylinders prior to installation of the engine on the aircraft. However, in case this has not been done and the engine is allowed to stand idle for an appreciable time after propeller installation and before engine run-up, the portion of the cylinders wiped clean of protective by rotating the propeller shaft during installation may corrode. In such cases, attach a single hoisting sling to the blade in line with the blank spline of the spider so that at installation the propeller will line up with the engine shaft wide spline (usually left in the top position) and it will not be necessary to rotate the shaft.

(*f*) Move the blades to a position near the low pitch setting using blade turning devices. Make sure the blades are at the same angle to prevent the cylinder cocking. Remove the thread protector or tape.

(*g*) Install the piston oil seal and piston oil seal nut in the inboard end of the piston. Tighten the nut and safety it with a cotter pin. Apply thread lubricant conforming to Specification No. AN-C-53-1, or clean engine oil, to the piston threads. Insert the piston through the cylinder, and then install the hub snap ring, front cone spacer, and front cone on the inboard end of the piston. Move this group inboard until the piston contacts the shaft threads. Start the piston onto the propeller shaft using the proper installation wrench and a short bar. As the piston is tightened, the oil supply pipe is forced through the piston oil seal. When the piston does not start easily or it binds as it is being installed on the shaft, one or more of the following checks should be made. Reinspect the piston and propeller shaft threads for damage, and if necessary, clean up slight imperfections with a fine stone and crocus cloth. Always thoroughly clean and dry the parts after reworking. If the cylinder is cocked, installation of the piston may be difficult. Tap the cylinder back into line with rawhide or nonmetallic hammers, checking the piston at the same time. In extreme cases, it may be necessary to take out the counterweight bearing shafts and completely free the cylinder to get the piston started on the propeller shaft threads. See paragraph 2.d. in section VI for complete disassembly instructions.

(*h*) Using a 4-foot bar inserted in the installation wrench, apply a force of 180 pounds to finish tightening the piston. Tap the bar once near the wrench with a 2-1/2 pound hammer to finally secure the assembly.

(*i*) If the counterweight bearing shafts were removed to free the piston, reassemble the counterweight thrust bearing assemblies and thrust washers into the bushings in the cylinder, and reassemble the counterweight bearing assemblies into the brackets. Screw the bearing shafts into the cylinder. Align the locking holes in the bearing shafts with those in the cylinder flange, and install the cotter pins. Place the counterweight bearing retainer spacers in position, install the counterweights on the brackets, and then add the adjusting screw assemblies in the counterweight cam slots. Make certain the adjusting nuts are correct for the angle settings required. Install the counterweight caps on the counterweights and lock them in place with clevis pins and cotter pins. (Each part must be reinstalled in its correspondingly numbered bracket.)

(*j*) Position the front cone spacer against the front cone, and then install the hub snap ring in the spider groove.

(*k*) Move the blades to full high pitch, and then install the piston gaskets on the piston.

WARNING

Under no circumstances should the piston gaskets be soaked in oil. Preoiling can soften the portion of the gasket under the retaining nut sufficiently to cause failure of the gasket and serious oil leakage from the propeller. Gaskets that have been preoiled or are otherwise not in satisfactory condition are to be replaced.

(*l*) Start the piston gasket nut by hand, and finally tighten it with a short bar inserted through the installation wrench.

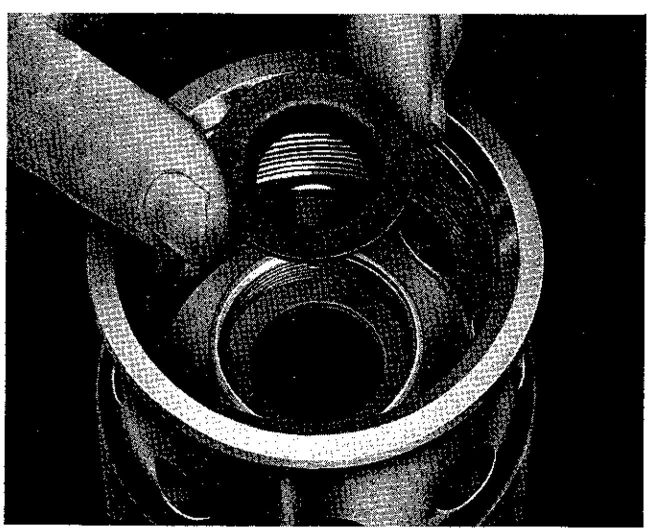


Figure 44 — Installing Piston Oil Seal in Piston — 2E40 Model

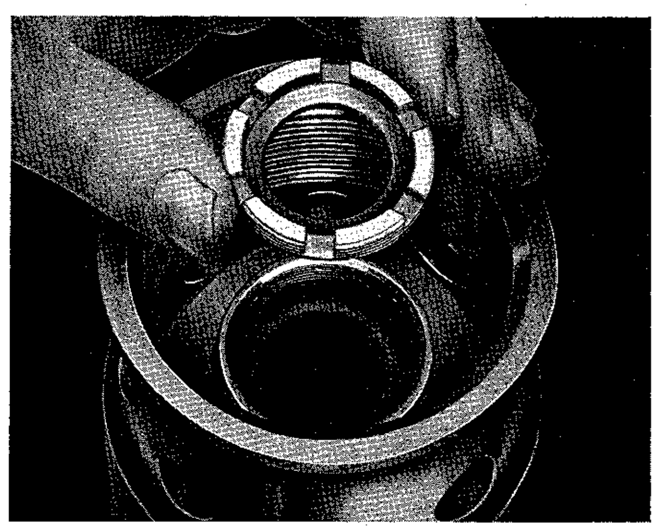


Figure 45 — Installing Piston Oil Seal Nut in Piston — 2E40 Model

(*m*) Install the puller bolt spring over the inboard end of the puller bolt, and insert the puller bolt through the piston gasket nut. After placing the cylinder head gasket in the cylinder, install the cylinder head and tighten it with a short bar through the installation wrench. Line up a locking hole in the cylinder head with a locking hole in the cylinder. Install the cylinder head lock ring in the cylinder head.

(*n*) Install the vernier lock plate and ring over the puller bolt and into the cylinder head. The groove and ring on one side of the lock plate are to facilitate its removal, and therefore the lock plate should be installed with this ring facing outward. Place the cylinder head clamp nut gasket on the cylinder head, and tighten the cylinder head clamp nut onto the puller bolt. Lock this assembly by installing the clamp nut lock ring inside the clamp nut. Check all external lock wire, cotter pins, lock rings, etc.

(2) PROPELLERS WITH SPRING RETURN ASSEMBLY.—The installation procedure for 2E40 propellers incorporating spring return assemblies is the same as that described for 2E40 propellers that do not incorporate spring return assemblies up to the point where the piston is tightened on the propeller shaft and the hub snap ring installed. (See paragraph 5.a.(1) in this section.) The following paragraphs describe the installation procedure from that point on.

(*a*) Using blade turning devices, move the blades to full high pitch and install the piston gaskets on the piston. Turn the spring return assembly into the piston using the regular installation wrench and a short bar. (If the spring return unit is not assembled, refer to section VI, paragraph 6.d.(3) for its assembly procedure.) Install the cylinder head gasket in the cylinder (using grease to hold it in place if necessary), and install and tighten the cylinder head. Install the cylinder lock ring to secure the assembly.

(*b*) Insert the vernier lock plate over the spring puller bolt and into the cylinder head so that the ring on one side of the lock plate faces outward.

(*c*) After placing the cylinder head clamp nut gasket on the cylinder head, install and tighten the cylinder head clamp nut. Lock the assembly by adding the clamp nut lock ring.

(*d*) Check all external lock wire, cotter pins, lock rings, etc.

b. ADJUSTMENTS.—Check the high and low blade angles with a bubble type protractor. These angles should be the same as the specified setting within a tolerance of 0.1 degree on high blade angle and 0.3 degree on low blade angle. Blades must be within 0.2 degree of each other. Consult applicable technical publications for the correct blade angle settings. Adjust blade angle settings, if required, by means of the stop nuts on the counterweight adjusting screw assembly.

c. REMOVAL PROCEDURE.

(1) Move the blades to the full high pitch position with blade turning devices. This will push some oil out of the cylinder and, in the case of propellers incorporating spring return assemblies, will relieve all compression from the springs. If the blades are not in the high pitch position, the springs will be in compression, and the cylinder head clamp nut threads may be damaged during removal of the nut. Take out the cylinder head clamp nut lock ring and unscrew the clamp nut. Remove the nut and cylinder head clamp nut gasket. Remove the vernier lock plate. Failure to

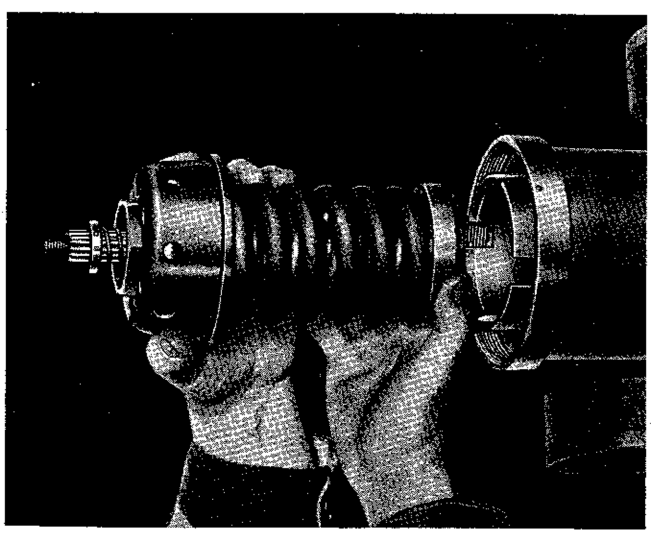


Figure 46 — Installing Spring Return Assembly in Piston — 2E40 Model

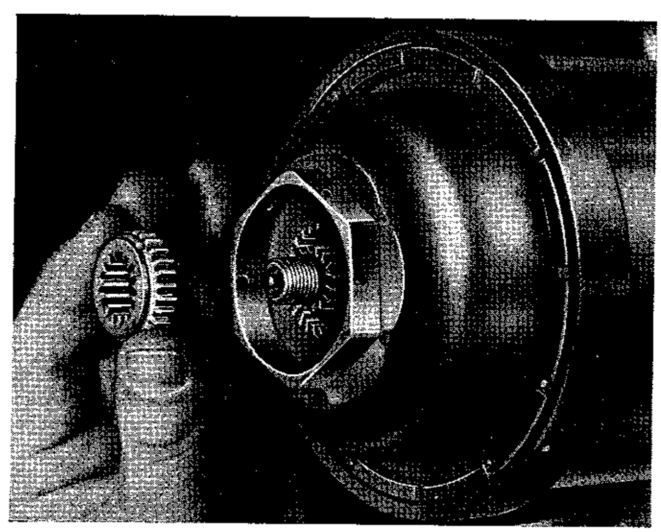


Figure 47 — Installing Vernier Lock Plate in Head — 2E40 Model

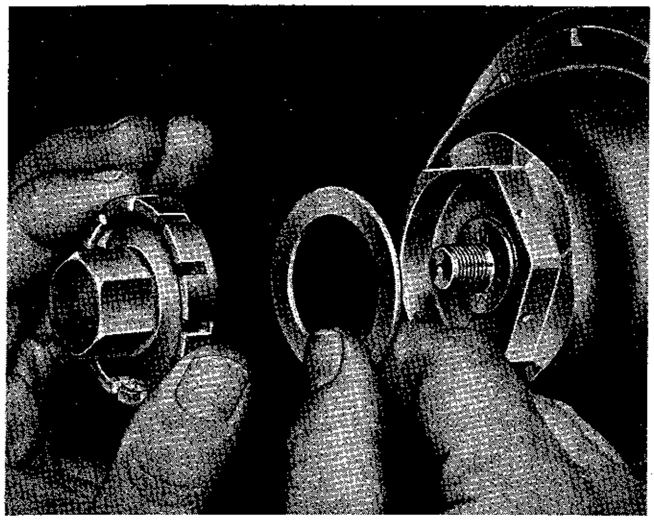


Figure 48 — Installing Cylinder Head Clamp Nut Gasket and Nut — 2E40 Model

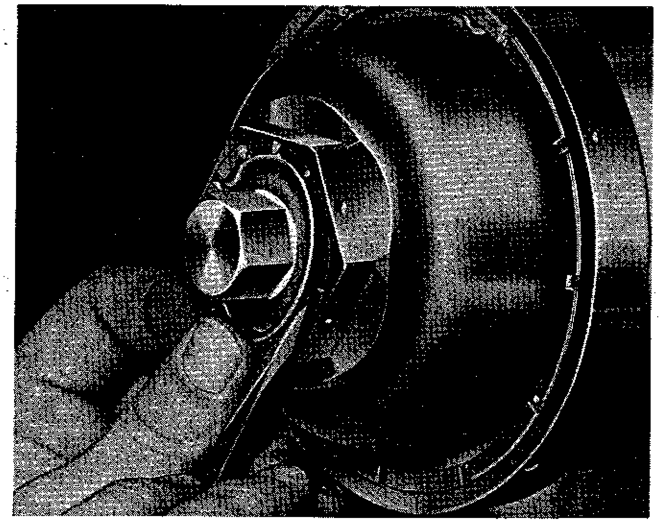


Figure 49 — Installing Cylinder Head Clamp Nut Lock Ring — 2E40 Model

remove the lock plate before unscrewing the cylinder head will result in serious damage to the spring puller bolt. Next, take out the cylinder head lock ring and then unscrew and remove the cylinder head. Remove the cylinder head gasket.

(2) In the case of propellers not incorporating a spring return assembly, remove the puller bolt and the puller bolt spring.

(3) Unscrew and remove the piston gasket nut. In the case of propellers incorporating a spring return assembly, the spring return unit will be removed complete when the piston gasket nut is unscrewed.

(4) Attach a hoisting sling to the propeller.

(5) Using the installation wrench and bar, turn the piston completely off the propeller shaft threads. The hub snap ring will back the propeller partially off the shaft. With blade turning devices, move the blades to the low pitch position. Remove the front cone, the front cone spacer, and the hub snap ring. Remove the piston from the cylinder.

(6) Cover the propeller shaft threads with a thread protector or wrap them with tape. Slide the propeller carefully off the shaft.

(7) On propellers for shaft breathing engines, remove the safety wire from the inboard end of the oil supply pipe and carefully unscrew the pipe. Take out the oil supply pipe gasket if one is used. In the case of propellers for crankcase breathing engines, remove the safety wire from the "hex" base of the shaft plug and from the locking screw, and turn the hex base in a clockwise direction until the compression on the chevron packing is relieved. Then take out the four screws that protrude through the locking holes in the propeller shaft, and remove the oil plug assembly.

(8) If another propeller is not to be installed immediately, clean, oil, and cover the propeller shaft. If the propeller is to be stored, protect all surfaces with a corrosion preventive meeting Specification No. AN-VV-C576a-1.

6. MODEL 3D40.

The installation, removal, and adjustment procedures for the model 3D40 propeller are the same as that described for the model 2E40 propeller in paragraph 5.a. of this section, with the exception that some early models do not incorporate the vernier lock plate arrangement for safetying the piston. The installation and removal procedure for these models, such as the 3D40-57, is the same as that described for the model 2D30 propeller in paragraph 2.a. of this section.

7. MODEL 3E50.

Model 3E50 propellers do not incorporate front cone spacers; otherwise, the installation, removal, and adjustment procedures for a model 3E50 propeller are the same as that described for the model 2E40 propeller in paragraph 5.a. of this section, with the exception that some early models do not incorporate the vernier lock plate arrangement for safetying the piston. The installation and removal procedure for these models, such as the 3E50-65 propeller, is the same as that described for the model 2D30 propeller in paragraph 2.a. of this section.

SECTION IV
OPERATION

1. PRINCIPLES OF OPERATION.

From an operational standpoint, Counterweight type propellers can be divided into two main groups; those without a spring return assembly, and those with a spring return assembly. Propellers without a spring return are in turn subdivided into Controllable and Constant Speed propellers. A detailed description of the operating principles of these different types is included in the appropriate paragraphs of this section.

a. PROPELLERS WITHOUT SPRING RETURN ASSEMBLY.

(1) GENERAL.—The operating principles of a typical Constant Speed type Counterweight propeller without a spring return assembly are shown in figures 50, 51, and 52. In each of these diagrams, the governor and propeller parts change position as required by the condition shown, and the varying oil pressures necessary to make or compensate for these changes are shown in the colors which represent these pressures. Blade angle changes are accomplished in the Counterweight type propeller by the utilization of two forces, one hydraulic and one mechanical. When oil flows into the cylinder (5), the cylinder is moved outward against the centrifugal force set up by the counterweights (7). This action moves the counterweights inward and the blades (9) are rotated toward the low angle. If oil is allowed to drain from the cylinder (5), the centrifugal force of the counterweights (7) takes effect and the blades (9) are turned toward the high angle. In the Controllable type, only the high and low angles are utilized, whereas any angle within the range setting of the propeller can be used in the Constant Speed type.

(2) CONTROLLABLE TYPE.—The Controllable type propeller is identical with the Constant Speed type, the only difference being in the manner of control. With the Controllable propeller, the operating oil pressure is obtained from the engine, and the flow of this oil is regulated by a manually operated valve. Two blade angles are available, either high or low. In one position, the valve allows the oil to flow from the engine through the transfer rings into the front end of the propeller shaft and then out to the propeller cylinder. This oil moves the cylinder outward which pulls the brackets inward and the blades are turned to the low angle. In the other position, the valve shuts off the flow from the engine and allows the oil in the propeller cylinder to drain back to the engine sump. Oil draining from the propeller allows the centrifugal force of the counterweights to take effect, and as the cylinder moves inward, the brackets move outward and the blades are turned to the high angle position. This path of oil flow and the resulting changes in the propeller are shown in figures 50 and 52. It should be noted that these illustrations show a constant speed control (governor) and do not show the control valve.

(3) CONSTANT SPEED TYPE.—As previously noted, the Constant Speed type propeller itself is physically identical with the Controllable type, the only difference being the angle range and the manner of control. When the Counterweight propeller is set up for Constant Speed operation, the control valve is replaced by a governor unit called the Constant Speed Control. In this case, the flow of oil is exactly the same as for the Controllable type, except that the governor automatically regulates the amount of oil which enters or drains from the propeller cylinder (5).

(*a*) GOVERNOR MECHANISM.—The propeller constant speed control unit is an engine driven governor of the fly-weight type. It incorporates a gear pump which takes oil at engine supply pressure and boosts it to the pressure required for propeller operation; a pilot valve (3) actuated by the fly-weights (2) that controls the output oil flow; and the speeder spring (1) by means of which the initial load on the pilot valve can be changed (through the rack and pulley arrangement). The required balance between the oil force in the propeller cylinder and the centrifugal force of the propeller counterweights is maintained by the governor which either meters to or allows oil to drain from the propeller cylinder in the quantity necessary to maintain the proper blade angle for constant speed operation. The rpm at which the propeller will operate is adjusted in the governor head. The operator can change this setting by changing the position of the governor rack through the governor cockpit control. As the rack is lowered, the compression in the speeder spring (1) is increased. This means the engine speed necessary to maintain a balanced relationship between the centrifugal force of the fly-weights (2) and the speeder spring force is also increased. Raising the rack decreases the compression in the speeder spring and lowers the rpm necessary to maintain this balance, and lowering the rack increases the rpm setting. The position of the pilot valve (3) with respect to the propeller-governor metering port regulates the quantity of oil which will flow through this port to or from the propeller.

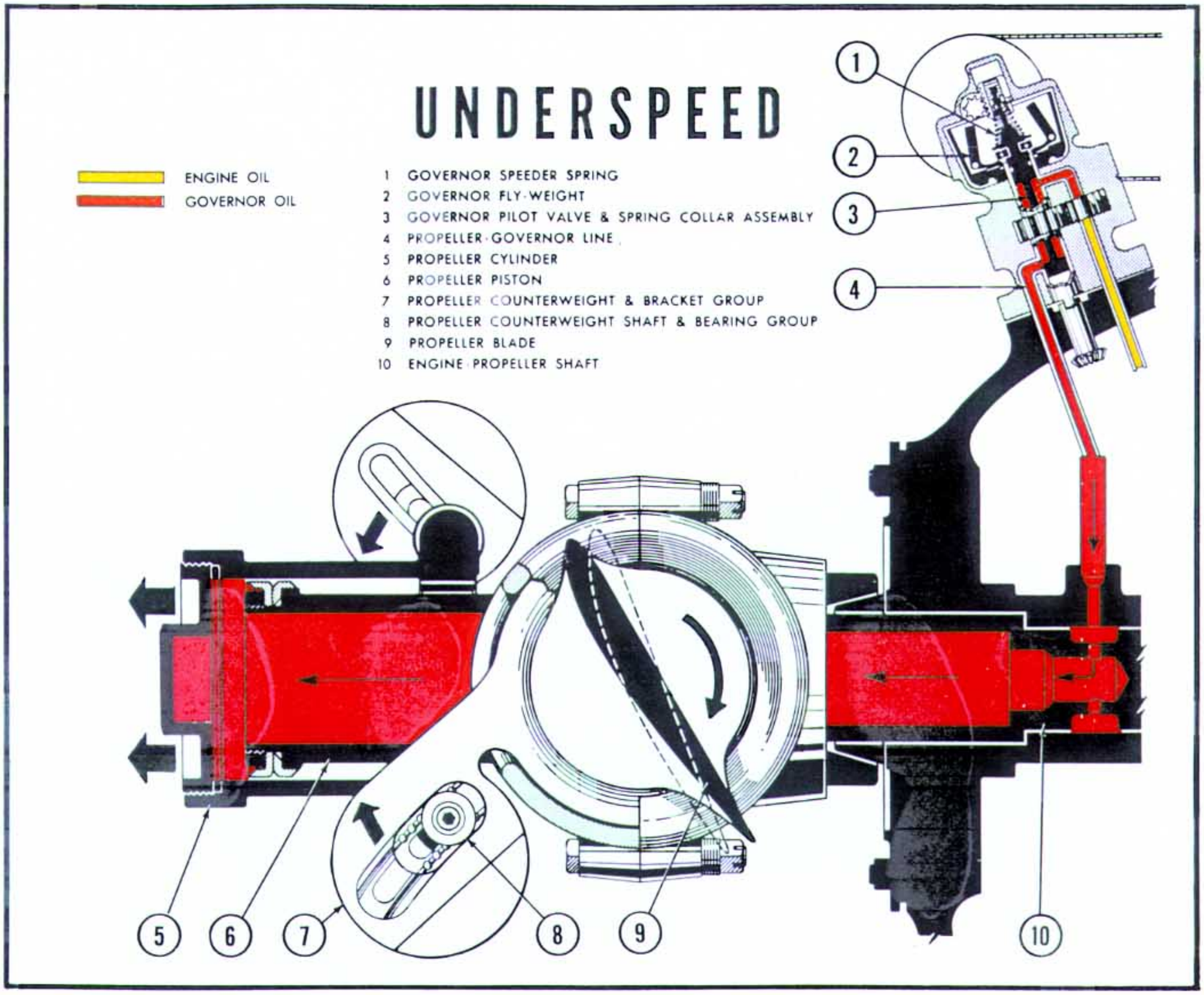


Figure 50 — Propeller Operating Diagram — Underspeed Condition

(*b*) UNDERSPEED CONDITION.—The propeller is operating in an underspeed condition when it is rotating at less than the rpm setting. As shown in figure 50, the blades (solid black section) have moved to a higher angle than that required (dotted outline) for constant speed operation. The arrow indicates the direction in which the blades will be turned to reestablish on-speed operation. When the engine speed has dropped below the rpm for which the governor is set, the resulting decrease in centrifugal force allows the governor fly-weights (2) to move inward under the force of the speeder spring (1) and the pilot valve (3) is lowered. This action opens up the propeller-governor metering port and oil flows from the governor booster pump, through the propeller-governor line (4) and the propeller shaft (10). It enters the propeller piston (6) and the cylinder (5) moving the cylinder outward. Since the cylinder is connected to the counterweight brackets (7) by the shaft and bearing group (8), the centrifugal force of the counterweights is overcome and the brackets (7) are moved inward. The brackets are directly connected to the blades (9), and consequently the blades are moved to the lower angle indicated by the dotted outline. As the blades assume a lower angle, the load on the engine is decreased and engine speed increases. An increase in engine speed is reflected in the governor fly-weights (2) by an increase in centrifugal force, and consequently they move outward overcoming the speeder spring force. The pilot valve (3) is raised and the flow of oil to the propeller gradually cut off. This action continues until the blade angle is once again that required for on-speed operation at which time the governor fly-weights are in a vertical position and the pilot valve practically closes off the flow of oil to the propeller. (The pilot valve never completely closes off the propeller line since a certain amount of oil is lost to drain at the propeller shaft oil transfer rings. It is

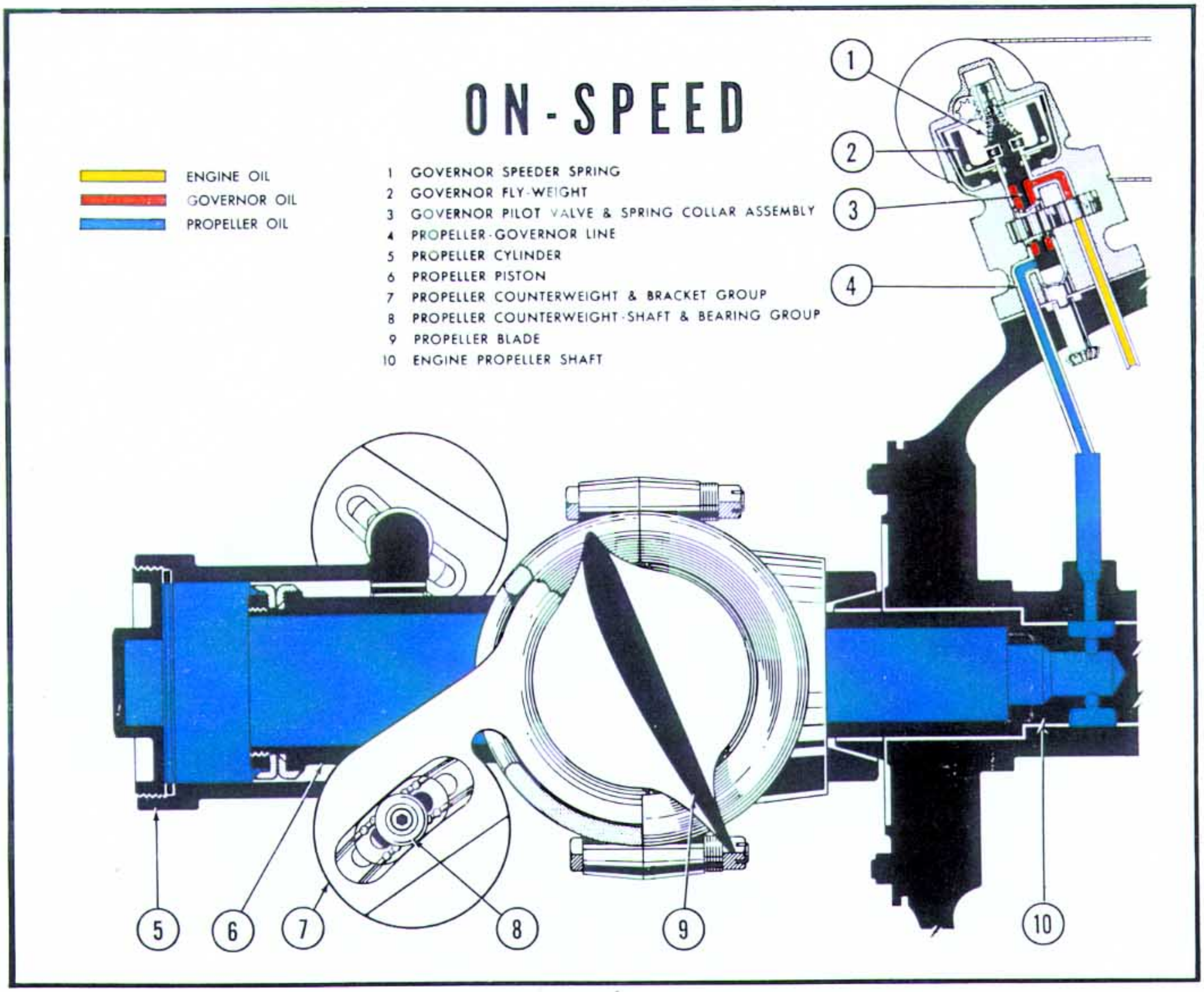


Figure 51 — Propeller Operating Diagram — On-Speed Condition

therefore necessary for the governor to make up this loss in order that the propeller will remain on-speed.)

(*c*) ON-SPEED CONDITION.—In the on-speed condition shown in figure 51, the propeller and governor forces are in equilibrium. The governor fly-weights (2) are in a position which permits the pilot valve (3) to close the propeller-governor metering port completely except for a small bleed flow which replaces normal leakage to the engine oil sump past the propeller shaft oil transfer rings.

(*d*) OVERSPEED CONDITION.—The propeller is operating in an overspeed condition when it is rotating above the rpm setting. As shown in figure 52, the blades (solid black section) have moved to a lower angle than that required (dotted outline) for constant speed operation. The arrow indicates the direction in which the blades will be turned to re-establish on-speed operation. When the engine speed has increased above the rpm for which the governor is set, the resulting increase in centrifugal force moves the governor fly-weights (2) outward overcoming the force of the speeder spring (1) and raising the pilot valve (3). This action opens the propeller-governor metering port to drain, and oil flows from the propeller cylinder (5) into the engine oil sump. The centrifugal force of the counterweights then becomes effective, the brackets (7) move outward, and the blades (9) are turned to the higher angle indicated by the dotted outline. As the blades assume a higher angle, the load on the engine is increased and engine speed decreases. A decrease in engine speed is reflected in the governor fly-weights (2) by a loss in centrifugal force, and consequently they move inward under the force of the speeder spring (1). The pilot valve (3) is lowered and the flow of oil from the propeller gradually cut off. This action continues until the blade angle is once again that required for on-speed operation at which time the governor fly-weights are in a vertical

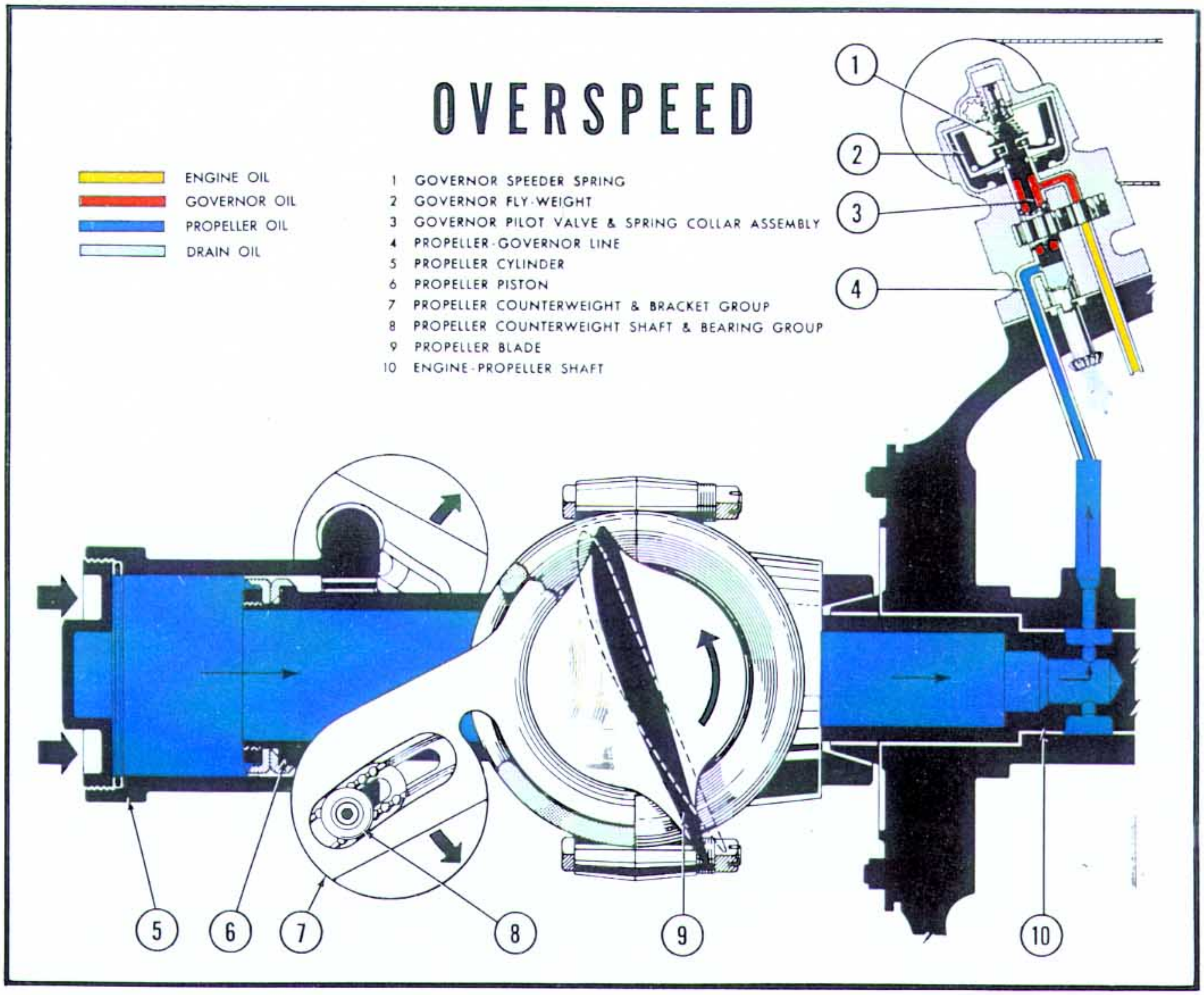


Figure 52 — Propeller Operating Diagram — Overspeed Condition

position and the pilot valve closes off the propeller line. Again, the valve does not completely close off this line since a small amount of oil must be supplied to the propeller in order to replace normal leakage past the propeller shaft oil transfer rings.

b. PROPELLERS WITH SPRING RETURN ASSEMBLY.—Because of the increased angular travel and the cam slope in the counterweight brackets, certain models require additional operating force toward high pitch. These propellers incorporate two co-axial springs set inside the propeller piston. The springs are compressed when the cylinder moves outward as the blades go to low pitch, and they open up aiding the propeller toward high pitch when the cylinder moves inward. The spring force is greatest in full low pitch, becoming less as the blades move toward a higher angle. About two-thirds the way between full low and full high pitch, the spring force is discontinued.

2. OPERATION INSTRUCTIONS.

Note

The procedures outlined in this section are suggestions for operation of the Counterweight type propeller. To account for various changes which are peculiar to any given aircraft, consult the engine or aircraft manufacturers' Handbooks.

a. GROUND TESTS.—Start the engine in the normal manner with the cockpit propeller control in the full low rpm (high pitch) position. With the governor set in this positive high pitch position, the propeller will operate as a fixed pitch propeller and the engine will be controlled by the throttle only. As soon as oil pressure is indicated, move the control to the high rpm position. If the propeller does not respond, shut down the engine immediately and check the propeller and governor. If operation is satisfactory, warm up the engine in accordance with the manufacturer's specifications, and after completion of the warm-up period, advance the throttle to some intermediate (65 to 70 percent of normal rated) engine speed; for example, 1600 rpm. Move the propeller control several times between the minimum and maximum settings, and check to see that the propeller and governor function properly. Finally, move the control to the high rpm position and make the customary check of engine manifold pressure against engine rpm. (In some installations it is impossible to obtain take-off rpm on the blocks with take-off manifold pressure.) Refer to section III for complete instructions regarding adjustment of settings.

b. FLIGHT TESTS.

(1) TAKE-OFF.—Place the propeller control in the full high rpm position. Gradually advance the throttle to the take-off manifold pressure desired. Engine rpm will increase until it reaches the take-off rpm for which the governor has been set. Normal overspeeding is to be expected with rapid throttle opening. The rpm will be held constant by the governor, which means that full power is available during take-off and climb without excessive engine speed. Soon after take-off it is generally desirable to reduce power and then rpm. All changes in governor control and throttle setting should be made smoothly. In the case of the Controllable type propeller, operate the control valve to put the propeller in low pitch during take-off, and when sufficient altitude has been obtained, reverse the control valve position to put the propeller blades in high pitch.

Note

If power and speed are to be increased, increase the propeller rpm setting first and then the throttle. If power and speed are to be decreased, reduce the throttle first and then the propeller rpm setting. These procedures prevent excessive cylinder head pressure.

(2) CRUISING.—Once the cruising rpm has been set, it will be held constant by the governor. All changes in attitude, altitude, and engine manifold pressure can be made without affecting the rpm as long as the blades do not contact the pitch limit stops. If the Controllable type propeller is used, the correct blade angle will be the high pitch angle.

(3) FIXED PITCH OPERATION.—The Constant Speed type propeller can be operated in positive high pitch if desired by moving the propeller control to the positive high pitch position.

(4) POWER DESCENT.—Power descent operation in which the power absorption limits of the propeller are not exceeded is fully controlled by the governor. As the air speed increases during a descent, the governor will move the propeller blades to a higher angle in order to hold the rpm at the desired setting. If the high pitch limit of the propeller is high enough, the rpm will remain constant, but if the blades contact the stops, the propeller rpm will be affected by any further increase in air speed or throttle setting. Since an increase in rpm, a decrease in manifold pressure, or a decrease in air speed requires a decrease in blade angle, it is possible for the governor to regain control by increasing the rpm with the propeller control, decreasing the manifold pressure, or decreasing the air speed. In the case of the Controllable type propeller, the blades remain in full high pitch for a power descent.

(5) APPROACH AND LANDING.—Adjust the propeller control to the maximum cruising rpm position, and then make all further rpm adjustments by means of the throttle. With the propeller control in this position, emergency requirements can usually be met by throttle adjustment alone. Upon landing, place the governor control in the full high rpm position. This moves the blades to full low pitch which affords better ground control and more satisfactory operation of the engine. In the case of the Controllable type propeller, operate the valve to move the blades into the full low pitch position, adjust the throttle to prevent overspeeding, and then make all further rpm adjustments by means of the throttle only.

(6) STOPPING THE ENGINE.—The propeller should be shifted to the positive high pitch position before stopping the engine. This procedure protects the piston bearing surface from collecting foreign matter, and also empties the propeller cylinder of oil which might otherwise congeal in cold weather. Movement to high pitch will be facilitated by short bursts of the throttle.

(7) MIXTURE CONTROL.—Since the constant speed control holds engine rpm constant regardless of power output, the mixture cannot be adjusted by watching the tachometer except when the governor has been placed in the positive high pitch position. This does not apply to the Controllable type.

(8) ENGINE FAILURE.—It is very desirable to reduce engine speed to a minimum in case of engine failure. Since positive high pitch offers the least drag, the propeller should be placed in this position.

(9) COLD WEATHER OPERATION.—On aircraft equipped with provision for dilution of the engine oil system, operate the propeller control to obtain a change of 400 rpm. and repeat this operation three times during the last two minutes of the oil dilution operation. This procedure provides diluted oil in the propeller and control system. In this case also, the engine should be stopped with the propeller control in positive high pitch.

SECTION V
SERVICE INSPECTION, MAINTENANCE, AND LUBRICATION

1. SERVICE TOOLS REQUIRED.

NAME OF TOOL	PROPELLER MODELS						APPLICATION
	2B20	2D30	12D40	2E40	3D40	3E50	
Counterweight Cap Wrench	M-754	M-157	M-157	M-157	M-157	M-157	Used to tighten and remove steel counterweight caps.
Counterweight Cap Wrench	M-754	M-742	M-742	M-742	M-742	M-742	Used to tighten and remove aluminum counterweight caps.
Installation Wrench	M-1087	M-1088	M-1089	M-1096	M-1096	M-1097	Used to tighten and remove propeller piston, piston gasket nut, and cylinder head.
Grease Gun Extension	51318	51318	51318	51318	51318	51318	Used on grease gun to lubricate spider arm.
Blade Turning Device	M-712	M-712	M-712	M-712	M-712	M-712	Used to turn blades in an assembled propeller.
Propeller Hoisting Sling	M-462	M-462	M-462	M-462	M-462	M-462	Two-strap hoisting sling for propellers.

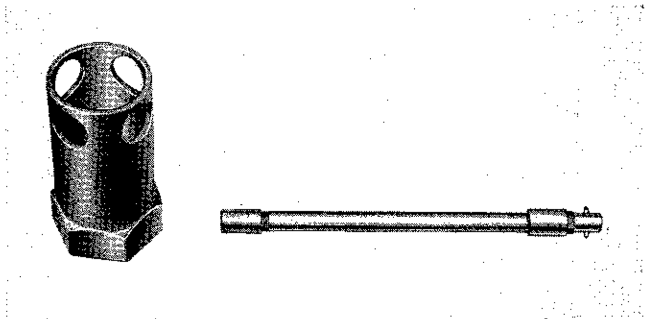


Figure 53 — Grease Gun Extension and Installation Wrench

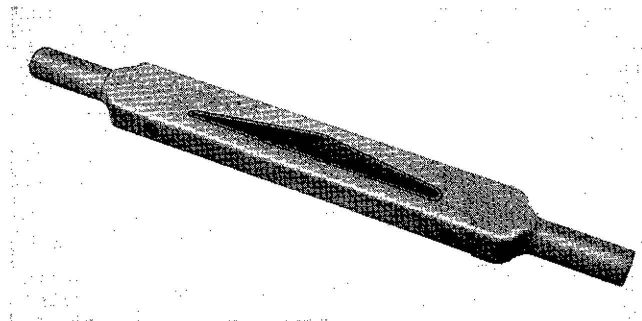


Figure 55 — Blade Turning Device

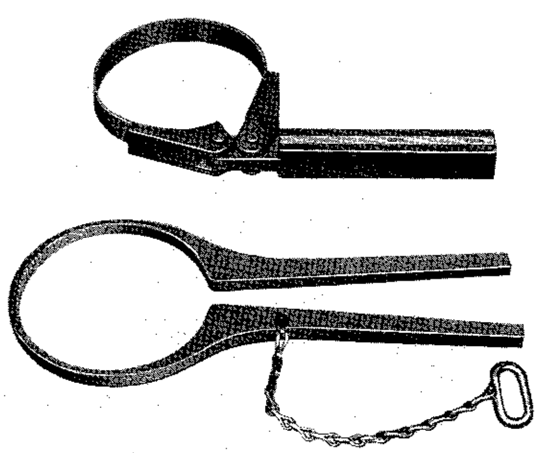


Figure 54 — Counterweight Cap Wrenches

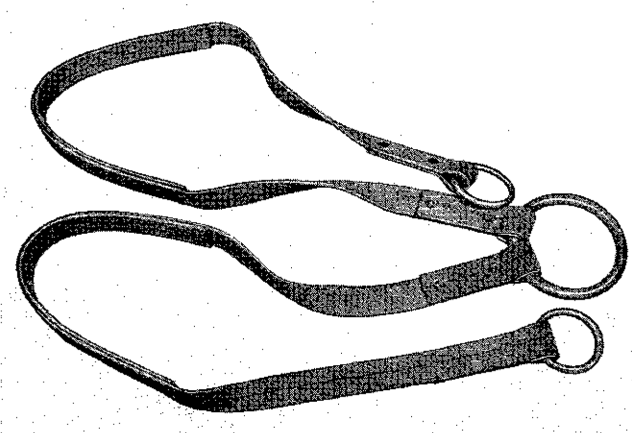


Figure 56 — Propeller Hoisting Sling

2. SERVICE INSPECTION.

Note

Inspection periods established for Army Air Forces and Navy service organizations are not identical. Therefore, the inspection periods specified in this section in terms of hours consist of two figures; e.g., 25-30 Hour Inspection. The first figure indicates the Army Air Forces inspection period, and the second the comparable Navy inspection period. In accordance with T.O. No. 00-20A-2, a summary of the period inspections prescribed below will be entered by Army Air Force Personnel on the Master Airplane Maintenance Forms maintained in the back of Form 41B for the airplanes affected.

——COLUMN NO. 28——

PROPELLERS AND ACCESSORIES

a. PREFLIGHT INSPECTION.

(1) Perform preflight inspection as specified in the Handbook for the aircraft.

(2) Prior to starting engines equipped with Counterweight propellers, the cockpit control should be in the minimum rpm position (positive high pitch) in order to avoid possible lack of oil at the master rod bearings. Start the engine in the normal manner and, as soon as oil pressure is indicated, move the control to the high rpm position. If the propeller does not respond, shut down the engine immediately and check the propeller and governor. If operation is satisfactory, warm up the engine in accordance with the manufacturer's specifications.

(3) With the engine running at reduced throttle, operate the propeller control three or four times through its entire range. The propeller should respond to movement of the propeller control (as indicated by the tachometer) within the power limit of the reduced throttle setting. This test serves to show up any improper operation of the propeller, governor, or engine.

(4) Move the propeller control to the maximum rpm position, advance the throttle and make the customary check of engine rpm against full allowable manifold pressure on the blocks. It should be remembered that on some installations it is impossible to obtain take-off rpm on the blocks with maximum allowable manifold pressure.

b. DAILY INSPECTION.

(1) HUB.

(*a*) The exterior of the hub will be carefully examined for any evidence of damage.

(*b*) Check for proper safetying at the following points.

1. Cylinder head lock ring.

2. Clamp nut lock ring on 2E40, 3D40, and 3E50 models only.

3. Counterweight cap clevis pins and cotter pins.

4. Piston lock ring cotter pins on 2B20, 2D30, 12D40 models only.

5. Barrel bolt cotter pins.

6. Counterweight bearing shaft cotter pins.

(*c*) Visually check for oil leakage at the cylinder head, base of cylinder, piston breather holes, base of piston, and rear cone area. Look for excessive grease on the blade shanks and at the outboard and inboard ends of the barrel.

(*d*) To check for looseness of the propeller, attempt to move the hub fore and aft on the propeller shaft. Outside of allowable looseness in geared reduction drives, no looseness of the hub on the propeller shaft is permitted.

(*e*) Inspect for ample lubrication of the counterweight bearing. No disassembly of the propeller is necessary as this inspection can be made at the inside face of the bracket slot.

(2) BLADES.

(*a*) Inspect all blades for corrosion, bends, nicks, cracks, raised edges, etc. If a more complete check for cracks is considered necessary, apply local etching. See paragraph 3.a.(1) of this section for minor blade repair procedure.

(*b*) Check the blades for deterioration of markings. If markings are obliterated, see paragraph 3.f.(1) of this section.

(*c*) If the blades incorporate fairings, check for damage to these and, if necessary, repair according to the procedure outlined in paragraph 5.b.(9) of section VI.

(3) TWO-WAY VALVE CONTROL UNIT.—This unit is installed for Controllable type Counterweight propellers only. Check all connections for oil leaks and controls for full travel.

c. 25-30 HOUR INSPECTION.

(1) Inspect the exposed portion of the piston for corrosion, galling, or nicks. Using blade turning devices, move the blades into the low pitch position for this check. On 20-degree Counterweight propellers the spring return assembly must be removed before the blades can be placed in low pitch.

(2) The exterior of all parts of the propeller blades will be examined for cracks, bends, nicks, and other damage. The entire leading edge, trailing edge, and tip portion of the blades will be carefully inspected for development of cracks. When necessary,

use a magnifying glass during these inspections and perform local etching according to paragraph 3.a.(1) of this section.

d. 50-60 HOUR INSPECTION.—Check the piston for tightness by removing the locking means and applying a force of 180 pounds on the end of a 4-foot bar inserted in the proper installation wrench.

e. 100-120 HOUR INSPECTION.—Check to insure that the counterweight bearing and shaft installation is not loose. Using a thickness gage, check the clearance between the counterweight bracket and bronze thrust washer. A clearance of .003-.006 inch at the tightest point is specified for all Counterweight propellers. (See section VI, paragraph 6.a.(6)(e).)

f. 200-240 HOUR INSPECTION.

(1) Check the counterweight thrust bearings for ample lubrication.

(2) The counterweight bearing retainers should be thoroughly cleaned and the balls examined for pit marks or cracks.

(3) The counterweight bearing races should be closely examined for wear, galling, or brinelling, and visually inspected for fatigue cracks.

g. ENGINE CHANGE INSPECTION.—Check the propeller operating time since the last overhaul. If the total time since the last overhaul, plus the maximum possible operating time for the replacement engine, totals more than the allowable operating time between propeller overhauls, remove and overhaul the propeller as outlined in section VI.

h. SPECIAL INSPECTIONS.

(1) As soon as possible after a propeller strikes or is struck by any object, the propeller will be carefully examined for possible damage. A propeller involved in an accident will not be used before it is first disassembled and the parts carefully inspected for damage and misalignment. Steel parts will be inspected by an approved magnetic inspection method. The aluminum alloy blades, if otherwise serviceable, will be tested by anodic treatment or by any other approved method for detecting cracks.

(2) The piston of a newly installed propeller should be checked for tightness after the first flight.

3. MAINTENANCE.

a. MINOR BLADE REPAIR.

(1) LOCAL ETCHING.—Caustic solution for local etching will be prepared locally by adding one pound of commercial technical-grade caustic soda to a gallon of water. The quantity of solution will depend on the amount of etching to be done. With No. 00 sandpaper or crocus cloth, clean and smooth off the area containing the apparent crack. Apply a small quantity of caustic solution to the suspected area with a swab or brush. After the area is well darkened, thoroughly wipe it off with a clean (dampened) cloth. Too much water may entirely remove the solution from a crack and spoil the test. If a crack extending into the metal exists, it will appear as a dark line or mark, and by using a magnifying glass, small bubbles may be seen forming in the line or mark. Immediately upon completion of the final checks, all traces of the caustic solution will be removed with a solution of one part of concentrated technical-grade nitric acid to five parts of water. Wash the blade thoroughly with clean (fresh) water. The blade will then be dried and coated with clean engine oil.

(2) BLADE REPAIR PROCEDURE.

(*a*) To avoid dressing off an excessive amount of metal, check by local etching at intervals during the process of removing cracks and double-backed edges of metal. Suitable sandpaper or fine cut files may be used for removing the necessary amount of metal. In each case, the area involved will be smoothly finished with No. 00 sandpaper, and each blade from which any appreciable amount of metal has been removed will be properly balanced before it is used.

(*b*) Raised edges of cuts, scars, scratches, nicks, etc. will be removed; however, if their removal or treatment takes the blade below the allowable repair limits, the blade shall be retired from service.

(*c*) The metal around longitudinal surface cracks, narrow cuts, and shallow scratches will be removed in such a way that shallow saucer-shaped depressions as shown in figure 58 are formed. Blades requiring the removal of metal which would form a finished depression more than 1/8 inch in depth at its deepest point, 3/8 inch in width, and one inch in length, will be sent to an approved overhaul base.

(*d*) The metal at the edge of wide scars, cuts, scratches, nicks, etc. will be rounded off and the surfaces within the edges smoothed out as shown in figure 58. Blades that require the removal of metal to a depth of more than 1/8 inch and a length of more than 3/4 inch will be sent to an approved overhaul base or depot.

WARNING

The only acceptable methods of repairing cuts, nicks, cracks, etc. in blades are those by which metal containing and adjacent to the damage is removed from the blade to leave a smooth well-faired surface. Methods which attempt to relocate metal by cold-working to cover or conceal the defect rather than remove the damage are not acceptable.

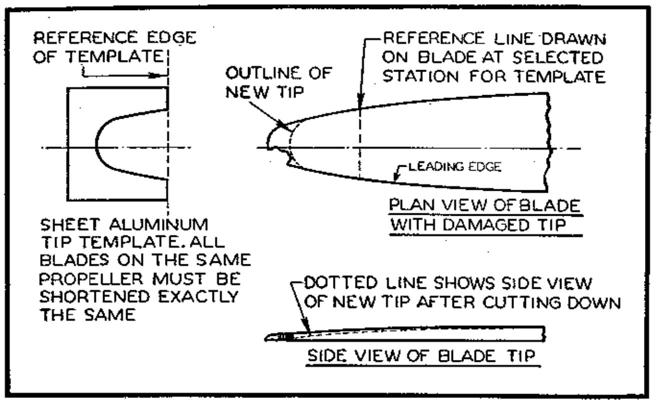


Figure 57 — Template for Blade Tip Rework

(*e*) With the exception of cracks, it is not necessary to completely remove or "saucer out" all of a comparatively deep nick unless it has a sharp bottom. Since it is essential that no metal be removed unnecessarily, properly rounding off the edges and smoothing out the surface within the edges is usually sufficient.

(*f*) A reasonable number of repairs per blade may not be dangerous (if within the limits specified) unless their location with respect to each other is such as to form a continuous line of repairs that would materially weaken the blade.

(*g*) Blades that have the leading edges pitted from normal wear may be reworked by removing sufficient material to eliminate the irregularities. The metal will be removed by starting at approximately the thickest section, and working forward over the leading edge camber so that the contour of the reworked portion will remain substantially the same. In all cases, avoid abrupt changes in section or blunt edges.

(*h*) When the removal or treatment of damage to the blade tip necessitates shortening a blade, each blade used with it will likewise be shortened. Blades reworked in this manner will be kept together as sets. The method used in accomplishing this rework is shown in figure 57.

(*i*) Straightening of repairable bends in aluminum alloy blades will be accomplished as described in paragraph 5.b. of section VI.

(*j*) CONDEMNATION.—Unless otherwise specified, a blade having a crack, cut, scratch, scar, etc. that cannot be dressed off within repair limits shall be retired from service.

(*k*) DISPOSITION.—Unless otherwise specified, all propellers, blades, hubs and attaching parts (except those on service test) that are worn out through fair wear and tear, or damaged beyond economical repair will be disposed of in accordance with existing instructions.

b. LEAKAGE.—Replace any damaged gaskets or seals. For full details covering leakage, refer to paragraph 5. in this section.

c. CLEANING OF PROPELLERS.—Except in the case of etching, caustic material will not be used on a propeller. The removal of enamel and varnish from propeller parts will be accomplished by the use of

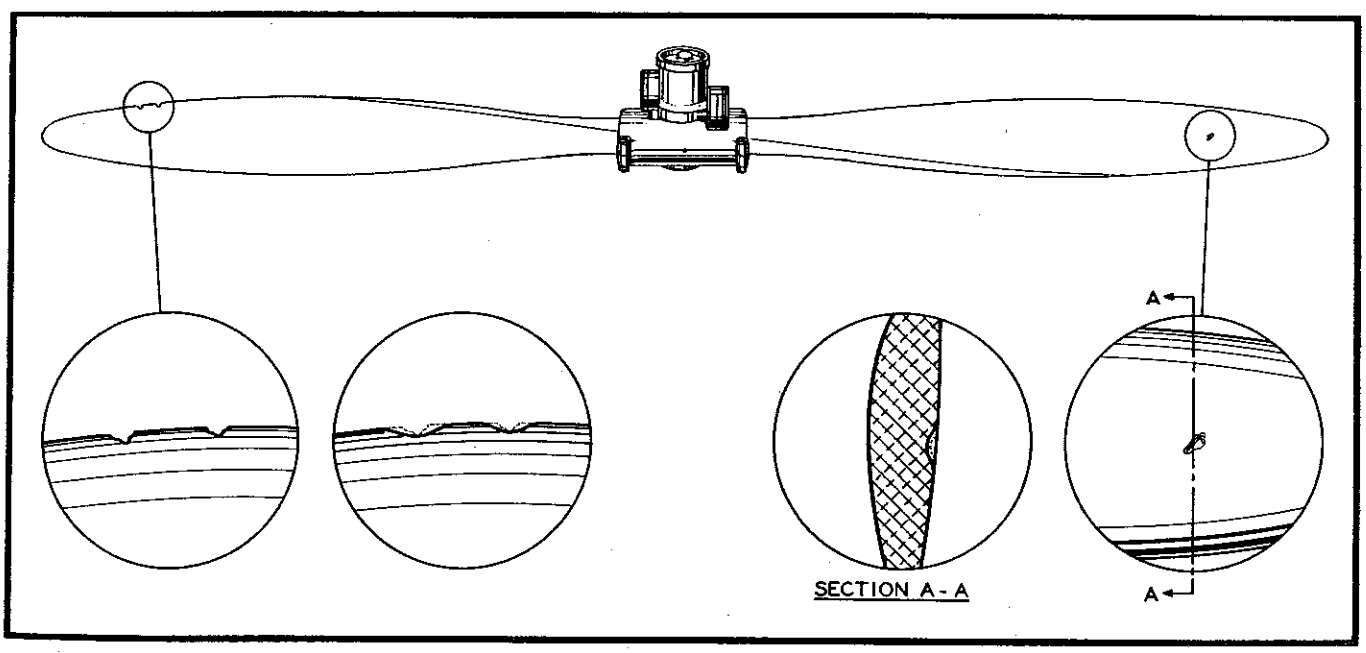


Figure 58 — Sketch Showing Typical Nicks in Blades and Method of Removal

approved lacquer thinners and solvents. As soon as possible after a propeller has been subjected to salt water, all traces of salt on all parts of the propeller will be flushed off with fresh water and the propeller then thoroughly dried and coated with clean oil.

(1) STEEL HUBS.—Steel hubs will be cleaned with soap and fresh water, unleaded gasoline, or kerosene. Use suitable cloth or brushes. Tools and abrasives that will scratch or otherwise damage the plating will not be used, and under no circumstances will acid or caustic material be used.

(2) PISTONS.—To clean the exposed portion of the piston, first put the propeller in full low pitch position using blade turning devices. For cleaning, use kerosene or unleaded gasoline, and then coat the surface of the piston with clean engine oil. Return the propeller to the full high pitch position.

(3) ALUMINUM ALLOY BLADES.—Warm fresh water and soap, unleaded gasoline, or kerosene, and suitable brushes or cloth, as may be available and practical, will be used for the cleaning of aluminum alloy blades. Except as authorized herein for operations of etching and repair, scrapers, power buffers, steel wool, steel brushes, and any other tool or substance that will scratch or otherwise mar the surface will not be used on blades. In special cases where a high polish is desired, a responsible party may authorize the use of a good grade of metal polish, provided that upon completion of the polishing all traces of polish are immediately removed and the blades cleaned and coated with a thin film of clean engine oil.

d. REMOVAL OF CLEANING SUBSTANCES.—All cleaning substances will be immediately removed on completion of the cleaning of any propeller part. Soap in any form will be removed by thoroughly rinsing with fresh water, after which all surfaces will be dried and coated with clean engine oil.

e. HUB MARKINGS.—Propeller hubs now being furnished have the model number applied by etching or stamping with ink. All remarking shall be done in the same manner.

f. BLADE MARKINGS (ARMY).

(1) Each Army blade will be marked with 1/2-inch letters and numbers between the 18- and 24-inch station on the camber side in accordance with the following:

(*a*) AAF serial number. (Preceded by the letter "R" if a repaired blade.)

(*b*) Part or drawing number.

(*c*) Blade angle settings.

(2) The foregoing data will be painted, stenciled, or rubber stamped on the blade. In no instance will such markings be indented or cut into the metal. The markings will be protected with a coat of spar varnish or clear lacquer.

(3) Blades will be painted to agree with local requirements, and in accordance with the procedure described in paragraph 5.b.(8) of section VI. No decorative markings will be placed on military blades; however, manufacturers' trade marks are not considered decorative and are required on the camber side of each blade.

g. VIBRATION.—If propeller vibration has been reported, check all blade angle settings by using a bubble protractor at the blade reference station. The blade angles between blades should be the same within 0.2 degree. The high angle should be within 0.1 degree of the specified high pitch setting, and the low angle within 0.3 degree of the specified low pitch setting. If necessary, check the track of each blade. This can be accomplished by fixing a rigid pointer on the aircraft fuselage, wing or engine nacelle, extending to the face of the propeller blade near the extreme tip. Rotate the propeller and measure the distance from the end of the pointer to a point near the tip of each blade. For propellers having a nominal diameter of less than 10 feet 6 inches, the blades shall track within 1/8 inch. For propellers having a nominal diameter greater than 10 feet 6 inches, the blades shall track within 3/16 inch.

4. LUBRICATION.

Note

Unless otherwise specified, grease to Specification No. AN-G-4-2 or its equivalent, such as Mobilgrease No. 3, shall be used as a lubricant wherever grease application is required on Counterweight propellers.

a. SPIDER.—The spider arms shall be greased every 25-30 hours. If a power operated grease gun is used, set the cut-out pressure to 2000 p.s.i. If a hand type grease gun is used, care should be taken not to build up excessive pressure as damage to the leather grease retainers and the grease fittings may result. A sudden increase of resistance to operation of the gun is a good indication that sufficient grease has been forced into the spider. Hold the grease gun firmly and squarely on the grease fitting so that grease cannot work into the barrel. To prevent an unbalance condition, care should be taken that all of the fittings on the propeller are greased. (There is one fitting for each blade of the propeller assembly.)

b. COUNTERWEIGHT BEARINGS.—Under certain operating conditions excessive wear on the counterweight bearings may occur. To minimize this wear, daily lubrication is recommended. However, if conditions warrant, a maximum duration of 10 hours may elapse between lubrication periods of these bearing retainers. The counterweight cap need not be removed as grease can be inserted with the fingers directly onto the counterweight bearings through the inside face of the slot in the counterweight bracket.

c. COUNTERWEIGHT THRUST BEARINGS.—These bearings shall be lubricated at the 200-240 hour inspection.

d. BLADE THRUST BEARINGS.—It is necessary to disassemble the propeller to grease the blade thrust bearing assemblies; consequently, they are lubricated at propeller overhaul only.

5. SERVICE TROUBLES AND REMEDIES.

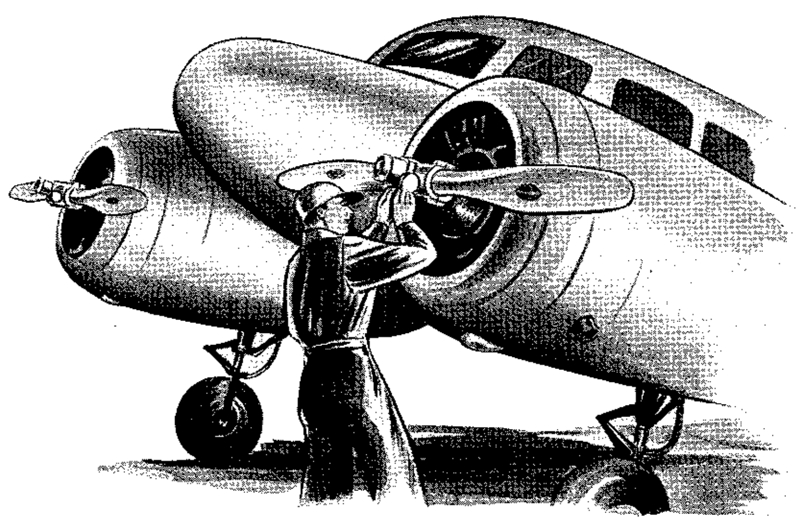
a. The following information in its condensed table form lists the troubles, the probable causes, and the remedies most frequently encountered in propeller Field servicing work. Some of these troubles might also be the result of malfunctioning of the governor, the engine, or other accessories in the aircraft.

b. This information, supplemented by a thorough understanding of the principle of operation of the propeller, should make trouble-shooting relatively simple. Careful and accurate determination of the troubles, their related causes, and remedies will reduce to a minimum the time required for servicing and will aid in extending the life of the equipment.

TROUBLE	PROBABLE CAUSE	REMEDY
INABILITY TO ATTAIN TAKE-OFF RPM ON THE BLOCKS	Improper setting of stop nuts on the adjusting screw in the counterweight.	Remove counterweight caps. Reset and check nuts.
	Wrong indexing of counterweight bracket on blade bushing.	Relocate index pins.
	Incorrect plugging of propeller shaft.	Correct plugging.
Caution With take-off manifold pressure, it is impossible, in some installations, to obtain take-off rpm on the blocks.	Faulty oil control valve (controllable type propeller).	Consult engine manual.
	Wrong setting of governor or incorrect rigging of control system.	Consult governor manual.
	Excessive engine transfer ring leakage.	Replace rings according to engine manufacturers' specifications.
	Low engine power.	Consult engine manual.
	Erroneous reading tachometers or manifold pressure gages.	Calibrate instruments.
ROUGHNESS	Ice on propeller blades.	Operate de-icing equipment.
	Excessive propeller shaft run-out.	Consult engine manual.
	Propeller unbalance.	Remove propeller and re-balance.
	Blade angles vary among blades.	Check location of index pins. If satisfactory, see section VI, paragraph 5. b. (3) for repair of twisted blades.
	Blades out of track.	Repair bent blades. See section VI, paragraph 5. b.
	Cocked cylinder.	Remove counterweight caps and adjust setting of stop nuts on adjusting screw.
	Propeller loose on engine shaft.	Check front and rear cones for galling. Clean up with crocus cloth, and then re-install properly.
	Front cone halves not matched.	Install matched cone.
	Poor ignition or carburetion.	Consult engine manual.

TROUBLE	PROBABLE CAUSE	REMEDY
OIL LEAKAGE		
Between cylinder head and cylinder.	Cylinder head gasket worn or damaged.	Replace gasket.
	Cylinder head loose.	Tighten cylinder head.
At base of cylinder.	Outboard piston gasket damaged.	Replace gasket.
	Piston gasket nut loose.	Tighten gasket nut and safety.
	Cylinder liner worn or scored.	Rework liner with fine emery and crocus cloth as long as cylinder is oil tight. Otherwise, replace with new cylinder assembly or insert new steel liner in old cylinder. See section VI, paragraph 5. a. (13) (b).
	Inboard gasket installed in place of outboard gasket.	Remove cylinder head and install gaskets correctly.
At rear cone.	Loose piston.	Tighten piston.
	Front cone packing washer damaged.	Remove piston and install new front cone packing washer.
	Master spline screw loose or missing.	Remove propeller from engine shaft and tighten or replace screw.
From breather holes in piston.	Oil supply pipe packing nut loose.	Tighten nut and safety.
	Oil supply pipe packing washer worn or damaged.	Install new packing washer.
	Incomplete engine scavenging or excessive blow-by.	Consult engine manual.
At inboard end of oil supply pipe.	Loose pipe or nut.	Tighten loose nut or pipe and safety.
	Damaged pipe gasket.	Replace damaged gasket.
Between cylinder head and clamp nut.	Worn or damaged clamp nut gasket.	Install new clamp nut gasket.
	Loose clamp nut.	Tighten clamp nut.
GREASE LEAKAGE		
Between spider and barrel.	Worn or damaged grease retainer.	Disassemble propeller and install new retainer.
	Grease retainer blown due to excessive lubricating pressure.	Disassemble propeller and install new retainer.
	Grease accidently pumped into barrel while lubricating.	Disassemble propeller and wipe off excess grease. Recheck grease balance of propeller.
From counterweights.	Excessive amount of grease in counterweight bracket assembly.	Remove counterweight caps and wipe off excess grease.
OVERSPEEDING AT TAKE-OFF	Improper setting of stop nuts on the adjusting screw in the counterweight.	Remove counterweight cap and correct stop nut settings.
	Angles wrong because counterweight improperly stamped.	Remove propeller from engine and correct stamping and setting.
	Wrong setting between the bracket and bushing.	Disassemble propeller and relocate index pins.
	Wrong setting on governor.	Consult governor manual.
	Too rapid opening of throttle.	Advance throttle evenly and slowly.
	Erroneous reading tachometers or manifold pressure gages.	Calibrate instruments.

TROUBLE	PROBABLE CAUSE	REMEDY
POOR SYNCHRONIZATION	Brinelled races in counterweight bearing assembly.	Install new bearing races.
	Insufficient or excessive thrust washer clearance.	See section VI, paragraph 6. a. (6) (e).
	Bent counterweight bracket.	See section VI, paragraph 5. a. (6).
	Worn or damaged blade thrust bearings.	Disassemble propeller and clean, lubricate, or replace worn parts. See section VI, paragraph 5. b. (2) (c).
	Insufficient lubrication in hub assembly.	Lubricate with grease to Specification No. AN-G-4-2.
	High blade frictional torque.	Disassemble and adjust torque. See section VI, paragraph 6. a. (3).
	Worn inboard and/or outboard piston gaskets.	Replace gaskets.
	Piston gasket nut too tight.	Loosen nut and tighten properly.
	Twisted spring puller bolt.	Replace bolt.
	Sludge in governor pilot valve or relief valve.	Consult governor manual.
	Erroneous reading tachometers.	Calibrate instruments.
	Ignition or carburetion trouble.	Consult engine manual.
	Excessive engine transfer ring leakage.	Consult engine manual.



SECTION VI
DISASSEMBLY, INSPECTION, REPAIR AND REASSEMBLY

1. OVERHAUL TOOLS.

NAME OF TOOL	PROPELLER MODELS						APPLICATION
	2B20	2D30	12D40	2E40	3D40	3E50	
Assembly Table	M-33	M-33	M-33	M-33	M-33	M-33	Used for assembly and disassembly of propellers.
Assembly Post & Support	M-167						Holds assembly & balance sleeve on assembly table. Specify details 1, 3, 4, 9.
Assembly Post & Support		M-167	M-167	M-167	M-167		Holds assembly & balance sleeve on assembly table. Specify details 1, 3, 4, 7.
Assembly Post & Support						M-167	Holds assembly & balance sleeve on assembly table. Specify details 1, 2, 3, 4.
Blade Service Table	M-116	M-116	M-116	M-116	M-116	M-116	Used for blade repair work.
Headstock	M-300	M-300	M-300	M-299	M-300	M-299	Holds blade parallel to service table during blade repair. "B" shank blades use arbor 6095-T-9, details No. 9 and 10, and clamps M-594.
Propeller Protractor (90-degree)	PE-105	PE-105	PE-105	PE-105	PE-105	PE-105	Used for checking blade angles.
Blade Torque Bar	M-1095	M-1095	M-1095	M-1095	M-1095	M-1095	Used to determine tightness of blades in hub. Incorporates dial for direct torque reading.
Propeller Hoisting Sling	M-462	M-462	M-462	M-462	M-462	M-462	Used for hoisting propellers.
Blade Turning Device	M-712	M-712	M-712	M-712	M-712	M-712	Used to turn blades in an assembled propeller.
Balancing Stand (Pit Type)	M-46	M-46	M-46	M-46	M-46	M-46	Used for balancing propellers and blades. Does not include knife edges.
Balancing Stand (Portable Type)	M-716	M-716	M-716	M-716	M-716	M-716	Used for balancing propellers and blades. Does not include knife edges.
Knife Edge Assembly	M-232	M-232	M-232	M-232	M-232	M-232	Supports arbor during blade or propeller balance on M-46 and M-716.
Assembly & Balance Sleeve	M-756	M-758	M-759	M-759	M-759	M-760	Used as a base for propeller during assembly and balance.
Propeller Balancing Arbor	TAM-477-3	TAM-521-2	TAM-521-2	TAM-521-2	TAM-521-2	M-168	Used with assembly & balance sleeve.
Master Balancing Hub	M-750	6095-T-1	6095-T-1	6103-T-2	6095-T-1	6103-T-2	Used for balancing blades after repair or rework.
Master Balancing Hub Arbor	TAM-477-3	TAM-477-3	TAM-477-3	TAM-477-3	TAM-477-3	TAM-477-3	Used with master balancing hub.
Dummy Balancing Piston				M-762	M-762	M-763	Used to hold assembly & balance sleeve in propeller during balance.

NAME OF TOOL	PROPELLER MODELS						APPLICATION
	2B20	2D30	12D40	2E40	3D40	3E50	
Installation Wrench	M-1087	M-1088	M-1089	M-1096	M-1096	M-1097	Used on propeller piston, cylinder head, and piston gasket nut.
Counterweight Cap Wrench	M-754	M-157	M-157	M-157	M-157	M-157	Used on steel counterweight caps.
Counterweight Cap Wrench	M-754	M-742	M-742	M-742	M-742	M-742	Used on aluminum counterweight caps.
Blade Bushing Inserter	TAM-536	M-381	M-381	M-381	M-381	M-381	Used to install blade bushing.
Blade Bushing Puller	TAM-537	M-591	M-591	M-535	M-591	M-535	Used to remove blade bushing.
Blade Balancing Plug Puller	M-916	M-916	M-916	M-916	M-916	M-916	For use in removing blade balancing plug.
Grease Gun Extension	51318	51318	51318	51318	51318	51318	Used on grease gun to lubricate spider arms.
Blade Taper Bore Plug Gage	6109-T-6	6095-T-5	6095-T-5	6103-T-6	6095-T-5	6103-T-6	Used for bluing and squareness check of blade taper bore.
Blade Taper Bore Hand Reamer	6095-T-8	6095-T-8	6095-T-8	6095-T-8	6095-T-8	6095-T-8	Used to ream blade taper bore.
Blade Bushing Bore Gage	1201P-29	1201P-29	1201P-29	1201P-29	1201P-29	1201P-29	Used to check I. D. of blade bushing bearing surfaces. Made by Federal Products Corporation.
Blade Bushing Bore Gage	Model 41	Model 41	Model 41	Model 41	Model 41	Model 41	Used to check I. D. of blade bushing bearing surfaces. Made by Standard Gage Company, Inc.
Blade Fillet Tool	6135-T-3	6101-T-13	6101-T-13	6105-T-4	6101-T-13	6105-T-4	Used (in holder) to rework blade fillet. (Holder included in 6135-T-3.)
Blade Fillet Tool Holder	Not Required	6105-T-11	6105-T-11	6105-T-11	6105-T-11	6105-T-11	Used to hold blade fillet tool.
Blade Fillet Bluing Gage	M-1091	M-1092	M-1092	M-1093	M-1092	M-1093	Used to check radius of blade fillet after repair.
Rear Cone Lapping Tool	M-384	TAM-588	TAM-587	TAM-587	TAM-587	TAM-586	Used to remove galling from rear cone.
Spider Spline NO-GO Gage	M-150-20	M-150-30	M-150-40	M-150-40	M-150-40	M-150-50	Used to check width of spider splines.

2. DISASSEMBLY.

During all disassembly operations, check the position numbers of the hub and blade parts to make certain they were originally installed in the proper position. Keep mating parts with the same position numbers together as this will aid in correctly reassembling the propeller.

a. MODEL 2D30.

(1) DISASSEMBLY OF HUB.

(*a*) Install the assembly & balance sleeve on the assembly post, and then lower the propeller over the sleeve. Wrap paper around the shank section of the blades to protect them from damage.

(*b*) Remove the cotter pins and the clevis pins from the counterweight caps. Unscrew the caps from the counterweights using the correct counterweight cap wrench. Record the blade angle setting by noting the position of the adjusting screw nuts relative to the degree graduations on the counterweights, and then take out the adjusting screws. Remove the safety wire from the counterweight screws and take out the screws. Tap the counterweights off from the brackets with a soft hammer, using care not to bend the brackets or damage the surfaces of the brackets or counterweights. Take out the counterweight bearing retainer spacers, if they are used. Remove the counterweight bearing shaft cotter pins. Unscrew the counterweight bearing shafts, and then remove the counterweight bearing outer races and retainer assemblies together. While doing this, hold the cylinder to keep it from dropping. If counterweight thrust bearings and thrust washers are used, take out the thrust washers as soon as the bearing shafts have been removed. Remove the cylinder being careful not to drop the counterweight thrust bearing assemblies, and take out the counterweight thrust bearing outer races and retainer assemblies. Remove the counterweight bearing inner races from the bracket slots.

(*c*) Take out the cotter pins from the barrel bolts, unscrew the barrel bolt nuts, and remove the washers and the barrel bolts. Insert a soft metal drift in the slots at the parting surface of the inboard barrel half and pry the two halves apart a sufficient amount to permit the outboard barrel half to be tapped off with a lead or rawhide hammer. While removing the outboard barrel half, move the brackets toward low pitch to prevent the barrel from hitting the bracket arms. Tap the inboard barrel half off using care not to let the barrel or the thrust bearing retainer assemblies drop onto the assembly table. Remove the thrust bearing retainers and the barrel supports, if used. If the barrel supports incorporate vertical balancing washers, unscrew the self-locking nuts, take off the small washers and lead balancing washers, and remove the screws with their washers. Remove the grease fittings from the spider and take the blades off the spider arms.

CAUTION

If difficulty is experienced in removing the blades, turn the blades on the spider arm and pull at the same time. Under no circumstances should the blades be loosened by prying between the spider and shim plates.

Remove the shim plates, spider shims, and the leather grease retainers, if used, from the spider. Keep each set of shim plates and shims together. Remove the phenolic spider ring from the base of the spider. Lift the spider off the assembly & balance sleeve, leaving the sleeve on the assembly post. Remove the inboard barrel half from the assembly post.

(2) DISASSEMBLY OF BLADES.—Before removing the brackets from the blades, note and record the location of the index pins in the bushing and bracket in order to facilitate reassembly. Using a lead or rawhide hammer, remove the brackets from the blades keeping the index pins with their proper brackets. If blade chafing rings are used, take off the chafing rings by springing them sufficiently to allow them to be detached from the blades. When necessary, blade bushings or balancing plugs may be removed by means of the following procedure.

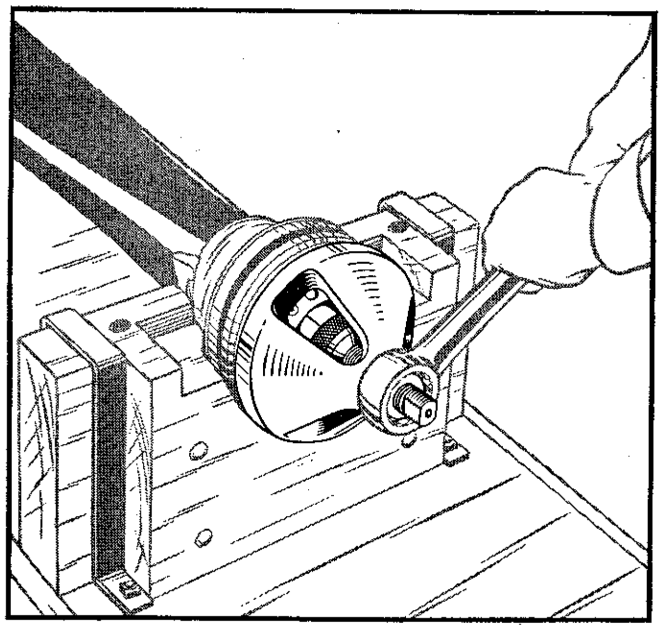


Figure 59 — Removing Blade Bushing

(*a*) Take out the bushing screws. Remove the bushing using the correct size blade bushing puller listed in paragraph 1. of this section. The expander portion of this tool is inserted inside the blade bushing and the flange at the base locked behind the end of the blade bushing. The "hat" portion is placed over

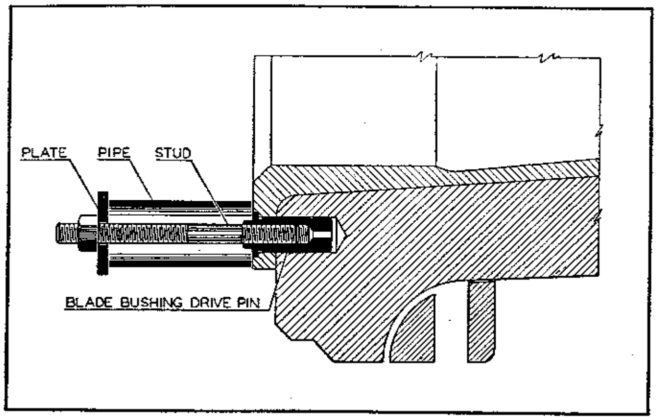


Figure 60 — Fixture for Pulling Blade Bushing Drive Pin

the blade butt with the expander stud protruding through the middle. The stud nut is then attached and tightened as shown in figure 59. If the shoulder on the blade bushing drive pins breaks off, and the pins do not come out with the bushing, they can be removed by drilling and tapping to 1/4 inch-20 N.C. Then install a steel stud (with the same thread) in the pin. This same bar should be threaded at the opposite end, a somewhat shorter pipe slipped over it, and a small piece of plate steel placed over the bar and against the pipe as shown in figure 60. Attach a nut onto the bar and pull the bushing drive pin by slowly and evenly tightening down on this nut.

(*b*) To remove the blade balancing plug, use the correct blade plug puller listed in paragraph 1. of this section. This tool is similar to the one for pulling the blade bushing drive pins except that the stud incorporates a 1/2 inch-20 N.F. thread to fit the balancing plug stud. If this tool is not available, a set-up

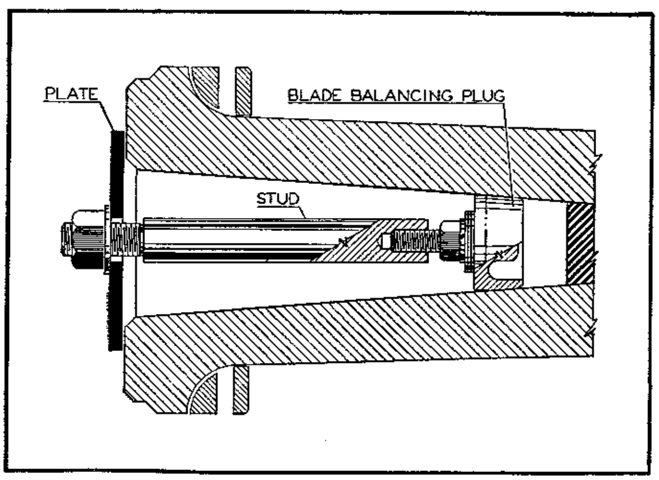


Figure 61 — Fixture for Pulling Blade Balancing Plug

similar to the one used to pull the drive pins may be used except that a flat plate with a hole for the stud is used in place of the pipe as shown in figure 61.

b. MODEL 2B20.—The disassembly procedure for the model 2B20 propeller is the same as that for the model 2D30 except for the following differences.

(1) DISASSEMBLY OF HUB.—Lock washers are used to safety the counterweight screws instead of safety wire. Counterweight bearing retainer spacers, counterweight thrust bearings, and barrel bolt washers are not used. Some models do not have thrust washers.

(2) DISASSEMBLY OF BLADES.—Before removing the brackets from the blades, note and record the number of degrees the blade keys are offset in order to facilitate reassembly. The offset of the keys is indicated by a number stamped on the key face preceded by a (+) or (−) sign except key part number 50140 which is a neutral key with no offset. Using a lead or rawhide hammer, remove the brackets from the blades. Remove the blade key screws and tap out the keys. Keep the blade keys with their proper brackets. Removal of the blade bushings and balancing plugs is accomplished in the same manner as described for the 2D30 propeller with the exception that blade bushing drive pins are not used in "B" shank blades.

c. MODEL 12D40.—The disassembly procedure for the 12D40 is the same as for the model 2D30.

d. MODEL 2E40.—The disassembly procedure for the model 2E40 is the same as that for the model 2D30 except that lock washers instead of safety wire are used to safety the screws which hold the counterweights to the brackets. If a spring return assembly is used, it should be disassembled as follows. Take out the puller bolt nut cotter pin and unscrew the puller bolt nut. Holding the piston gasket nut, remove the spring puller bolt and the puller bolt spring, then remove the piston gasket nut from the springs. Disassemble the spring puller plate and the inner and outer spring. To disassemble the piston, remove the cotter pin from the piston oil seal nut, unscrew the nut, and remove the piston oil seal.

e. MODEL 3D40.—The disassembly procedure for the model 3D40 is the same as that for the model 2D30 except that certain dash number propellers have barrel supports incorporating a barrel support rivet and key or plug. These parts, however, should not be disassembled. Some 3D40 propellers do not incorporate a phenolic spider ring. If a spring return assembly is used, refer to the disassembly procedure outlined for the model 2E40 propeller.

f. MODEL 3E50.—The disassembly procedure for the model 3E50 is the same as that for the model 2D30 except for the following differences. Lock washers instead of safety wire are used to safety the screws which hold the counterweights to the brackets. All later model 3E50 propellers use a counterweight bearing shaft clevis pin and cotter pin in place of the cotter pin alone. If a spring return assembly is used, refer to the disassembly procedure outlined for the model 2E40 propeller.

3. CLEANING.

a. The cleaning fluid used must be kept free from dirt or grit, and must be periodically renewed. All propeller parts are to be thoroughly cleaned by spraying, immersion, or by wiping with a soft cloth soaked with kerosene, non-leaded gasoline, or some other approved non-corrosive cleaning solution.

b. Wire brushes, steel wool, or any other tool or abrasive that will scratch or otherwise damage the propeller parts will not be used.

4. INSPECTION. (See clearance chart, figure 62.)

Note

The allowable manufacturing and service clearances for parts and assemblies are listed in table I, and shown in figure 62. As an example, item 15 under the 2D30 propeller model is shown as T.0015 / L.005 } —L.008. The dimensions shown to the left of the bracket are manufacturing tolerances; that is, the part (or assembly) may vary from an interference fit (indicated by a "T") of .0015 inch, to a loose fit (indicated by a "L") of .005 inch. The dimension listed to the right of the bracket indicates the allowance for service use; in this example, the fit between the barrel and each barrel support may be loose .008 inch.

TABLE I

Item Number	2B20	2D30	12D40	2E40	3D40	3E50	Remarks
1	.114 Min.	.114 Min.	.114 Min.	.114 Min.	.114 Min.	.114 Min.	Minimum thickness of counterweight bracket web portion.
2	L.002 / L.010 } L.020	L.002 / L.010 } L.020	L.002 / L.010 } L.020	L.002 / L.010 } L.020	L.002 / L.010 } L.020	L.002 / L.010 } L.020	Difference in length between slot and screw should not exceed limits shown.
3	See Remarks	See Remarks	See Remarks	See Remarks	See Remarks	See Remarks	Index pins to be light drive fit between bushing and bracket.
4	L.0005 / L.0025 } L.005	———	———	———	———	———	Clearance between blade key and slot in counterweight bracket.
5	L.0005 / L.0025 } L.005	———	———	———	———	———	Clearance between blade key and slot in blade butt face.
6	T.003 / .000 } *	T.003 / .000 } *	T.003 / .000 } *	T.003 / .000 } *	T.003 / .000 } *	T.003 / .000 } *	Fit between shim plate dowel and spider.
7	L.0003 / L.0017 } L.0025	L.0003 / L.0017 } L.0025	L.0003 / L.0017 } L.0025	L.0003 / L.0017 } L.0025	L.0003 / L.0017 } L.0025	L.0003 / L.0017 } L.0025	Clearance between OD of shaft and ID of bushing.
8	T.002 / .000 } *	T.003 / T.001 } *	T.003 / T.001 } *	T.003 / T.001 } *	T.003 / T.001 } *	T.002 / .000 } *	Fit between OD of bushing and ID of cylinder bore.
9	L.003 L.006	L.003 L.006	L.003 L.006	L.003 L.006	L.003 L.006	L.003 L.006	Clearance between face of counterweight bracket and thrust washer. Clearance measured at tightest point of bracket range.
10	.353 Min.	.353 Min.	.353 Min.	.408 Min.	.353 Min.	.408 Min.	Minimum wall thickness for barrel blade bore in critical area. (Critical area extends inward ⅜ inch from blade thrust shoulder.)

LEGEND
T — Tight Fit   L — Loose Fit
Clearance measured at 21° C. (70° F.)
*Replace parts as required when any looseness is in evidence.

TABLE I (Continued)

Item Number	2B20	2D30	12D40	2E40	3D40	3E50	Remarks
11	.345 Min.	.345 Min.	.345 Min.	.400 Min.	.345 Min.	.400 Min.	Minimum values may be reduced .030 inch in local areas covering less than 20 percent of circumference.
12	L.001 L.011 L.031	L.0005 L.0085 L.031	L.0005 L.0105 L.031	L.0005 L.0085 L.031	L.0005 L.0065 L.031†	T.001 L.005 L.031‡	Clearance between spider ring and barrel at spider bore. †For 3D40 models below—200. ‡For 3E50 models below —200.
13	A = .235	A = .261	A = .308	A = .308	A = .308	A = .379	Splines shall be checked with a single key NO-GO gage of "A" width. Spider shall be rejected if gage enters more than 20 percent of splines.
14	———	.000 L.004 L.006	.000 L.004 L.006	.000 L.004 L.006	.000 L.004 L.006	.000 L.004 L.006	Clearance between blade butt face and bushing flange.
15	T.0015 L.005 L.008	T.0015 L.005 L.008	T.0015 L.005 L.008	T.0015 L.004 L.008	T.0002 T.0082 L.005	T.0001 T.008 L.005	Clearance between barrel and each barrel support.
16	L.0018 L.0037 L.006	L.0018 L.0037 L.006	L.0018 L.0037 L.006	L.0018 L.0037 L.006	L.0018 L.0037 L.006	L.0018 L.0037 L.006	Clearance between small ID of blade bushing and small OD of spider arm.
17	5.395 Max.	6.770 Max.	6.770 Max.	7.270 Max.	6.770 Max.	7.270 Max.	Maximum ID of barrel blade bore.
18	L.0018 L.0037 L.006	L.0018 L.0037 L.006	L.0018 L.0037 L.006	L.0018 L.0037 L.006	L.0018 L.0037 L.006	L.0018 L.0037 L.006	Clearance between large ID of blade bushing and large OD of spider arm.
19	———	T.0038 T.0045 *	T.0038 T.0045 *	T.0038 T.0045 *	T.0038 T.0045 *	T.0038 T.0045 *	Fit between blade bushing drive pin and blade.
20	———	.0000 L.0007 L.0012	.0000 L.0007 L.0012	.0000 L.0007 L.0012	.0000 L.0007 L.0012	.0000 L.0007 L.0012	Clearance between blade bushing drive pin and blade bushing.
21	L.008 L.013 L.031	L.008 L.013 L.031	L.008 L.013 L.031	L.008 L.013 L.031	L.008 L.013 L.031	L.008 L.013 L.031	Clearance between phenolic cylinder liner and piston.
22	See Remarks	See Remarks	See Remarks	See Remarks	See Remarks	See Remarks	Liner may be reworked as long as assembly remains oil-tight.
23	See Remarks	———	———	———	———	———	End of bushing must be flush with or below blade butt face.
24	———	———	———	L.0015 L.0055 L.015	L.0015 L.0055 L.015	L.0015 L.0055 L.015	Clearance between puller bolt nut and spring puller plate.
25	———	———	———	L.010 L.035 L.060	L.010 L.035 L.060	L.010 L.035 L.060	Clearance between spring puller plate and piston.

LEGEND
T — Tight Fit   L — Loose Fit
Clearance measured at 21° C. (70° F.).
*Replace parts as required when any looseness is in evidence.

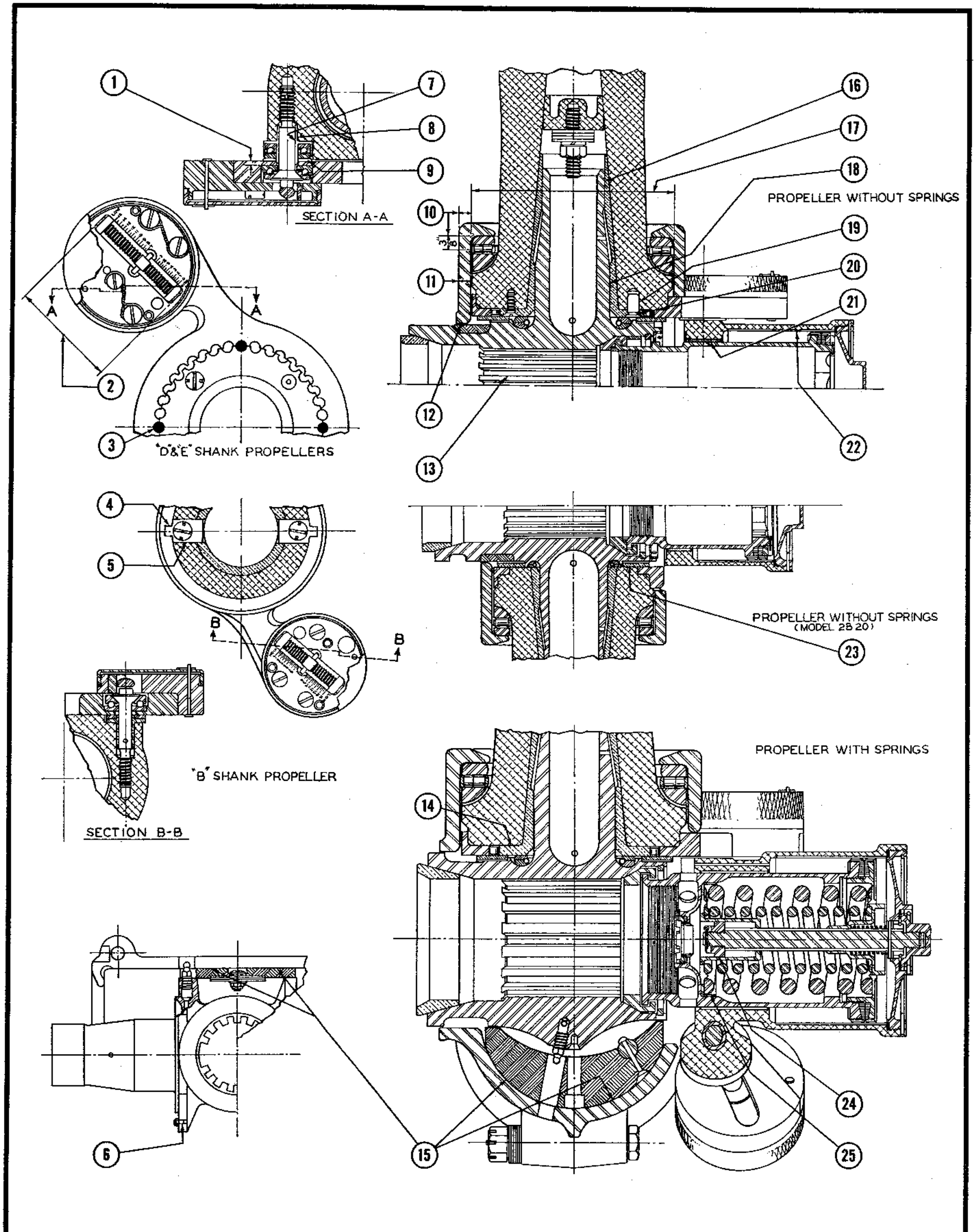


Figure 62 — Clearance Chart for Counterweight Type Propellers

a. HUB ASSEMBLY.—All parts are to be carefully inspected for wear and damage as outlined in this paragraph. If necessary, seals, gaskets, and packings are to be replaced. When distorted, seals made of synthetic rubber, such as the front cone packing washer, can sometimes be restored to shape by boiling them in water for 20 minutes.

(1) HUB GROUP.

(*a*) SPIDER.

1. Inspect the front and rear cone seats for wear, galling, and high spots. If a cone seat shows wear or galling on 20 percent or more of the area, it should be resurfaced by lapping or grinding. The gage length between cone seats must not be decreased below the limits listed in table II.

TABLE II

Spider Spline Size	Minimum Cone Seat Gage Length (Inch)
*20	5.190
20	6.190
30	6.596
40	6.534
50	6.721

*For spider part No. 51460 having one inch shorter cone seat gage length.

2. Check the width of the spider splines with a single key NO-GO gage of maximum width "A" as specified in item 13 in the clearance chart tabulation. If this gage enters more than 20 percent of the splines, the spider shall be scrapped.

3. Inspect the spider arm bearing surfaces for wear and galling. This damage may be cleaned up with a fine oil-stone so long as the maximum clearances between the spider arms and the blade bushings listed as items 16 and 18 in the clearance chart are not exceeded. If the clearance exceeds that listed because the spider arms have worn too small, the spider shall be scrapped; however, first make certain that the blade bushing has not worn oversize.

4. Item 6 in the clearance chart specifies a tight fit between the shim plate dowel and the spider, and requires replacement of the dowel whenever any looseness is in evidence. Loose dowels may be replaced by dowels which are .006 inch oversize, but it is necessary to first ream the dowel holes in the spider as described in this section, paragraph 5.a.(2)(c).

5. Spiders which have been damaged or involved in an accident shall be dimensionally inspected for conformance of the most important dimensions to the applicable spider drawing. Particular attention shall be given to determine squareness of the spider arms to the cone seat axis, and angular spacing of the spider arms to each other.

6. Item 12 in the clearance chart specifies the allowable clearance between the phenolic spider ring and the barrel at the spider bore. Excessive clearance may be eliminated by shimming between the spider ring and the spider.

7. Magnetically inspect the spider in accordance with the instructions given in paragraph 4.c. of this section.

(*b*) BARREL.

1. Inspect the inner surface of the barrel for wear and galling, and if necessary, smooth out this area according to the procedure described in paragraph 5.a.(3) of this section. The inside diameter of the barrel at the blade bores shall be checked in accordance with item 17 of the clearance chart. Evidence of wear on these surfaces can be ground out as explained in paragraph 5.a.(3) of this section. However, if the diameter exceeds the maximum allowance, the barrel shall be scrapped.

2. The wall thickness of the barrel at the blade bores shall be inspected close to the blade thrust lip as illustrated by item 10 in the clearance chart. The circumferential area extending 3/8-inch inward from the blade thrust shoulder is considered the critical portion, and the wall thickness over this section may not be reduced beyond the limits listed in the clearance chart as item 10. The wall thickness inward from this 3/8-inch portion may be reduced an additional .030 inch below that specified in item 11 in local areas which cover less than 20 percent of the circumference. These repair operations should be done according to the instructions contained in paragraph 5.a.(3) of this section, and if the barrel cannot be reworked within these limits, it shall be scrapped.

3. If the clearance between the phenolic spider ring and the inboard barrel half exceeds that listed in item 12, it shall be brought back within the allowable tolerance by shimming between the spider ring and the spider.

4. By making a trial assembly of the propeller without blades, check the clearance between the barrel and each barrel support. This clearance shall be such that the barrel will show no looseness on the spider when a .008-inch maximum shim is inserted between the barrel and each barrel support on a two-blade propeller, or a .005-inch maximum shim on a three-blade propeller. If the barrel is loose under either of the above conditions, the barrel supports shall be replaced.

5. Magnetically inspect the barrel. See paragraph 4.c. of this section.

(*c*) FRONT AND REAR CONES.—Inspect the front and rear cones for wear and galling. If the cones are galled over more than 20 percent of their bearing surface, they shall be scrapped. Cones which fall within the allowable repair limits may be reworked. See paragraph 5.a.(17) of this section.

(*d*) BARREL SUPPORTS.—The allowable clearance between each barrel support and the barrel is specified in item 15 of the clearance chart. Conformance with this requirement shall be determined by a trial assembly of the propeller without blades, and if the barrel shows no looseness when a .008-inch maximum shim is inserted between the barrel and each barrel support on a two-blade propeller, or a .005-inch maximum shim on a three-blade propeller, the barrel supports are still dimensionally satisfactory. Supports which are cracked shall be scrapped.

(*e*) SPIDER SHIM PLATES AND SHIMS.

1. Shim plates shall be inspected for wear, galling, and cracks. Any cracks are cause for scrapping the shim plate. If one face of the shim plate is worn or galled, the plate may be reversed on the spider to provide a smooth bearing surface for the blade bushing. If both surfaces of the self-lubricating type shim plate are worn, the plate shall be replaced. Evidence of wear or galling on steel shim plates will be removed by careful stoning according to the procedure outlined in paragraph 5.a.(5) of this section. If the phenolic strip incorporated in some of these steel plates becomes loose, it may be recemented according to this same repair procedure. Cracked or broken phenolic chafing rings shall be replaced.

2. Spider shims, which have become bent or worn in such a way that they are no longer accurate and blade torque cannot be satisfactorily maintained, shall be replaced. If the propeller incorporates laminated spider shims, they may still be used if all the laminations are intact and blade frictional torque is still obtainable. When laminated type shims are scrapped, they should be replaced by the superseding solid brass shims part No. 52987 for all "D" shank propellers, and "E" shank propellers —199 and below. Spider shim No. 53007 is used for "E" shank propellers —200 and above.

(*f*) MISCELLANEOUS.—Parts such as barrel bolts and nuts, hub snap ring, piston lock ring, front cone spacer, oil supply pipe, leather grease retainer, and front cone packing washer shall be visually inspected for wear and damage and replaced as required. Barrel bolts and nuts shall also be magnetically inspected in accordance with paragraph 4.c. of this section.

(2) BRACKET & COUNTERWEIGHT GROUP.

(*a*) BRACKETS.

1. The counterweight bracket shall be inspected for wear and galling. Particular attention shall be given to the counterweight bracket web upon which the inner race of the counterweight bearing rests. If this web is damaged or galled, it may be reworked as outlined in paragraph 5.a.(6) of this section provided its thickness after repair is not less than the minimum dimension specified in item 1 of the clearance chart. Brackets on which this web thickness falls below .114 inch shall be scrapped.

2. To determine if a damaged counterweight bracket has been bent or twisted, place the bracket on a flat surface with the large circular end held firmly against the flat surface, and then with a feeler gage, measure the amount the small end of the bracket is above the surface plate. Turn the bracket over and repeat this check with the opposite side against the measuring surface. If the distortion, as a result of either a bend or a twist, is less than .063 inch, the bracket may be straightened cold; however, if this distortion exceeds .063 inch but is less than .125 inch, the bracket may be straightened cold, but in this case, it must be marked with the letters "STR". See paragraph 5.a.(6) of this section for the complete repair procedure. Damaged or cold straightened brackets must be carefully inspected against the applicable blueprint to insure that the relation of the bracket slot to the semi-circular indexing pin serrations is within drawing tolerances.

3. On 2B20 models only, check the clearance between the blade key and the slot in the counterweight bracket. If this clearance exceeds the .005 inch allowance shown as item 4 in the clearance chart, the damaged or worn part shall be replaced. On "D" and "E" shank blades, check to see that the index pins are a light drive fit between the bracket and bushing. Replace loose index pins with oversize pins. See paragraph 6.a.(1)(d) of this section.

4. Magnetically inspect the counterweight bracket in accordance with the instructions in paragraph 4.c. of this section.

(*b*) COUNTERWEIGHTS.—Visually inspect the counterweights for wear, galling, and damage. If the counterweights are damaged or galled to such an extent that their weight or strength will be decreased enough by rework to affect propeller operation, they shall be scrapped. Check the dowels for looseness and also for damage which would not allow the counterweight to be assembled on the bracket. Damaged dowels shall be replaced, but the counterweight shall be scrapped if a new dowel cannot be installed as a light drive fit.

(*c*) COUNTERWEIGHT ADJUSTING SCREW ASSEMBLY.—The adjusting screw nuts are to be inspected for wear on the bearing surfaces, and replaced if badly worn. If the threads on the adjusting screw and nuts are damaged in a way which would prevent their being properly assembled, the parts shall be scrapped. The clearance chart specifies the difference in length between the adjusting screw and the cam slot in the counterweight, and if the clearance exceeds these limits, the adjusting screw (or counterweight) shall be replaced.

(*d*) COUNTERWEIGHT CAPS.—Visually inspect the counterweight caps for damage, and check the fit of the cap on the counterweight. Caps which are damaged to such an extent that repair would result in a substantial decrease in weight shall be scrapped. If the caps are worn so that they cannot be tightened onto the counterweights and the locking holes lined up, they may be reworked as described in paragraph 5.a.(8) of this section.

(*e*) COUNTERWEIGHT BEARING ASSEMBLY.

1. Inspect the counterweight bearing retainer assembly for wear and cracks. Any crack in a retainer is cause for scrapping the part, and if more than 1/3 of the balls are excessively worn, the retainer assembly should be replaced. Check the fit of the balls in the retainer. If they are excessively loose, they may be restaked in the retainer according to the procedure outlined in paragraph 5.a.(10) of this section. When the retainer is worn to the point where restaking is impossible, or if the balls have worn through the unstaked side, the retainer assembly shall be scrapped.

2. Inspect the counterweight bearing races for wear and cracks. If the retainer is cracked, it shall be scrapped, and any race showing more than six distinct wear lines any one of which is measurable as being .005-inch or more deep, shall be scrapped.

3. If used, visually check the counterweight bearing spacer for cracks and damage. If the part is cracked, it shall be scrapped. Evidence of damage may be cleaned up with a fine oil-stone so long as the part will function properly.

(3) CYLINDER GROUP.

(*a*) CYLINDER, COUNTERWEIGHT BEARING SHAFTS, AND BUSHINGS.

1. If the clearance between the phenolic cylinder liner and the piston exceeds the allowable limit of .031 inch specified in the clearance chart, the liner shall be removed from the cylinder and a new one installed according to the procedure described in paragraph 5.a.(13)(c) of this section. If the liner is loose but still serviceable, it shall be recemented according to this same procedure.

2. Carefully check the inner surface of the steel liner for galling and damage. This surface may be reground or reworked with fine emery and crocus cloth as long as the assembly remains oiltight. If leakage occurs as a result of rework, the liner can be replaced as described in paragraph 5.a.(13)(b) of this section.

3. Magnetically inspect the counterweight bearing shafts according to the instructions in paragraph 4.c. of this section. Determine the clearance between the counterweight bearing shaft and the bushing. As specified in the clearance chart, figure 62, this clearance is not to exceed .0025 inch. If necessary, the bushing and/or shaft are to be replaced as described in this section, paragraph 5.a.(13)(e). Also check the shaft for straightness, and scrap any shafts which are bent. Excessive wear on the shaft head bearing surface is cause for replacement of the part. It is also necessary to inspect the counterweight bearing shaft bushing to determine if it is a tight fit in the cylinder. If the bushing is loose, it may be either that the cylinder bore has worn too large or the OD of the bushing has worn smaller. Enlarged bearing shaft bushing holes may be reworked to incorporate an intermediate sleeve according to the procedure described in paragraph 5.a.(13)(d) of this section, and undersize bushings can be replaced as described in paragraph (e) of this same reference. In the case of model 2B20 propellers, unserviceable bronze counterweight bearing shaft bushings are replaced by steel bushings and bronze thrust washers as described in paragraph 5.a.(13)(f) of this section.

(*b*) PISTON.—Check the propeller shaft thread portion of the piston. If the lead threads are damaged to an extent requiring removal of more than one full thread, the piston shall be scrapped. The allowable pitch diameter service limits of these threads are listed in table III. This allowable pitch diameter is a class 2 fit, and is based on the assumption that the pitch diameter of the engine shaft thread does not go beneath the limits of a class 2 requirement. Magnetically inspect the piston in accordance with the instructions in paragraph 4.c. of this section.

TABLE III

SAE Spline Size	Piston Part Number	Maximum Pitch Diameter (Inch)	Symbol
20	50686 50121	2.0148	12 NS
30	50416 50726	2.2650	12 NS
40	50386 50819 50292	2.7653	12 NS
50	S8457 50018 51248	3.3900	12 NS

(*c*) COUNTERWEIGHT THRUST BEARING ASSEMBLY AND THRUST WASHERS.—Carefully examine the counterweight thrust bearing retainer assemblies and races for cracks, damage, and excessive wear. The thrust bearing assembly is to be replaced if any of the parts are cracked, or worn to an extent which would impair proper functioning. Check the thrust washers for excessive wear and cracks. Cracked washers are to be replaced. Washers that are worn may be used so long as the clearance between the thrust washer and the counterweight bracket face in an assembled propeller is not more than .006 inch or less than .003 inch. As noted on the clearance chart, this clearance is measured at the tightest point in the angle range of the bracket with a .003-inch shim installed between the thrust washer and the other bracket(s). Oversize washers, .015 and .030 inch, may be ground down to the required thickness to obtain the specified clearance between the counterweight bracket and the thrust washer. (See paragraph 5.a.(14) of this section.)

(*d*) PISTON GASKETS AND NUT.—As long as the propeller remains oiltight, the piston gaskets need not be replaced; but gaskets that are frayed, worn, or excessively oil soaked to such an extent that continued satisfactory service is questionable are to be replaced. Inspect for minor damage to the piston gasket nut and threads. With propellers incorporating the spring puller bolt, check the vernier splines in the piston gasket nut for damage.

(*e*) MISCELLANEOUS.—In the case of spring return type propellers, inspect the spring puller bolt assembly and vernier lock plate for cracks and wear at the splines. The inner and outer springs shall be magnetically inspected in accordance with the instructions in paragraph 4.c. of this section. The puller bolt spring, the spring puller plate, and spring puller bolt nut should also be inspected for cracks and damage. Replace any parts which are excessively worn or cracked. The clearance between the puller bolt nut and the spring puller plate shall not exceed the .015 inch specified in the clearance chart. If the actual clearance is more than this allowance, replace the worn parts. Check the clearance between the spring puller plate and the piston. As shown in the clearance chart, this clearance shall not be more than .060 inch. If necessary, replace the spring puller plate.

b. BLADE ASSEMBLY.

(1) GENERAL.

(*a*) BLADE.—Visually inspect the blade for nicks, cuts, scratches, and other damage. Blades shall be scrapped when the necessary rework would require alteration beyond the repair limits given in paragraphs 5.b.(2)(a) and 5.b.(3)(c) of this section. As specified in the clearance chart, figure 62, the clearance between the blade key and the slot in the blade butt face on "B" shank blades shall not exceed .005 inch. The blade key or blade, or both, shall be replaced if the actual clearance exceeds this limit. Also check to see that the end of the bushing on "B" shank blades is flush with or below the blade butt face. If the bushing extends beyond the blade butt, see paragraph 5.b.(2)(f) of this section. On "D" and "E" shank blades, the clearance between the blade butt face and the bushing flange may not exceed .006 inch as required by the clearance chart, figure 62. Check to see that the bushing drive pin is a tight fit in the blade. Replace loose pins with oversize pins as described in paragraph 5.b.(2)(f) of this section.

(*b*) THRUST BEARING WASHERS.—The flat and beveled blade thrust washers shall be magnetically inspected for cracks in accordance with the specifications in paragraph 4.c. of this section. These washers shall also be visually examined for brinelling by the rollers, and for corrosion, pitting, and galling. If these conditions are present on the flat faces of the washers to such an extent that they cannot be satisfactorily cleaned up by local rework with crocus cloth, these surfaces may be reground as described in paragraph 5.b.(2)(c) of this section.

(*c*) THRUST BEARING RETAINER ASSEMBLY.—Inspect the blade thrust bearing retainer for cracks, and the rollers for flat spots and corrosion. Cracked retainers are to be scrapped, and damaged rollers which do not roll freely can be replaced as described in paragraph 5.b.(2)(c) of this section.

(*d*) CHAFING RING.—Inspect the phenolic chafing ring for cracks, frayed edges, and general deterioration of the material. Replace these rings as necessary.

(*e*) BUSHING.—Determine whether the clearance between the bushing bearing diameters (large and small) and the corresponding diameters on the spider arm exceeds the clearance chart limit of .006 inch. If necessary, scrap the bushing. Evidence of galling, corrosion, and wear may be cleaned off these bearings within the above limits. On "D" and "E" shank blades, the clearance between the bushing and drive pin may not exceed .0012 inch. Replace the pin with an oversize pin if the clearance exceeds this limit. (See paragraph 5.b.(2)(f) in this section.) Check to see that the end of the bushing on "B" shank blades is flush with or below the blade butt face, and that the clearance between the bushing flange and the blade butt face does not exceed .006 inch on "D" and "E" shank blades.

(2) INSPECTION METHODS.—For surface inspection of blades where damage or repair is suspected of having initiated cracks, chromic acid anodizing is preferred. Where equipment for such inspection is not available, caustic etch of the blade from the tip to about the 6-inch station and inspection by near ultra-violet light from the butt end to about the 12-inch station is satisfactory. Inspection of the blade with caustic etch in the locality of each rework is usually satisfactory; however, when there is any doubt that this inspection has not been conscientiously made, it is recommended that the entire blade be inspected by chromic acid anodizing or caustic etch in conjunction with near ultra-violet light.

(*a*) ANODIZING.—When chromic acid anodizing is used, the blade shall be completely anodized from the tip to a point which is at least 3/8 inch inboard from the edge formed by the bade fillet and the blade butt OD. Do not allow the chromic acid bath to contact the blade bushing, and electrically insulate the thrust washers from the blade. The anodizing shall be performed in accordance with Specification No. AN-QQ-A-696a. Immediately after anodizing, the blade shall be rinsed in cold, clear running water for three to five minutes, and then dried with an air blast. Allow the blade to stand for a minimum period of 15 minutes, and then inspect it for cracks and other damage. A crack will usually show up as a brown line against the clear anodized background when this process is used. Blades having cracks or damage that cannot be worked out within the repair limits given in paragraph 5.b. of this section shall be scrapped. If sealing of the anodized surface is desired, the blade may be immersed in hot water 82°-100° C. (180°-212° F.), for half an hour after inspection.

(*b*) ETCHING.—When caustic etching is used, the blade shall be etched from the tip to the 6-inch station and then neutralized with nitric acid. The etching bath shall be prepared using a caustic soda solution composed of one pound of commercial technical grade caustic soda for each gallon of water. Immerse the blade in the caustic soda solution up to the 6-inch station for at least one-half minute. If swabbing is used, the area to be inspected shall be completely covered with the caustic soda solution. Do not allow the caustic soda (or nitric acid) solution to contact the blade thrust washers, bushing, bushing drive pins, or screws. Rinse the blade in clear warm water. After the blade has been etched, it will be cleaned in a nitric acid solution composed of one part concentrated technical grade nitric acid to five parts of water. Immerse the blade in the nitric acid bath, or swab the blade with the acid. After the black deposit has been removed by the nitric acid, rinse the blade in clear warm water. Carefully inspect the blade for cracks and other damage. Cracks in the blade surface will appear as dark lines or marks. Blades having cracks or damage that cannot be worked out within the repair limits given in paragraph 5.b. of this section shall be scrapped. If no cracks are discovered, the blade should be polished after inspection to remove all traces of the etch.

(*c*) ULTRA-VIOLET LIGHT INSPECTION.—The shank end of the blade shall be inspected for cracks from the butt end to the 12-inch station by the use of near ultra-violet light in conjunction with a solution of 50 percent aircraft engine oil and 50 percent kerosene. This solution should be maintained at a temperature between 32° to 54° C. (90° to 130° F.), and the oil used should be tested under near ultra-violet light to make certain that it has fluorescent quality. Immerse the shank of the blade in the solution to the 12-inch station, and allow it to remain for a minimum time of 10 minutes. After this time, remove the blade from the bath, allow the excess solution to drain off, and then spray the blade with carbon tetrachloride or trichlorethylene to completely remove the remaining solution. If any other cleaning solvent is used, make certain it has no fluorescent properties. Allow the blade to stand for at least 15 minutes so that bleeding out of the penetrating solution may occur in any cracks present. Examine the shank area in a darkened enclosure with near ultra-violet light. Cracks will show up as bright fluorescent lines as the penetrating solution bleeds out. Blades having cracks or damage that cannot be worked out within the repair limits given in paragraph 5.b. of this section shall be scrapped.

(3) BENT BLADES.

(*a*) FACE ALIGNMENT.—A blade bent in face alignment shall be inspected with a protractor similar to that shown in figure 63. Mark each arm of the protractor at a point one inch out from the axis. Place the protractor on the blade at the point of maximum bend. The angle measurement is made by bringing the protractor arms at the one-inch marks tangent to the blade on either side of the maximum point of bend. Determine the angle of bend, and then measure the thickness of the blade at the same point. Figure 63 shows the maximum angle of bend in a length of two inches for straightening an aluminum alloy blade without heat treatment. One curve is marked "maximum bend for cold straightening", and the other "maximum bend for field repair". From the thickness and angle measurements previously taken, determine where the corresponding point would fall with respect to the curves shown in figure 63. A blade which is bent in face alignment within the permissible amount shown for field repair may be straightened cold (for face alignment and angle) without annealing by approved activities; however, a blade which is bent in face alignment beyond the permissible amount for field repair but within the limits for cold straightening may be straightened cold without annealing but should be sent to a repair depot equipped to handle this type of work. A blade which is bent in face alignment in excess of the permissible amount for cold straightening shown in figure 63 shall be annealed in accordance with the specification described in paragraph 5.b.(6) of this section prior to straightening, and then reheat-treated after straightening.

(*b*) EDGE ALIGNMENT.—A blade which has a gradual bend in edge alignment that does not exceed two inches at the tip may be straightened after it has been annealed. This shall be done only at approved repair depots capable of handling this type of work. A blade which has been straightened after annealing shall be reheat-treated according to the procedure described in paragraph 5.b.(6) of this section. If the bend exceeds two inches at the tip, the blade shall be removed from service.

(4) HARD ALLOY BLADE INSPECTION.—The taper bore of blade designs 6227, 6237, 6241, and 6249, which are made of hard alloy material, shall be inspected for cracks at overhaul and whenever these blades have been straightened either cold or in the annealed state. If the taper bore is to be reamed, this inspection shall be made after the reaming operation and just prior to the shot-blasting of the bore described in paragraph 5.b.(2)(e) of this section.

(*a*) ULTRA-VIOLET LIGHT.—The taper bore of a hard alloy blade is to be inspected for cracks using near ultra-violet light in conjunction with an oil solution having fluorescent properties as described in paragraph 4.b.(2)(c) of this section.

(*b*) PURPLE DYE.—Where facilities are not available to inspect the taper bore by ultra-violet light, purple dye may be used.

1. Thoroughly swab the taper bore with carbon tetrachloride using enough of the liquid to allow some of it to remain in any cracks present in the taper bore after the surface of the bore has dried.

2. Dissolve a small amount of analine purple dye (approximately one-quarter teaspoon of powder for every gallon of mixture) in a solution of 95 parts commercial alcohol and five parts glycerine. Paint the taper bore surface with this dye solution and then swab off all the dye on the surface of the bore with clean alcohol. Wipe the bore clean.

3. After a short time, any crack will be visible due to evaporation of the carbon tetrachloride and to "bleeding out" of the purple dye solution.

(*c*) VISUAL.—If it is not possible to use either the near ultra-violet light or purple dye method to inspect the taper bore, the bore should be carefully cleaned and the surface examined minutely by means of a small flash-light bulb fitted with a suitable extension. However, when borderline cases are discovered by use of this method, the blades should be sent to a station equipped to perform inspection by either near ultra-violet light or purple dye methods.

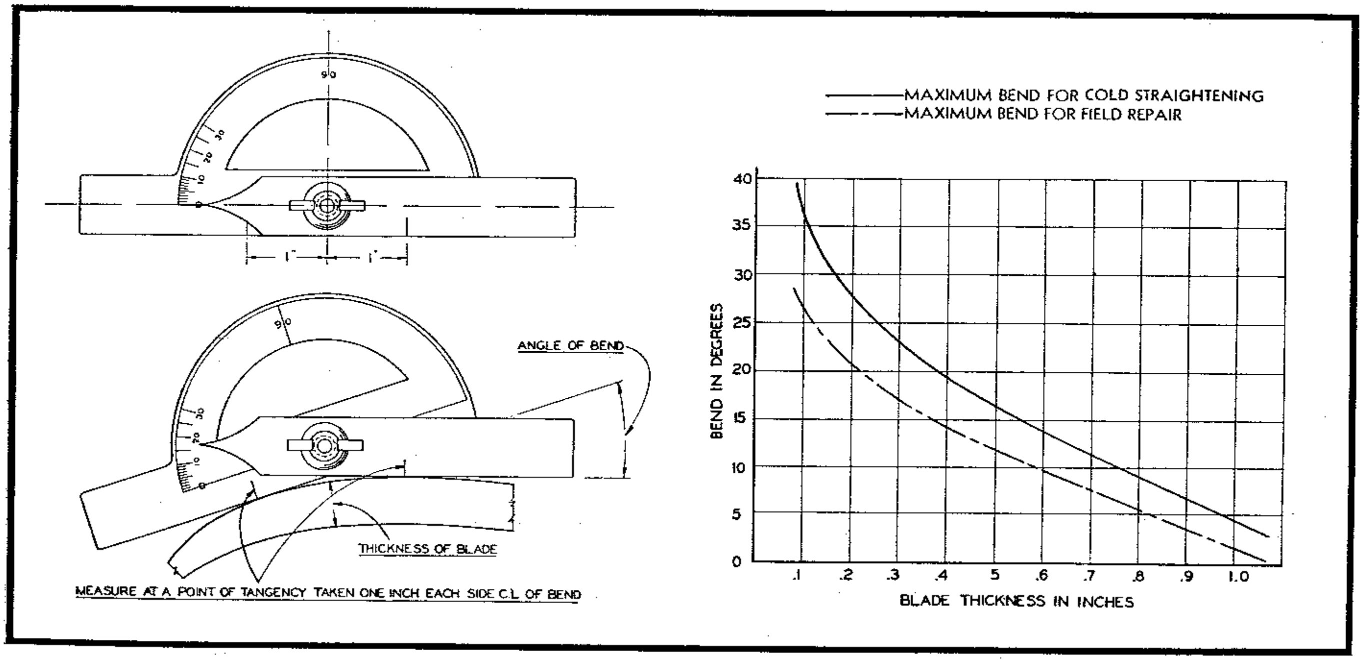


Figure 63 — Protractor and Maximum Angle of Bend Curves for Bent Blades

c. MAGNETIC INSPECTION.

(1) SCOPE.—The parts listed in table IV and shown in figure 65 and 66 shall be magnetically inspected in accordance with Specification No. AN-QQ-M-181a-2 and then carefully examined to determine whether any fatigue cracks have developed.

NOTE

In the case of blade thrust washers, extreme care shall be used during magnetization to prevent arcing or burning of the washers which may cause residual stresses resulting in washer failure under operating loads. Because of their cushioning and resilient nature, copper braid contacts are recommended. Use a test machine with a pneumatic head, and operate under the lowest possible air pressure. Eliminate all traces of grease and dirt on the washers; and if light oxidation produced during the blade heat treatment is present, it shall be removed with fine emery and crocus cloth from the areas that are to touch the contacts.

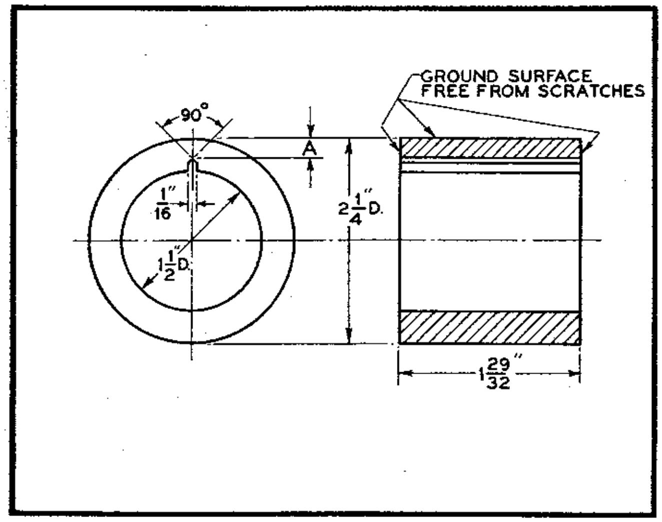


Figure 64 — Magnetic Inspection Calibration Piece

(2) CALIBRATION. — The equipment and method employed will be calibrated by means of the calibration piece shown in figure 64, details 1, 2, 3, 4, and 5. These calibration pieces shall be made from AMS 6415 steel and heat treated to a Brinell hardness of 375-415. The equipment may be calibrated at one of the three levels of current density listed in table IV, depending upon the diameter of the part to be inspected in a particular inspection unit.

(*a*) PROCEDURE.—The calibration pieces shall be contacted one at a time directly at both ends by the electrodes of the unit; a piece shall never be fluxed on a bar or in a coil. Each piece shall be fluxed so that the resulting magnetic field will be perpendicular to the slots and the slots shall be placed uppermost. Each piece shall be demagnetized before each test fluxing and shall have a clean bright surface over the slot area. The indications shall be affected as little as possible by washing or run off of the bath. Only a single "shot" or flux of current shall be used to magnetize a bar and the continuous method of applying indicating solution shall be used. The concentration of indicating powder in the bath shall be between 1 and 1.5 ml per 100 ml of bath for tank or immersion units, or between 1.5 and 2 ml per 100 ml of bath for spray units as determined by a standard settling test.

(*b*) EQUIPMENT.

1. Equipment used to inspect parts of large cross-sectional areas, such as the spider, barrel, and counterweight bracket will be adjusted and the technique employed such that piece No. 5 will show no accumulation of indicating powder, piece No. 4 will just faintly show an accumulation of indicating powder, and piece No. 3 will show a definite accumulation of powder. If the unit is operating in a normal manner with continuous magnetization, these results should be obtained at approximately 2000 amperes.

TABLE IV

Test Bar Detail	A ±.001 inch	Powder Indication	Amperage	Time Interval (Seconds)	Propeller Parts
3	.260	Definite	2000	2	Barrel, Spider, and Counterweight Bracket
4	.275	Faint	2000	2	
5	.290	None	2000	2	
2	.240	Definite	1500	2	Blade Thrust Washers, Piston, and Inner and Outer Return Springs
3	.260	Faint	1500	2	
4	.275	None	1500	2	
1	.200	Faint	500	2	Barrel Bolts, Barrel Bolt Nuts, and Counterweight Bearing Shafts
2	.240	None	500	2	

2. Equipment used to inspect parts of medium cross-sectional areas, such as blade thrust washers, will be adjusted and the technique employed such that piece No. 2 will show a definite accumulation of powder, piece No. 3 will show a faint accumulation, and piece No. 4 will show no accumulation. If the equipment is operating in a normal manner, these results should be obtained at approximately 1500 amperes.

3. Equipment used to inspect parts of smaller cross-sectional areas, such as barrel bolts, barrel bolt nuts, and counterweight bearing shafts, will be adjusted and the technique employed such that piece No. 1 will show a faint accumulation of indicating powder and piece No. 2 will show no accumulation. If the equipment is operating in a normal

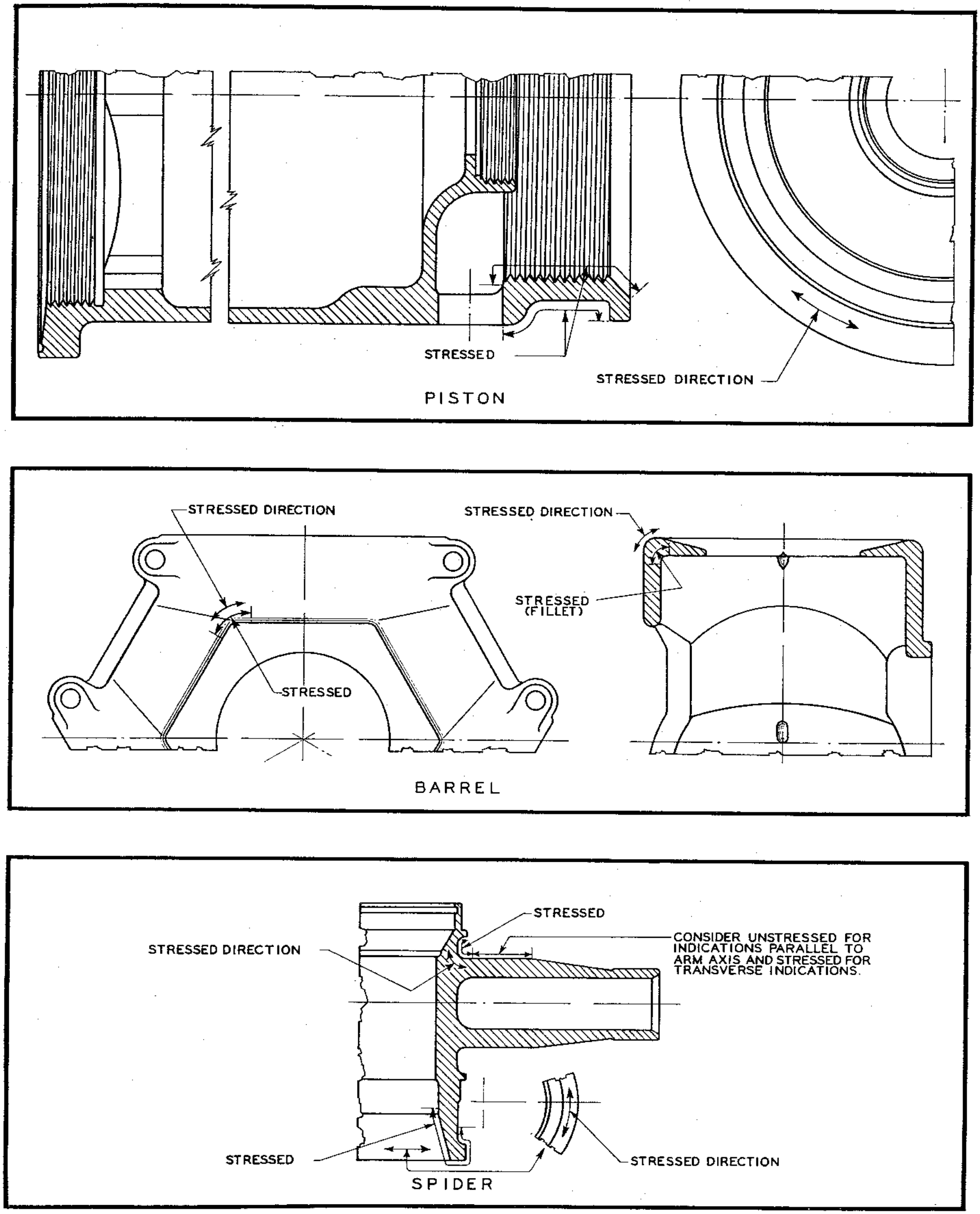


Figure 65 — Parts to be Magnetically Inspected

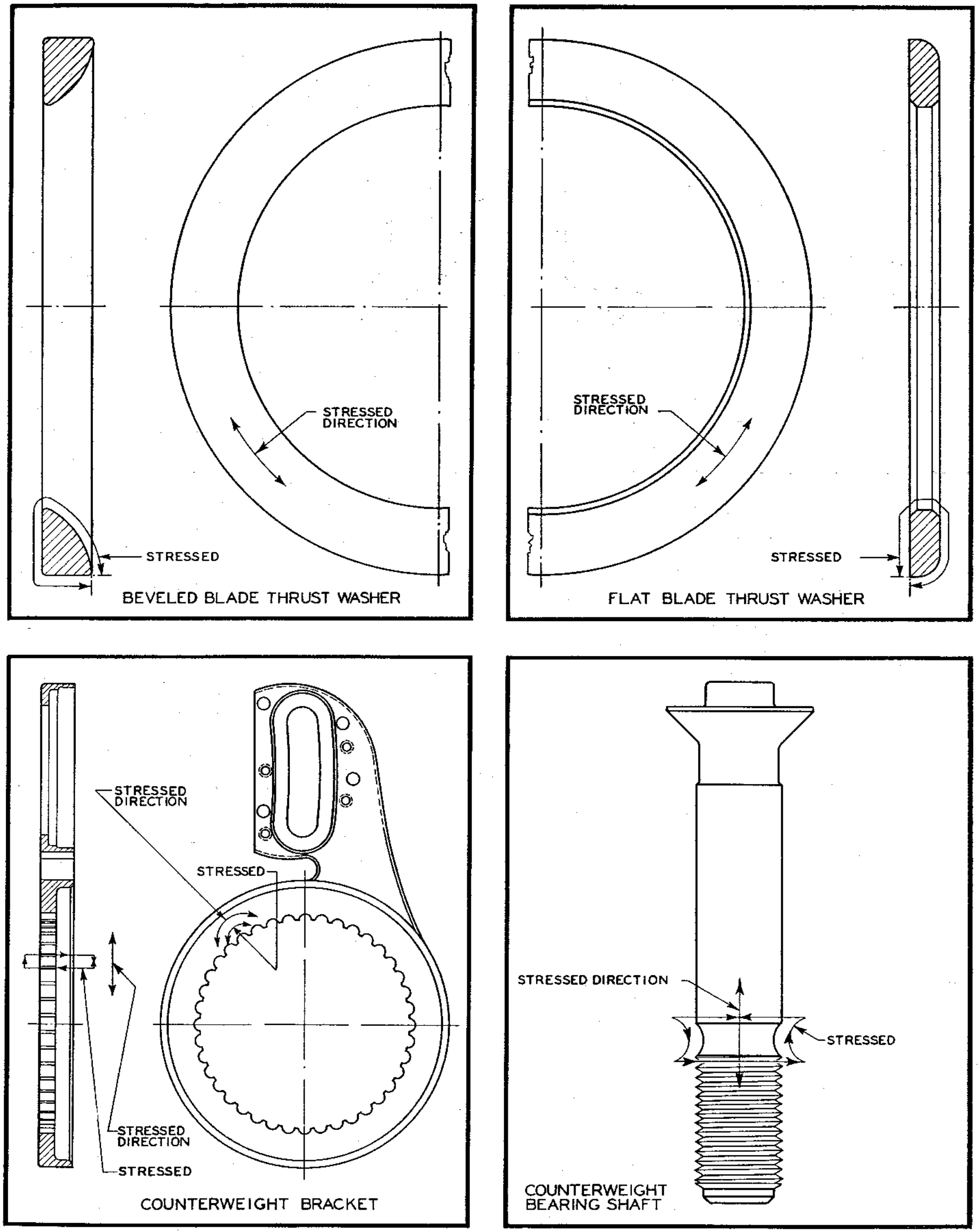


Figure 66 — Parts to be Magnetically Inspected

manner, these results should be obtained at approximately 500 amperes.

(3) BASIS OF ACCEPTANCE.—For purposes of interpreting indications, using calibrated equipment, portions of propeller parts requiring magnetic inspection will be classified as "stressed" and "unstressed". "Stressed" portions will be those locations on a part which are subject to comparatively large vibratory stresses, while "unstressed" portions are those in which the vibratory stresses are comparatively low. The terms "stressed" and "unstressed" are employed merely for convenience, and it should be understood that "unstressed" parts and areas may nevertheless be subject to substantial stresses of non-vibratory character. The following indications are cause for rejection of a part.

(*a*) For areas subject to low vibratory stresses ("unstressed").

1. Irregular, heavy patterns having a length greater than one-quarter inch.

2. Straight, heavy, continuous indications following grain lines and having a length greater than one inch.

(*b*) For areas subjected to high vibratory stresses ("stressed").

1. Indications parallel (±45 degrees) to a stressed direction.

a. Any indications having a length greater than one-quarter inch.

b. Any indications located less than 1/16 inch apart in a transverse direction relative to a stressed direction.

2. Indications perpendicular (±45 degrees) to a stressed direction.

5. REPAIR.

a. HUB ASSEMBLY.

(1) GENERAL.

(*a*) All plated propeller parts on which the plating has been damaged to such an extent that the base metal is exposed shall be replated after any corrosion or damage has been repaired and the parts inspected.

(*b*) Any part on which the surface is worn or slightly galled shall be smoothed out with a fine oil-stone and crocus cloth.

(2) SPIDER.

(*a*) Any galling or bronze pick up from the blade bushing on the spider arm bearing surfaces shall be removed with a fine oil-stone and crocus cloth.

(*b*) Cone seats showing wear on 20 percent or more of the area shall be resurfaced by grinding. The grinding shall be accomplished in such a way that the axis of the cone seat will be maintained coincident with the spline axis. This can best be accomplished with a fixture that centers on the sides of the splines. If, in order to resurface the cone seats properly, material must be removed to an extent that will make the cone seat gage length less than that shown in table V, the spider shall be scrapped.

TABLE V

SAE Spline Size	Repair Limit Cone Seat Gage Length (Inch)
*20	5.190
20	6.190
30	6.596
40	6.534
50	6.721

*For Spider Part No. 51460 having one inch shorter cone seat gage length.

(*c*) Shim plate dowel part No. 50296 is used in all Counterweight propeller models. It is available .006 inch oversize, identified as part No. 50296-6. Spiders with slightly oversize dowel holes will accommodate the oversize dowel if the holes are reamed .1925-.1935 inch and countersunk 1/32 inch at 90 degrees.

(3) BARREL.—If the inner or outer surface of the barrel is worn or galled, it shall be smoothed out with fine emery cloth and crocus cloth. Evidence of wear around the blade bore can best be removed by grinding. The maximum allowable limits for this rework are shown in table VI.

TABLE VI

Shank Size	Maximum ID of Blade Bore (Inch)	Minimum Wall Thickness	
		Critical Area* (Inch)	Remainder (Inch)
B	5.395	.353	.345
D	6.770	.353	.345
E	7.270	.408	.400

*As shown in figure 62, the critical area of wall thickness is that area extending inward 3/8 inch from the blade thrust shoulder.

(*a*) The wall thickness outside the 3/8-inch critical area may be reduced locally .030 inch below the values in table VI shown under "Remainder", providing the repair does not cover more than 20 percent of the circumference of any one blade bore.

(*b*) If a barrel does not meet the dimensional requirements listed in table VI, it shall be scrapped.

(4) BARREL SUPPORTS FOR MODEL 2D30, 12D40, AND 2E40 PROPELLERS.—If not already incorporated, barrel supports for these propellers should be reworked so that the washers used to obtain

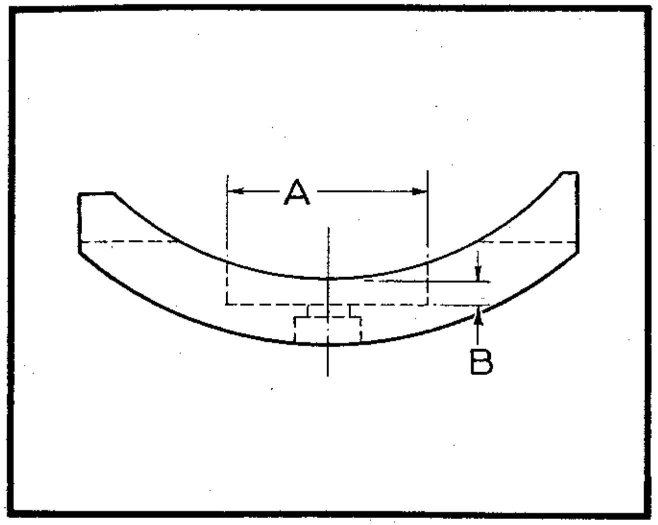


Figure 67 — Barrel Support Rework

TABLE VII

Propeller Model	A (Inch)	B (Inch)
2D30	1-25/32	3/32
12D40	1-25/32	3/32
2E40	1-25/32	11/32

preliminary vertical balance may be installed. To accomplish this rework, shape a wooden block so that it will fit the outside surface of the support and hold the support level. Then counterbore the inside surface of the support according to the dimensions listed in table VII, and shown in figure 67. Care should be taken not to exceed these dimensions, and all edges and corners should be slightly rounded off. The support assembly consisting of a screw No. AN 526-428-10, two washers No. AN 960-416L, and a self-locking nut No. AN 364-428 may then be added on the support to hold the required number of balancing washers No. 56831. The correct assembly is shown in figure 111, and the procedure for obtaining verical balance is explained in this section, paragraph 6.a. (5).

(5) SHIM PLATES AND SPIDER SHIMS.

(*a*) SELF-LUBRICATING TYPE.—If one surface of the shim plate is worn or galled, the plate may be reversed in its position in the hub to provide a smooth bearing surface for the blade bushing. If both surfaces are worn, the shim plate shall be replaced.

(*b*) STEEL TYPE.—Evidence of wear or galling on steel shim plates will be smoothed out by careful stoning. Phenolic strips which have become loosened shall be recemented to the shim plates. The cement used shall be an approved waterproof, air-drying non-corrosive cement, such as AAF Stock No. 7300-016000. Phenolic strips which have become broken shall be replaced.

(*c*) LAMINATED TYPE SHIMS.—If the propeller incorporates laminated spider shims, they may still be used if all laminations are intact and blade frictional torque is still obtainable. If all the laminations are not intact, the shims must be replaced by solid brass shims part No. 52987 which supersede the laminated type.

(6) COUNTERWEIGHT BRACKET.

(*a*) Bent or twisted counterweight brackets may be straightened cold provided the distortion from a plane surface does not exceed .125 inch. The distortion is determined by placing the bracket on a surface plate and finding the maximum thickness feeler gage that may be started under any edge. If the distortion as a result of either a bent or a twist is .063 inch or less, the bracket may be straightened cold; however if the distortion exceeds .063 inch but is less than .125 inch, the bracket may still be straightened cold, but in this case, the letters "STR" must be stamped on the bracket immediately preceding the part number.

(*b*) Any minor wear or galling shall be removed by careful hand stoning. If the shim plate and thrust washer face (bearing shaft bushing face in some "B" shank brackets) is heavily galled or worn, a maximum of .010 inch from the drawing value may be surface ground from the entire face area as shown in figure 62, item 1.

(*c*) INSTALLATION OF USED COUNTERWEIGHTS ON NEW COUNTERWEIGHT BRACKETS.—Used counterweights may now be installed on new counterweight brackets according to the following procedures. These procedures vary slightly depending upon the type of dowels used. For straight dowels which are driven into the counterweights, use PROCEDURE NO. 1, and for dowels which are fastened to the counterweight by upsetting one end of the dowel, use PROCEDURE NO. 2.

1. PROCEDURE NO. 1.—Straight dowels are to be removed from the counterweights before the counterweights are attached to the new brackets. It is recommended that in order to avoid increasing the size of the dowel holes, the center portion of the dowels be drilled before they are driven out of the counterweights. Attach the counterweight to the new bracket using the counterweight screws, and draw it down firmly into place. Using the counterweight as a guide fixture, rough ream the dowel holes in the bracket to the full depth of the hole for that bracket as listed in table VIII. Remove the counterweight from the bracket, and finish ream the dowel holes in the bracket to the size specified in table VIII.

TABLE VIII

Counter-weight	Bracket	Counter-weight Bracket Assembly	Counter-weight Dowels	Rough Ream Bracket (Inch)	Finish Ream Bracket ±.0005 inch	HSP Reaming Fixture
50606	50605	51162	50307(3)	.307	.3135	50606-T-7 Less Det's. 2 & 9
51783	52282	52375	S8488(3)	.245	.2510	None
51139	52285	52374	S8488(3)	.245	.2510	None
51431	51430	51455	50306(1) 50307(3)	.245 .307	.2510 .3135	51431-T-6 Less Det's. 3, 7, & 8
51432	51430	51456	50306(1) 50307(3)	.245 .307	.2510 .3135	51431-T-6 Less Det's. 3, 7, & 8
50214	50213	51164	S8489(2) 50006(2)	.307 .245	.3135 .2510	None
50289	50390	51163	50306(2) 50307(2)	.245 .307	.2510 .3135	50289-T-12 Less Det. 2

Then, install new dowels in the counterweights. Lay the counterweight (stamped side down) on a smooth, solid surface, and drive the dowels in until they are flush with the stamped side. Finally, install the used counterweights on the new brackets.

2. PROCEDURE NO. 2.—On used counterweights which have dowels staked on the ends next to the face bearing the angle graduations, removal of the dowels is not required. However, the use of a line reaming fixture for the attachment of the counterweights to new brackets is necessary. Securely fasten the proper line reaming fixture to the bracket. (See table VIII.) Ream the dowel holes in the bracket to the sizes listed in this table. Then, remove the reaming fixture and install the counterweights on the brackets. Where minor corrections to account for slight misalignment of the dowel holes are required, slightly reduce the size of the dowels with emery cloth.

(7) COUNTERWEIGHT.

(*a*) Any galling on the counterweight shall be removed by careful stoning.

(*b*) If the counterweight dowels have become worn or damaged, they should be removed and new dowels installed.

1. It is recommended that in order to avoid increasing the size of the dowel holes, the center portion of the dowels be drilled before they are driven out of the counterweights.

2. New dowels are a drive fit in the counterweight. A soft metal drift or hammer should be used during installation to avoid damaging them. When rivet type dowels are driven into the counterweight, the hollow ends should be expanded slightly with a steel punch in order to secure them in place. When installing straight dowels, lay the counterweight (stamped side down) on a smooth, solid surface, and drive the dowels in until they are flush with the stamped side.

(8) COUNTERWEIGHT CAP.—If, due to wear or excessive tightening, the counterweight cap is not a "snug" fit on the counterweight when the locking holes are aligned, the cap should be screwed down until a snug fit is obtained, and a new locking hole then drilled through the cap using the locking hole in the counterweight as a guide for a 1/8-inch drill. If the cap cannot be advanced enough to allow drilling a new hole, the contacting edge of the counterweight cap should be lapped sufficiently to permit drilling a new locking hole. The old hole is then plugged.

(9) COUNTERWEIGHT BEARING SHAFT.—Damage to the end of the shaft may be repaired with a fine oil-stone so long as the cylinder will not be cocked when the shaft contacts the pitch adjusting nuts. The procedure for installing new bearing shafts in old and new cylinders, and for adjusting the clearance between the counterweight bracket and thrust washer (counterweight bearing shaft bushing face in some model 2B20 propellers) is described in paragraph 6.a.(6)(e) of this section.

(10) COUNTERWEIGHT BEARING RETAINERS.—In the manufacture of the counterweight bearing retainers, the balls are inserted into holes in the retainer and staked into position. The greatest wear occurs on the staked side of the retainer. The staking wears away but the balls remain in the race as long as the bearing assembly is in position. While the balls and the retainers remain in good condition, the retainers may be restaked as shown in

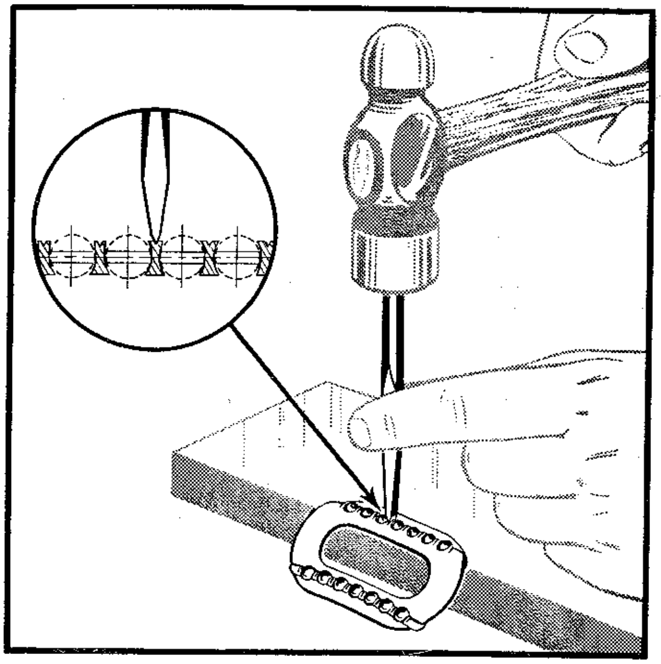


Figure 68 — Restaking a Counterweight Bearing Retainer

figure 68 at propeller overhaul. This restaking can continue until there is not enough metal left to stake, or until the balls wear through the other side of the retainer. Then the bearing retainer should be replaced.

(11) PISTON.—All galling and wear shall be removed by careful stoning with a fine oil-stone. If the lead thread of the propeller retaining nut portion of the piston is damaged to such an extent as to prevent the piston from being properly installed on the engine shaft, the piston shall be repaired by removing a maximum of one full thread. If it is necessary to remove more than one full thread in order to repair the piston properly, the piston shall be scrapped.

(12) PISTON GASKET NUT.—All evidence of galling and wear shall be removed by careful stoning with a fine oil-stone. Most model 2E40 and 3D40 propellers incorporate piston gasket nut part No. 51390. At propeller overhaul, to prevent possible failure, this nut (if not previously modified) should be reworked in accordance with figure 69.

(13) CYLINDER.

(*a*) LOCAL REWORK.—If the bearing surface of the steel liner inside the cylinder is scratched or worn, it shall be reworked with fine emery cloth and crocus cloth, or by grinding.

(*b*) REPLACEMENT OF STEEL CYLINDER LINER.—If the bearing surface of the steel liner becomes corroded, excessively worn or scored, and local rework would cause oil leakage, the liner can be replaced.

1. Place the cylinder in a lathe and turn down the inner diameter of the liner until a thin shell remains. Then, insert a sharp tool between the liner and the cylinder ID and pry the liner from the cylinder at two points approximately 180 degrees apart. Extreme care must be exercised so as not to damage the cylinder. Collapse the liner and remove it from the cylinder. Clean the cylinder ID and remove any tool marks with crocus cloth.

2. Heat the cylinder for 10 minutes in boiling water.

3. An inserting tool is used to install the new liner. This tool can be made from soft steel in accordance with figure 70 and table IX.

4. Cover the outside diameter of the new steel liner with a light coat of grease. Place the heated cylinder and the new liner, with the inserting tool installed, under an arbor press. (The tapered end of the liner must enter the cylinder first.) Care must be

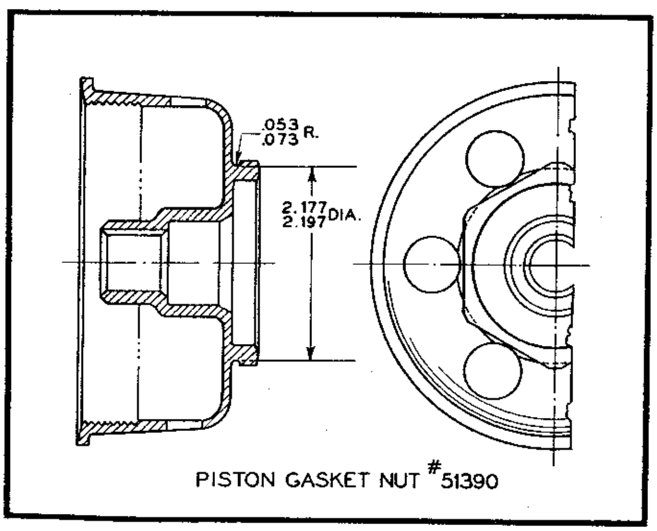


Figure 69 — Modification of Piston Gasket Nut

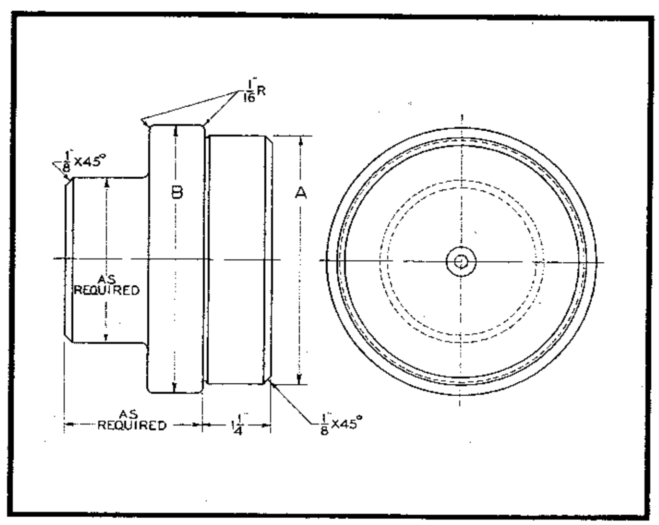


Figure 70 — Cylinder Steel Liner Inserting Tool

TABLE IX

Propeller Model	A ±.005 inch	B ±.010 inch
2B20	3.483	3.890
2D30	3.671	4.080
12D40	4.421	4.890
2E40	4.421	4.890
3D40	4.421	4.890
3E50	5.171	5.640

TABLE X

Propeller Model	Steel Liner	Finish Grind ID +.002 inch −.000 inch	Diameter of 30 Degree Chamfer ±.010 inch
2B20	51136	3.562	3-5/8
2D30	51035	3.750	3-13/16
12D40	51037	4.500	4-9/16
2E40	51037	4.500	4-9/16
3D40	51037	4.500	4-9/16
3E50	51257	5.250	5-5/16

TABLE XI

Propeller Model	A ±.005 inch	B ±.010 inch
2B20	2.780	3.502
2D30	2.967	3.690
12D40	3.592	4.440
2E40	3.592	4.440
3D40	3.592	4.440
3E50	4.217	5.190

TABLE XII

Propeller Model	Phenolic Liner	Finish Grind ID +.003 inch −.000 inch	Chamfer ID At Inboard End
2B20	51573	2.812	45° × 1/16"
2D30	51572	3.000	45° × 1/16"
12D40	51571	3.625	45° × 1/16"
2E40	51571	3.625	45° × 1/16"
3D40	51571	3.625	30° × 3-5/8"
3E50	51258	4.250	30°, flush with cylinder chamfer

taken to start the liner squarely into the cylinder. The liner is then forced into the cylinder until its tapered end bottoms in the cylinder.

5. Grind the inside diameter of the liner to the specifications listed for each propeller model in table X. Face the outboard end of the liner flush with cylinder head gasket seat, and chamfer 30 degrees to the diameter specified in the same table. The ID of the steel liner must be concentric with the ID of of the phenolic liner within .005 inch total indicator reading.

(c) REPLACEMENT OF PHENOLIC CYLINDER LINER.—If the phenolic cylinder liner becomes worn so that the clearance between the liner and the piston exceeds that listed in the clearance chart, figure 62, or should the liner become loose, it can be replaced in the following manner.

1. Loosen the old liner by dissolving the cement with acetone or toluol, and then remove the liner through the large end of the cylinder. Clean off all remaining cement on the cylinder. Next, place the cylinder in boiling water for a period of 10 minutes.

2. Chamfer the OD of one end of the new liner approximately 1/32 inch at 45 degrees. This chamfer is to help in starting the liner into the cylinder. Place the liner on the cylindrical inserting tool with the chamfered end facing away from the inserting tool shoulder. The proper size inserting tool can be made from soft steel in accordance with figure 71 and the dimensions in table XI.

3. Apply an approved waterproof non-corrosive, air-drying cement, such as AAF Stock No. 7300-016000 to the cylinder small bore ID and the OD of the liner. Then, insert the liner, chamfered end first, through the large bore of the cylinder and into the small bore.

4. Place the cylinder under an arbor press and bottom the flange of the inserting tool against

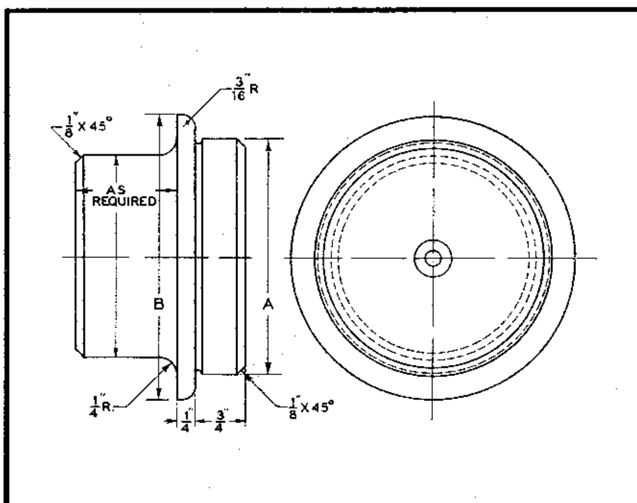


Figure 71 — Cylinder Phenolic Liner Inserting Tool

the base of the large bore of the cylinder. Remove the inserting tool.

5. Using a cloth dampened in acetone or toluol, wipe off the excess cement before it sets. Do not use more solvent than is necessary as an excess may work in between the liner and cylinder, thus causing the liner to become loose.

6. Grind or turn down the ID of the liner to the applicable dimension listed for each propeller model in table XII. Finish off the end of the phenolic liner flush with the inboard face of the cylinder. Chamfer the ID of the liner at the outboard end 45 degrees x 1/16 inch. Chamfer the ID of the liner at the inboard end to the specifications in table XII. In the case of 3E50 propellers in which the inboard end of the small cylinder bore is already chamfered, continue the chamfer into the phenolic liner as noted in table XII. The ID of the phenolic cylinder liner must be concentric with the ID of the steel cylinder liner within .005 inch total indicator reading.

(*d*) REWORK OF WORN COUNTERWEIGHT BEARING SHAFT BUSHING BORE.—Worn or damaged bearing shaft bushing holes in 2D30, 12D40, 2E40, and 3D40 propeller cylinders can be reworked to incorporate a steel counterweight bearing shaft sleeve part No. 65666. This rework is to be done according to the following procedure:

1. Remove the counterweight bearing shaft bushing.

2. Drill a 23/32-inch hole to a depth of .554-.574 inch, and then ream this hole to .7498-.7503 inch to a minimum depth of .521 inch. Using an end mill of the dimensions shown in figure 72, face off stock surrounding the cylinder hole to dimension "A" in table XIII. Finally, countersink the hole .844 inch x 90 degrees.

TABLE XIII

Propeller Model	Cylinder Detail	A +.000 inch −.005 inch
2D30	51539-1	1.500
12D40	51433-1	1.938
2E40	51433-1	1.938
3D40	51420-1	1.813

3. Press the sleeve into the cylinder hole. (Heating the cylinder first in boiling water will facilitate insertion of the sleeve.) Sleeve No. 65666 may be made from AMS 6370 steel, heat treated to 26-32 Rockwell "C". The dimensions after plating are shown in figure 72. Plating should be done in accordance with Specification No. AN-P-32-2 or AN-QQ-P-421a-1.

4. Press the counterweight bearing shaft bushing No. 51124 into the sleeve using an inserting tool similar to that in figure 72. If a new bushing is used, the ID should be reamed to the dimension listed in table XIV.

(*e*) REPLACEMENT OF DAMAGED COUNTERWEIGHT BEARING SHAFT BUSHING.—Bearing shaft bushings may be replaced when damaged. To accomplish this replacement, heat the cylinder in boiling water and then pull out the damaged bushing. Press in a new bushing using an inserting tool similar to that shown in figure 72. An inserting tool like the one shown as item 4 in figure 73 should be used for the bushing in a 2B20 propeller model. The ID of the new bushing is then reamed to the dimension listed in table XIV.

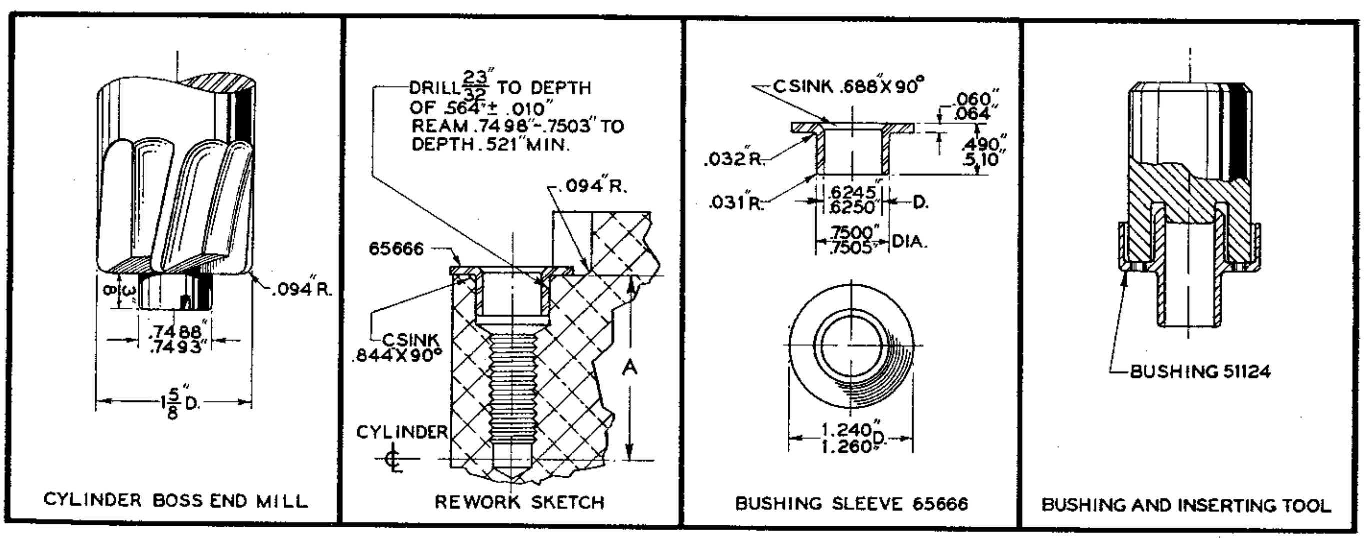


Figure 72 — Rework of Counterweight Bearing Shaft Bushing Bore

TABLE XIV

Propeller Model	Bushing Number	Ream Diameter +.0000 inch −.0009 inch
2B20	59346	.4380
2D30	51124	.5317
12D40	51124	.5317
2E40	51124	.5317
3D40	51124	.5317
3E50	51239	.6099

(*f*) MODEL 2B20 COUNTERWEIGHT BEARING SHAFT BUSHINGS.—If the propeller incorporates a bronze counterweight bearing shaft bushing, this bushing may be replaced at propeller overhaul by steel bushing part No. 59346. Bronze thrust washer part No. 59347 is then added to the assembly as shown in figure 73.

1. Remove the bronze bushing from the cylinder.

2. Using a 1-5/16 inch diameter end mill with a .530 inch diameter pilot, shown as items 1 and 2 in figure 73, mill the bushing boss on the cylinder to 1.738-1.748 inch. To insure that the bushing boss face on the cylinder will line up correctly during the milling operation, use a holding fixture similar to that shown as item 6.

3. Press in the steel bushing No. 59346, shown as item 3 in figure 73, using a small inserting tool similar to that shown as item 4. Counterweight bearing shaft bushing No. 59346 may be manufactured locally from AMS 5024 steel, heat-treated to 23-30 Rockwell "C" according to the sketch and dimension shown in figure 74. Dimensions shown in figure 74 are after plating. Plating should be done in accordance with Specification No. AN-P-32-2 or AN-QQ-P-421a-1, but the .5315-.5325 inch diameter is not to be plated.

4. The assembly is then completed by adding bronze thrust washer No. 59347 over the bushing No. 59346. Thrust washer No. 59347 can be made from bronze meeting Specification No. QQ-B-666

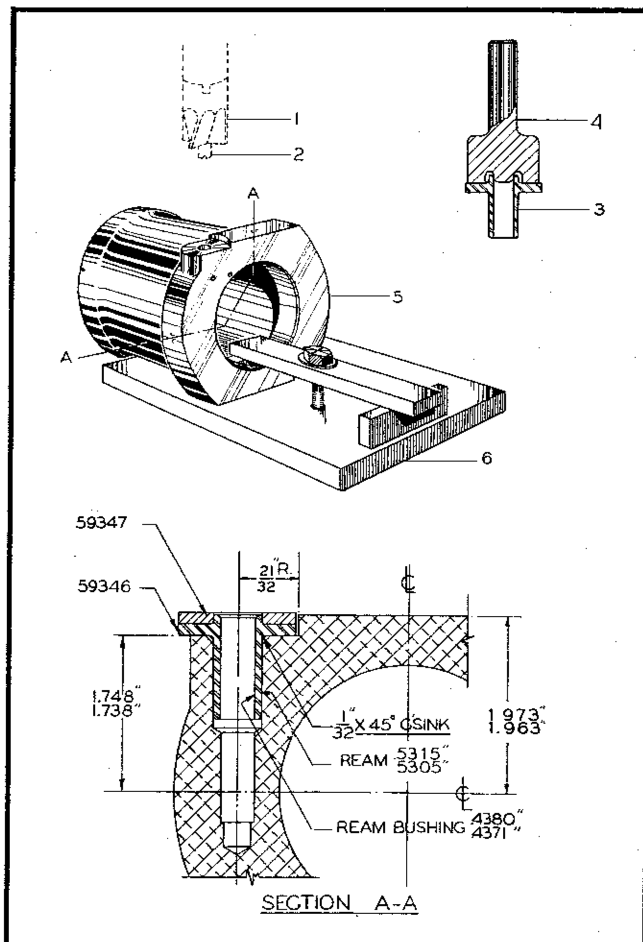


Figure 73 — Modification of 2B20 Counterweight Bearing Shaft Bushing

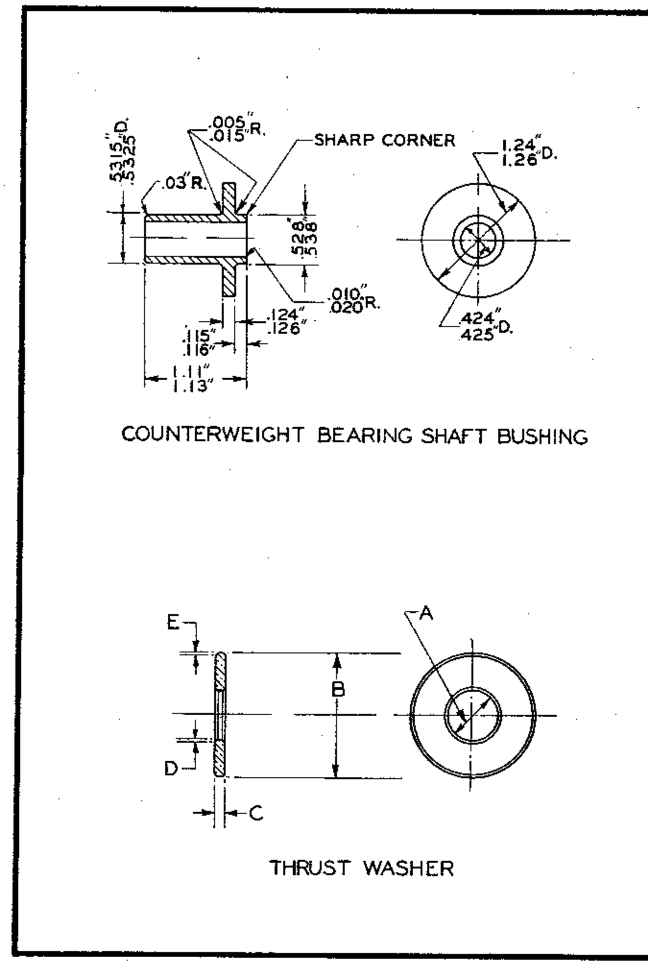


Figure 74 — Counterweight Bearing Shaft Bushing and Thrust Washer

grade B or AMS 4630, according to figure 74 and table XV.

5. The specified clearance between the thrust washer and face of the counterweight bracket must be maintained at assembly. (See paragraph 6.a.(6)(e) of this section.) To facilitate locking the counterweight bearing shaft, it will also be necessary at assembly to drill a .125-inch hole through the bushing, using the holes in the cylinder flange as a guide.

(14) BRONZE THRUST WASHERS.—Bronze thrust washers, being of an expendable nature, should be replaced at overhaul if they are worn or galled. To meet the required clearance (L.003-L.006 inch) between the bronze thrust washer and the face of the counterweight bracket, thrust washers are now manufactured .015 and .030 inch oversize for all propeller models as shown in table XV. If desired, these washers as well as the standard size washers can be manufactured locally from bronze meeting Specification No. QQ-B-666 grade B or AMS 4630 according to the sketch and dimension in figure 74 and table XV. During assembly, the washers may be ground to the required thickness to obtain the .003-.006 inch-clearance specified in figure 62.

(15) ADJUSTING SCREW ASSEMBLY.—Any burrs on the surfaces of the counterweight adjusting screw nuts shall be removed by careful stoning with a fine oil-stone. If the nuts are worn to an extent that will impair their serviceability, they shall be replaced.

(16) PHENOLIC SPIDER RING.—Should the clearance between the rear bore of the inboard barrel half and the OD of the phenolic spider ring exceed the limits shown in the clearance chart, figure 62, shimming between the spider ring and the spider to reduce the clearance to the specified limits shall be accomplished, or a new spider ring installed.

(17) FRONT AND REAR CONES.

(*a*) Any metal pick-up from galling of the front cone can be repaired by careful stoning with a fine oil-stone. Wear or damage covering more than 20 percent of the bearing surface is cause for rejection of the cone. Following any rework of the front cone, it must be replated in accordance with Specification No. AN-P-39.

(*b*) Remove high spots caused by galling on the rear cone with the correct size rear cone lapping tool as listed in paragraph 1. of this section. Install the rear cone on the cone holding part of the fixture so that the cone split fits around the holding key. Install the fixture into the inboard end of the spider, and rotate the cone by means of a bar inserted through the end of the fixture. Use an approved lapping compound between the cone and cone seat surfaces. Do not attempt to remove pits.

TABLE XVI

Propeller Model	Wrench	A ±.010 inch	B ±.010 inch	C ±.010 inch
2B20	M-1087	3-1/8	1-1/2	2-3/4
2D30	M-1088	3-5/16	1-3/4	2-15/16
12D40	M-1089	4-1/8	2-1/4	3-3/4

(18) MISCELLANOUS—REWORK OF INSTALLATION WRENCH.—Installation wrenches, No. 52578 for the model 2B20, No. 52472 for the model 2D30, and No. S8499 for the model 12D40 propeller, are so designed that they may be used to tighten the piston into the propeller shaft and the cylinder head onto the cylinder. These wrenches may be modified to provide a means for tightening the piston gasket nut by welding a circular plate on one end of the wrench and drilling two additional holes in the wrench shell as shown in figure 75. On shaft breathing installations of these models, and for all types of 2E40, 3D40, and 3E50 models, the standard installation wrench without this modification can be used to tighten the piston gasket nut. The piston gasket nut adapter plate can be manufactured locally from SAE 4130 steel, heat-treated to Rockwell 26-33 "C", using the sketch and dimensions shown in figure 75 and table XVI for wrenches Nos. 52578, 52472, and S8499 respectively. After a wrench has been

TABLE XV

Propeller Model	Thrust Washer	A (Inch)	B (Inch)	C (Inch)	D	E
2B20	59347 59347-15 59347-30	.531-.532 .531-.532 .531-.532	1.240-1.260 1.240-1.260 1.240-1.260	.124-.126 .139-.141 .154-.156	.015-.025" × 45° .015-.025" × 45° .015-.025" × 45°	Leave Square Leave Square Leave Square
2D30 12D40 2E40 3D40	51129 51129-15 51129-30	.756-.776 .756-.776 .756-.776	1.553-1.573 1.553-1.573 1.553-1.573	.082-.086 .097-.101 .112-.116	1/32" × 45° 1/32" × 45° 1/32" × 45°	1/32" × 45° 1/32" × 45° 1/32" × 45°
3E50	52486 52486-15 52486-30	.756-.776 .756-.776 .756-.776	1.865-1.885 1.865-1.885 1.865-1.885	.082-.086 .097-.101 .112-.116	1/32" × 45° 1/32" × 45° 1/32" × 45°	1/32" × 45° 1/32" × 45° 1/32" × 45°

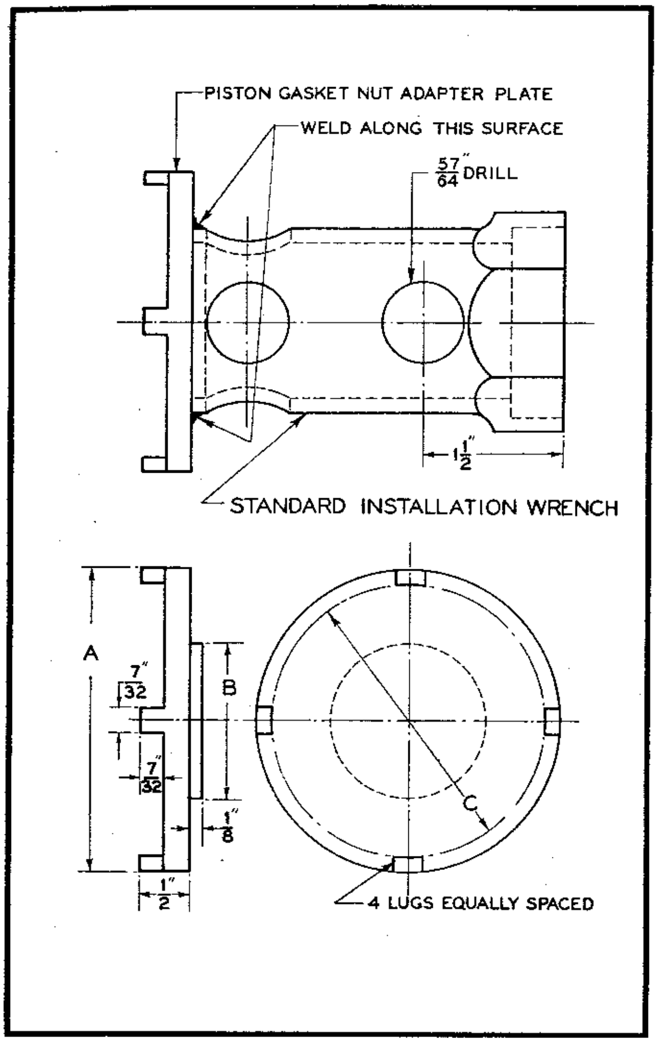


Figure 75 — Modification of Installation Wrenches

modified in accordance with these instructions, the part number shall be changed as indicated in table XVI. Wrench No. 52578 for the 2B20 propeller becomes M-1087, wrench No. 52472 for the 2D30 propeller becomes M-1088, and wrench No. S-8499 for the 12D40 propeller becomes M-1089.

b. BLADE ASSEMBLY.

(1) BENT BLADES.—A blade which is bent shall be inspected in accordance with the procedures outlined in paragraph 4.b.(3) of this section before an attempt is made to straighten it.

(*a*) FACE ALIGNMENT.—A blade which is bent in face alignment within the permissible amount shown in figure 63 for field repair may be straightened cold (for face alignment and angle) without annealing by approved activities; however, a blade which is bent in face alignment beyond the permissible amount for field repair but within the limits for cold straightening may be straightened cold without annealing but should be sent to a repair depot equipped to handle this type of work. A blade which is bent in face alignment in excess of the permissible amount for cold straightening shown in figure 63 shall be annealed in accordance with the heat treatment specification described in paragraph 5.b.(6) of this section prior to straightening, and then reheat-treated after straightening.

(*b*) EDGE ALIGNMENT.—A blade which has a gradual bend in edge alignment that does not exceed two inches at the tip may be straightened after it has been annealed. This shall be done only at approved repair depots capable of handling this type of work. A blade which has been straightened after annealing shall be reheat-treated according to the procedure described in paragraph 5.b.(6) of this section. If the bend exceeds two inches at the tip, the blade shall be removed from service.

(2) SHANK PORTION.—The term "shank" includes that portion of the blade from the butt face to the first blade station. The first blade station (designated as "H" in figure 76) is the innermost station for which the cross section is given on the blade drawing. On most blades, it is the 12-inch station; that is, the station 12 inches from the basic reference line. However, some blade designs have the first blade station at nine inches. Due to the difference "L" between the location of the basic reference line and the actual hub center line, the corrections in table XVII must be taken into account when locating the position of any blade station on an assembled propeller.

TABLE XVII

Propeller Model	Correction L (Inch)
2B20	0
2D30	0
12D40	7/16
3D40	5/16
2E40	1/8
3E50	1/8

(*a*) BUTT FACE.

1. REPAIR LIMITS.—The amount of material removed from the face of the blade butt, the blade fillet, and the thrust washers in reworking must not be so great that the overall dimension from the face of the blade butt to the outboard surface of the flat thrust washer (excluding the thrust bearing retainer assembly) is reduced beyond the minimum dimension "J" shown in figure 76 and listed in table XVIII. This dimension "J" shall not vary more than .002 inch when measured at several points around a blade. In the case of blades that do not have chafing

TABLE XVIII

Type of Blade	(J) Minimum Overall Dimension* (Inch)	Nominal Overall Dimension +.000 inch −.002 inch
B shank blade	1.820	1.875
D shank blade without chafing ring	2.039	2.094
D shank blade with removable chafing ring (measured with chafing ring removed)	1.992	2.047
E shank blade without chafing ring	2.195	2.250
E shank blade with removable chafing ring (measured with chafing ring removed)	2.133	2.188

* Face of blade butt to outboard surface of flat thrust washer, excluding thrust bearing retainer assembly.

rings, the dimension "J" of all blades used together in one propeller assembly must be maintained within .010 inch of each other.

2. REPAIR PROCEDURES.—The blade butt face should be reworked to remove evidence of corrosion and wear, or to realign the face after heat treatment of the blade or scraping of the taper bore. Remove the bushing according to the procedure described in paragraph 2. of this section, and then ream out the taper bore as described in paragraph 5.b.(2) (e), also in this section, to a depth sufficient to allow refacing the blade butt. Locate the blade on its taper bore in a lathe, and turn off the necessary amount of material from the butt face perpendicular to the taper bore axis. Check the squareness of the butt face with the taper bore axis. (See paragraph 5.b.(2)(e) in this section.) In the case of "B" shank blades, it is

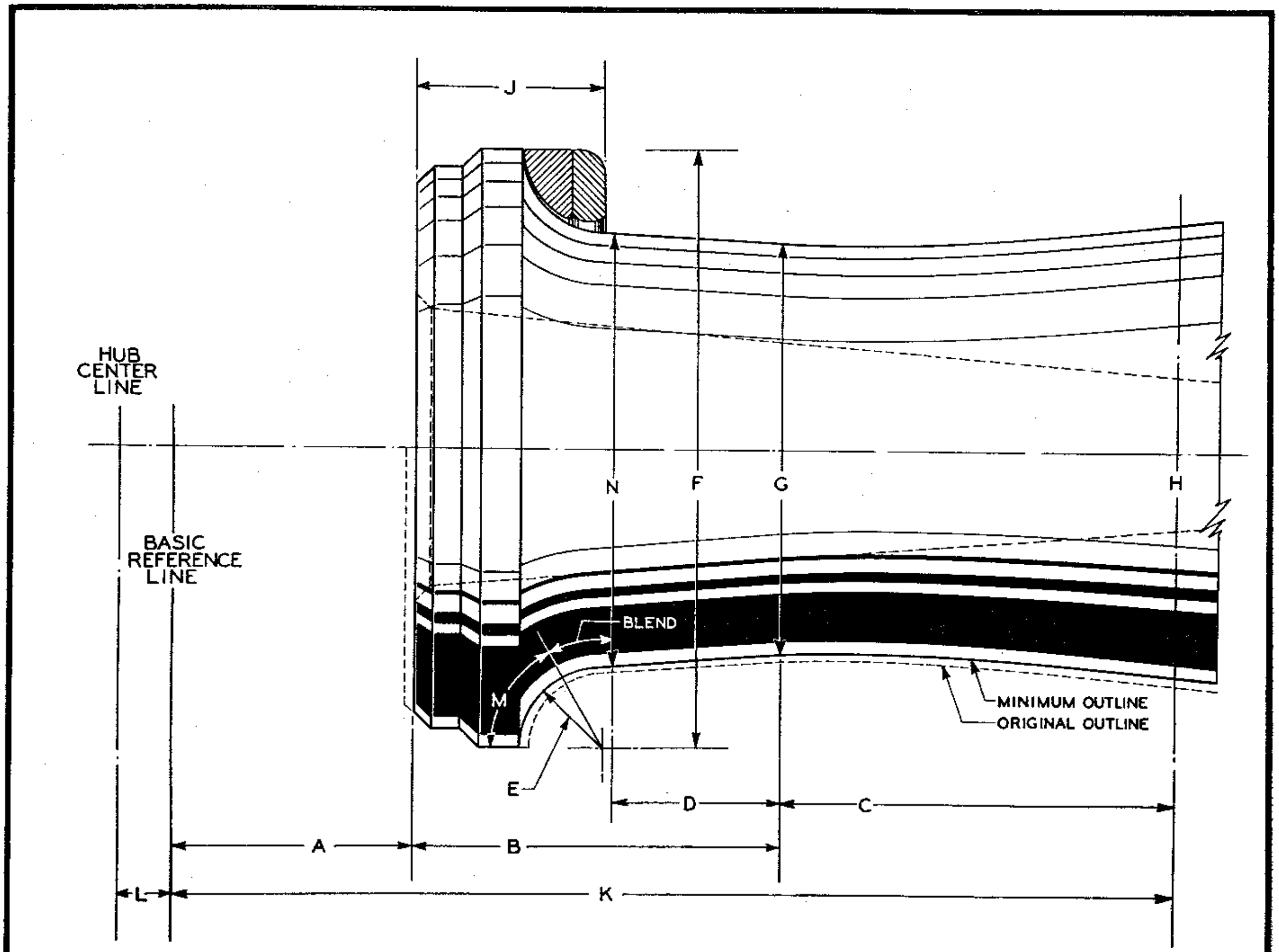


Figure 76 — Blade Shank Repair Diagram

necessary to recut the counterweight bracket seat and key slot to maintain these surfaces within .249 to .251 inch from the butt face. The material removed from the butt face must not reduce the dimension "J" shown in figure 76 below the limits in table XVIII. This distance may be reestablished, within certain limits, by the use of a thicker chafing ring, a steel spacer, and (in some cases) spider shims.

a. USE OF CHAFING RING.—Phenolic chafing rings are provided in various thicknesses for "D" and "E" shank blades and may be used to compensate for changes in the overall dimension "J" from the butt face to the outboard surface of the flat thrust washer due to wear, refacing the blade butt, recutting the blade filet, or grinding the thrust races. However, it is not possible to install a chafing ring on any "B" shank blade, or on a blade having a change letter (following the design designation) prior to that in table XIX. In a blade having a change letter prior to that listed, the beveled washer is made to fit directly on the blade fillet. Chafing rings range in thicknesses from .020 inch undersize to .020 inch oversize in increments of .005 inch. The standard chafing ring is .047 inch thick for a "D" shank blade and .063 inch thick for an "E" shank blade and is identified, in each case, by a -20 following the part number. To determine the correct size chafing ring, measure the distance from the blade butt face to the outboard surface of the flat thrust washer without the thrust bearing retainer assembly or chafing ring installed. Then select the ring from table XX which, when installed on the blade, will bring this overall dimension "J" to 2.090-2.096 inch on "D" shank blades, and 2.2465-2.2525 inch on "E" shank blades.

b. USE OF BEARING SPACER AND SPIDER SHIMS.—A .035 inch thick steel spacer may be used to compensate for a reduction of the overall dimension "J" (shown in figure 76) from the butt face to the outboard surface of the flat thrust washer due to wear or rework of the butt face, blade fillet, or the thrust washers. This spacer is installed around the blade shank between the flat thrust washer and the thrust shoulder of the barrel. These spacers are listed in table XXI. In the case of a blade which does not incorporate a chafing ring, one or two spider shims having a *total* thickness of .040 inch or less may be used in conjunction with the steel spacer to reestablish the dimension "J". The steel spacer is not necessary until the dimension "J" has been reduced beyond the .020 inch which can be made up by the use of the *extra* spider shim. In the case of a blade which incorporates a chafing ring, an oversize chafing ring may be used in conjunction with the steel spacer to reestablish the dimension "J". The steel spacer is not necessary until the dimension "J" has been reduced beyond the .020 inch which can be made up by the use of a maximum oversize chafing ring.

TABLE XIX

Blade Design Number	Change Letter	Blade Shank Size
6101A	AR	D
6101A-15T	Q	D
6127A	S	D
6167A	J	D
6167A-18	C	D
6237A	C	D
6103A	AN	E
6105A	AJ	E
6105A-14T	H	E
6105A-21T	J	E
6105A-33T	P	E
6111A	AJ	E
6157A	K	E
6157A-18T	A	E
6211A	F	E
6227A	F	E
6249A	B	E

TABLE XX

Blade Shank Size	Chafing Ring Part Number	Edge Thickness ±.002 inch
D	56371-0	.027
	56371-5	.032
	56371-10	.037
	56371-15	.042
	56371-20	.047
	56371-25	.052
	56371-30	.057
	56371-35	.062
	56371-40	.067
E	56370-0	.043
	56370-5	.048
	56370-10	.053
	56370-15	.058
	56370-20	.063
	56370-25	.068
	56370-30	.073
	56370-35	.078
	56370-40	.083

TABLE XXI

Blade Shank Size	Bearing Spacer
B	50374
D	50372
E	50373

(*b*) FILLET.—Evidence of galling and corrosion shall be removed from the blade fillet by using fine emery or crocus cloth. Take care to maintain a uniform seat for the beveled thrust washer or chafing ring. Severe galling or pitting of the fillet may be eliminated by carefully recutting the fillet on a lathe. The blade should be located on the taper bore, and the radius cutting tool listed in paragraph 1. of this section set so that its center is at a distance 1/2 "F" (shown in figure 76 and listed in table XXII) from the blade axis. Material shall be taken off gradually from the fillet by moving the tool parallel to the blade axis toward the blade butt face until the surface has been cleaned up. If it is necessary to remove so much material that dimension "J" is below its minimum limit, the blade must be scrapped. The surface "M", shown in figure 76, is the bearing surface and therefore must be cut with an accurate tool. The surface from "M" to the diameter "N" should be blended smoothly with the surfaces "M" and "D". The fit of the beveled washer to the fillet shall be checked on blades which incorporate a chafing ring by bluing the correct gage as listed in paragraph 1. of this section. At least 75 percent of the fillet shall show as a bearing surface. On blades which do not incorporate a chafing ring, this check may be made by bluing the beveled washer and checking it directly to the fillet surface. This is possible because the radius of curvature of the beveled washer on these blades is the same as that of the fillet.

(*c*) THRUST BEARING ASSEMBLY.

1. THRUST BEARING WASHERS.—If the flat faces of the thrust washers show evidence of brinelling by the rollers, corrosion, pitting, and galling, they shall be resurfaced by grinding. The grinding shall be accomplished in such a way that the new surface of the beveled washer is in a plane perpendicular to the blade taper bore axis within .0028 inch full indicator reading as measured at the washer OD when the washer is in position on its seat. The faces of the flat washer must be parallel within .001 inch full indicator reading measured at the washer OD, and no more material should be ground off than is necessary to eliminate the imperfections. Sharp corners left at the outside or inside extremities of the reground surfaces shall be carefully removed. If the outboard surface of the flat washer is reground, the original outboard radius at the OD of the washer must also be reground in order that the fit between the flat washer and the lip of the barrel will be correct. However, it is seldom necessary to rework this surface.

2. THRUST BEARING RETAINER ASSEMBLY.—Rollers that are brinelled or corroded to such an extent that they do not roll freely are to be removed and replaced. Set up the blade thrust bearing retainer in such a way that the area immediately surrounding the rollers to be removed is well supported. Drive out the damaged rollers, as shown in figure 77, using some tool which is small enough to fit between the sections of the bearing retainer. After the damaged rollers have been removed, turn the retainer over. Place the new rollers in position, being careful to note that the long and short rollers are alternated on "E" shank blades between the inner and outer position in the race, and between adjacent retainer slots. Two rollers of the same size are used in

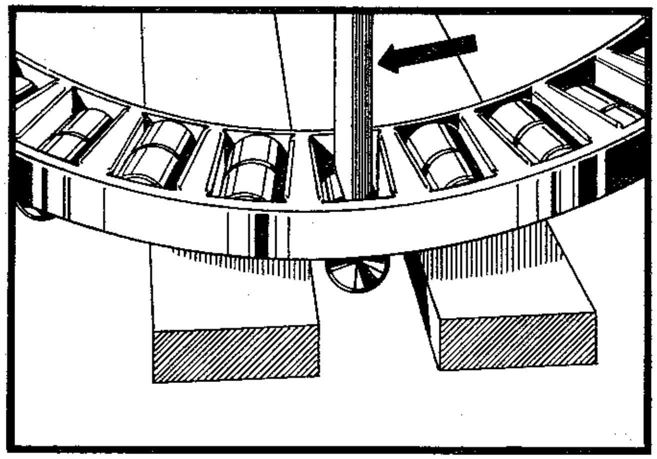


Figure 77 — Driving Out Damaged Rollers

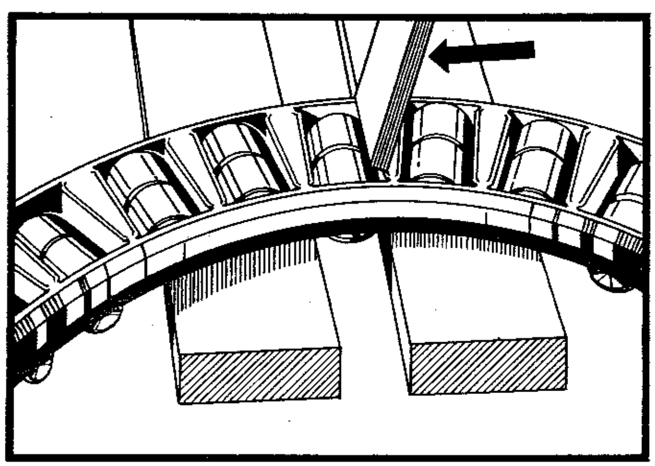


Figure 78 — Restaking Thrust Bearing Retainer

"D" shank blades, and "B" shank blades have one roller in each retainer slot. With a retainer supported as shown in figure 78, drive the new rollers into position. Reset the extended edges of the retainer over the new rollers, and stake the sides of the retainer to prevent the rollers from dropping out. It is recommended that reworked blade thrust bearing retainers be checked to make certain that all rollers are free to operate over the entire depth of the slot, and that they roll freely without binding.

(*d*) SHANK (FILLET TO FIRST BLADE STATION).—As shown in figure 76, reference diameter "G" is located a distance "B" from the blade butt face, and reference diameter "N" is located a distance "D" inboard of diameter "G". Stations "N" and "G" and the first blade station "H" determine the surface of the blade shank. These dimensions are the minimum necessary to maintain an adequate wall thickness, and when reworking the blade, as much material as possible should be left at and between these stations.

1. STATION "N" TO STATION "G".—The surface of the blade over length "D" shall be blended carefully and smoothly from diameter "N" to diameter "G". The surface in this section shall be concentric with the blade axis within .020 inch full indicator reading. It is desirable to keep diameter "G" as large as possible and still have smooth blending of surface "D" with both surface "C" and the fillet surface. No local hollow areas are permitted over length "D".

2. STATION "G" TO FIRST BLADE STATION "H".—The surface of the blade over length "C" shall be blended to maintain a smooth surface from diameter "G" to the blade surface outboard of station "H". The minimum possible blade dimensions at station "H" are determined by the limits given in paragraph 5.b.(3) of this section. Local hollow areas are permitted in length "C" if they do not go below the minimum outline of the blade, and if they are smoothly faired in.

(*e*) TAPER BORE.

1. REPAIR.—If the blade has been bent so that the taper bore is deformed beyond drawing limits, it is generally not feasible to attempt repair and such a blade is usually scrapped. If the taper bore is worn or damaged, it should be reamed with hand reamer 6095-T-8 listed in paragraph 1. of this section to bring it back within the proper limits. The taper bore should also be reamed whenever the blade butt is faced off, as described in the preceding paragraph

TABLE XXII

	B Shank	D Shank	D Shank	E Shank	E Shank
	56150	56151 Change A-K	56151 Change L	56152 Change A-J	56152 Change K
A	2.00″	2.438″	2.438″	2.813″	2.813″
B	2.875″	3.031″	3.031″	3.313″	3.313″
Surface C	Blend as Required	Blend as Required	Blend as Required	Blend as Required	Blend as Required
D	1.00″	1.00″	1.00″	1.063″	1.063″
Nominal Shank Taper D	.73″/Ft.	1.35″/Ft.	1.35″/Ft.	2.00″/Ft.	2.00″/Ft.
E	.628″ .622″	.878″ .872″	.878″ .874″	1.003″ .997″	1.003″ .999″
F	5.375″	6.730″ 6.725″	6.736″ 6.733″	7.240″ 7.235″	7.246″ 7.243″
G	4.000″ Minimum	4.803″ Minimum	4.803″ Minimum	4.997″ Minimum	4.997″ Minimum
H	According to Blade Design	According to Blade Design	According to Blade Design	According to Blade Design	According to Blade Design
M	75°	79°	79°	71°	71°
N	4.059″	4.924″	4.926″	5.184″	5.186″
Plug Gage Depth & Squareness	.003″ .000″	.205″ .203″	.205″ .203″	.220″ .218″	.220″ .218″

5.b.(2)(a) of this section, or whenever the blade is annealed and reheat-treated. In the case where the taper bore is being reamed to eliminate distortion due to annealing and reheat-treatment, the bore should be reamed only enough to provide a new and uniform bearing for the blade bushing. Any step left between the newly reamed taper bore surface and the original taper bore must be carefully blended out. Following the reaming operation, the butt end of the blade should be faced off square to the new taper bore axis, and the squareness and location of the butt face to the taper bore checked with the correct plug gage listed in paragraph 1. of this section. The plug gage must enter the taper bore to a depth within the limits given in table XXII, and the butt face must be square to the taper bore axis within these same limits when checked completely around the butt face. Apply bluing to the plug gage and check the fit of the plug gage in the taper bore. At least 75 percent of the taper bore bearing surface shall show bluing contact. If necessary, the taper bore should be scraped until the proper bluing contact is obtained. In the case of blade designs 6227, 6237, 6241, and 6249, which are made of hard alloy material (HSP 26), the taper bore shall be inspected for cracks (in accordance with the procedure outlined in paragraph 4.b.(4) of this section), and then shot-blasted after any reaming operation. Following the shot-blasting, the taper bore may be lightly scraped to obtain the proper fit and minimum bearing with the taper plug gage.

2. SHOT-BLASTING OF HARD ALLOY BLADES.—The taper bore of blade designs 6227, 6237, 6241, and 6249 which are made of hard alloy material (HSP 26) are to be shot-blasted after reaming. As shown in figure 79, the shot-blasting apparatus consists of a steel nozzle, a shot hopper, a blade holding device, and a shot-blasting shield. The tube which fits inside the nozzle housing is adjustable so that the maximum rate of shot flow can be maintained. Once this flow has been established, the inner nozzle is locked inside the nozzle housing by the lock nut. A long pipe is attached to the end of the nozzle so that shot can be directed to all portions of the blade bore, and the end of this pipe is tipped with brazing to prevent damage to the blade bore. Efficient nozzle operation is obtained with 100 p.s.i. air pressure. The hopper stores and feeds the shot. A gate attached to the shot pick-up pan on the hopper can be adjusted to regulate and maintain a continuous rate of shot flow. The proper shot pattern is obtained by the use of hard iron shot of $.060 \pm .010$ inch diameter. The shield is provided to protect the operator during the shot-blasting operation, and at the same time collect the used shot. The shield is fitted over the blade butt by adjusting the distance between the horseshoe ring and the adjustable ring on the shield. To hold the blade during the shot-blasting operation, the clamp arrangement shown in figure 79 is fitted over the blade tip section and then attached to an overhead girder. The butt end of the blade may be suitably supported by a wooden cradle. The nozzle is inserted through the open end of the shield and the shot flow through the nozzle adjusted to the maximum. Best results are obtained by tilting the blade at approximately a 45-degree angle. To obtain optimum peening results, the blasting shall be accomplished with the mouth of the nozzle one to three inches from the surface being blasted, and the angle at which the shot is directed toward the surface shall be maintained as near to 90 degrees as possible. A typical shot pattern obtained by the use of this rig is shown in figure 79. The operation usually takes about five minutes, and an even pattern can be obtained by slowly working the nozzle pipe up and down inside the blade bore, and then rolling the blade after each section of the bore has been satisfactorily blasted. When blasting the tip portion of the bore, the air should be shut off occasionally to allow the trapped shot to roll out. Care should be used not to scratch or gouge the shot-blasted taper bore with the nozzle. The shot-blasted taper bore should be visually inspected and must show complete coverage with no bare spots or areas. Any area of the blade which is not properly shot-blasted or which is scratched or gouged must be shot-blasted again. After the shot-blasting treatment, the shot-blasted taper bore must not be subjected to temperature above 146° C. (295° F.) and must not be held at any temperature above 66° C. (150° F.) for longer than 2-1/2 hours. Some difficulty may be encountered in reinserting the bushing after the bore has been shot-blasted. If clearance between the blade bushing and the blade butt exceeds .030 inch when the bushing is inserted by hand, the surface of the blade bore may be lightly scraped without injuring the effectiveness of the shot-blasting operation.

(*f*) BLADE BUSHING.—Evidence of wear or galling on the flange or bearing surfaces should be removed by stoning or by the use of fine emery cloth. These surfaces should then be polished with crocus cloth. No attempt should be made to remove the pits at the galled areas. The fit of the blade bushing in D and E shank blades should be such that when the bushing is inserted by hand into the taper bore, the gap between the blade butt face and the bushing flange does not exceed .030 inch. When finally installed in the blade, the clearance between the bushing flange and the blade butt face should not exceed .004 inch. The bushing should be flush with the blade butt face in B shank blades. When bushings are removed from blades, the fit between the blade bushing drive

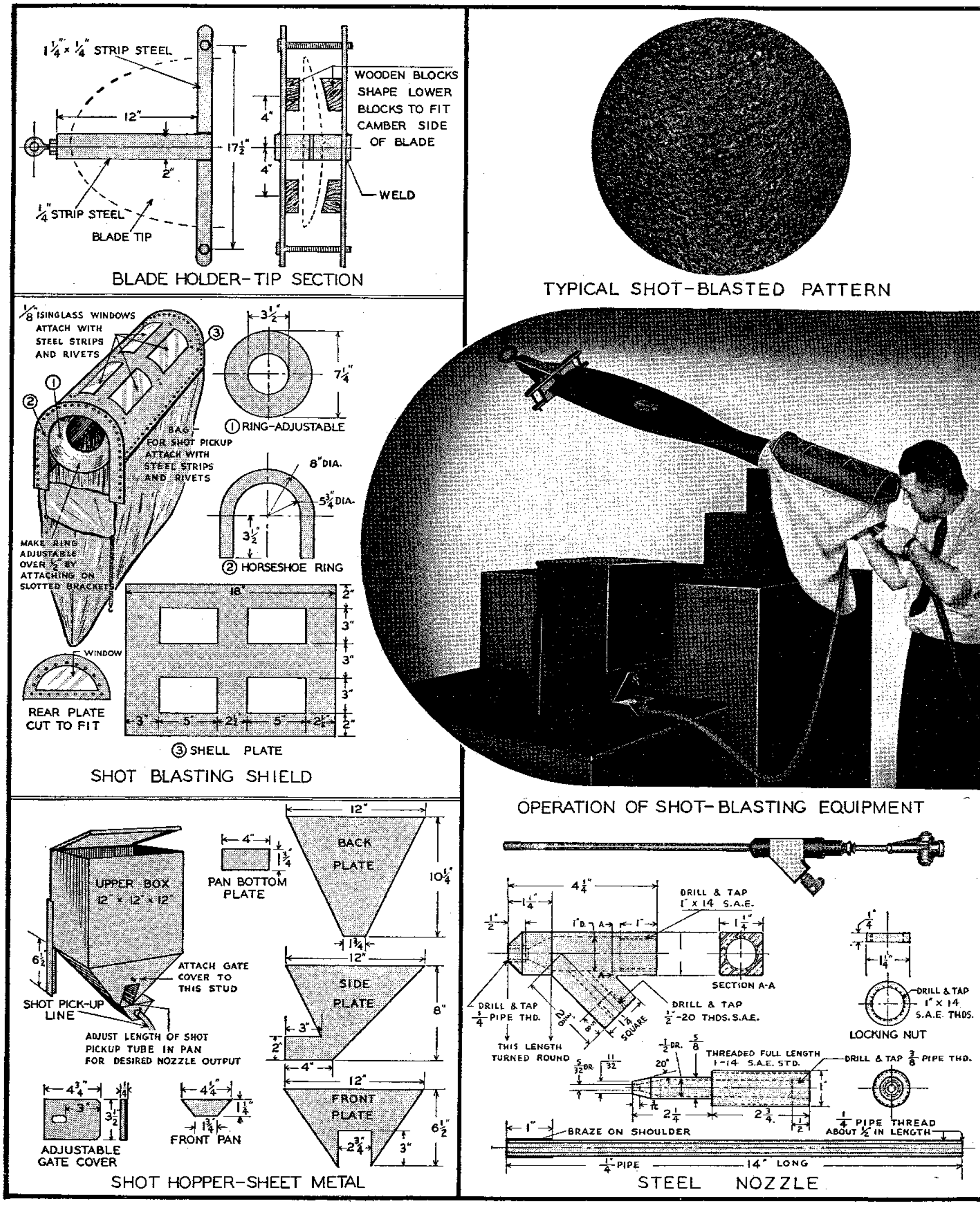


Figure 79 — Hard Alloy Blade Shot-Blasting Equipment

pins and the bushing and blade is often altered beyond allowable limits. If this fit is beyond the limits given in the clearance chart, figure 62, the pins should be replaced with oversize pins. The drive pin holes in the blade and bushing should be reamed to take the next oversize pin in accordance with table XXIII. The drive pin hole in the blade should be reamed to a depth of 9/16 inch for D shank blades and 5/8 inch for E shank blades. The nominal diameter of the bushing drive pin hole in hard alloy blades should be .002 inch more than listed in table XXIII.

(3) AIRFOIL SECTION.

(*a*) Nicks or dents that are too deep to be removed by the usual refinishing operations described in paragraph 3.a. of section V shall be removed by reworking the blades locally with a curved "riffle" file. Take care to remove the sharp base of the nick which acts as a stress raiser. The reworked surface shall then be polished with fine emery or crocus cloth, the entire operation being carried out according to the procedure shown and described in figure 57.

Note

The only acceptable methods of repairing cuts, nicks, cracks, etc. in blades are those by which metal containing and adjacent to the damage is removed from the blade to leave a smooth well-faired surface. Methods which attempt to relocate metal by cold-working to cover or conceal the defect rather than remove the damage are not acceptable.

(*b*) Select the blade from the propeller that will require the greatest modification and finish it up to a smooth contour. Any traces of corrosion shall be completely removed. The effects of the local reworking shall be faired out as much as possible, but it is unnecessary to remove them completely. The leading edge shall be kept in accordance with the drawing section and templates may be used for this purpose. The maximum amount of material that may be removed from the blade in refinishing shall be determined from figure 80 for locations on the blade from the first shank station to 90 percent of the blade radius. The outer 10 percent of the length may be modified as required. Blades requiring the removal of more material than that permitted shall be scrapped.

(*c*) The tolerances in table XXIV are those listed in the blade manufacturing specification, and they govern the width and thickness of new blades. These tolerances are to be used with the pertinent blade drawing to determine the minimum original blade dimensions to which the reductions of figure 80 may be applied. The following example shows how the minimum allowable repaired width at the 42-inch station would be determined for a 6101A-12 blade.

1. The blade radius is 4 feet 6 inches or 54 inches. Assuming one inch reduction after repair of the tip, the repaired blade radius would be 53 inches.

2. To determine the percentage of the repaired blade radius where the 42-inch station is located, divide 42 inches by 53 inches. The result is 79.2 percent. Referring to figure 80, the maximum percentage reduction allowed would be 6.32 percent.

3. Design width at the 42-inch station is 7.498 inch. Multiplying this dimension (7.498 inch) by the maximum percentage reduction allowed (6.32 percent) gives an allowable reduction of 0.474 inch, and subtracting this allowance of 0.474 inch from the design width of 7.498 inch leaves 7.024 inch remainder.

4. As shown in table XXIV, the manufacturing tolerance on the width dimension at the 42-inch station for a propeller (blade) having a basic diameter less than 10 feet 6 inches is .031 inch. Subtracting .031 inch from 7.024 inch leaves 6.993 inch as the minimum allowable width dimension in this example.

(*d*) Modify the remaining blades of the propeller to match the first blade. Template fit shall be determined by the use of templates which have been fitted to the first blade. As shown in figure 58, the

TABLE XXIII

Drive Pin "D" Shank	Drive Pin "E" Shank	Hole In Bushing +.0005 inch −.0000 inch	Hole In Blade +.0005 inch −.0000 inch
S-8112	S-8440	.3755	.371
S-8112-5	S-8440-5	.3805	.376
S-8112-10	S-8440-10	.3855	.381
S-8112-15	S-8440-15	.3905	.386
S-8112-20	S-8440-20	.3955	.391
S-8112-25	S-8440-25	.4005	.396
S-8112-31	S-8440-31	.4068	.402

TABLE XXIV

Basic Diameter Less Than 10′6″		Manufacturing Tolerance (Inch)
Blade Width	Shank to 24″ Station	±.047
	30″ Station to Tip	±.031
Blade Thickness	From Shank to Tip	±.025
Basic Diameter More Than 10′6″		
Blade Width	Shank to 24″ Station	±.063
	30″ Station to Tip	±.031
Blade Thickness	Shank to 24″ Station	±.030
	30″ Station to Tip	±.025

blade tip planforms shall also be matched to a template made to fit the first blade. The width and thickness of all blades must be above the minimum repair limits described in paragraph 5.b.(3)(c) of this section. The maximum allowable differences among corresponding measurements of blades for a given propeller assembly must be within the limits in table XXV.

(*e*) The angle formed by the center line of the drive pin holes (key slots in "B" shank blades) and the chord line of the reference station (42-inch station unless otherwise specified) may vary from that specified on the blade shank drawing by 0.2 degree; however, the maximum variation of this angle among blades selected for a given propeller assembly must be within 0.2 degrees.

(*f*) Blade angles may vary from those shown on the blade drawing within the tolerances given in the first column of table XXVI. The maximum variation between the manufactured angles of any two blades selected for use in a given propeller assembly shall be within the limits given in the second column.

(*g*) After repair, the blade shall be inspected for cracks according to the procedures described in paragraph 4.b.(2) of this section.

(4) BLADE BALANCE.

(*a*) Repaired bades shall be balanced horizontally by selecting the heaviest blade as a master and installing one 3/32-inch standard steel balance washer plus the lock washer and nut. The remaining blade or blades shall be balanced against this master to a tolerance equivalent to the moment caused by the addition of one 3/64-inch balance washer. A total of not more than three 3/32-inch steel washers plus the lock washer and nut may be used in the light blade. If it is not possible to obtain the specified balance with this number of washers, lead may be removed from the heavy blade or added to the light blade (or both) to bring the balance within this washer limit. The maximum amount of lead that may be used is listed in table XXVII. After the correct amount of lead has been installed, the taper bore shall be plugged with a cork which is to be glued in place.

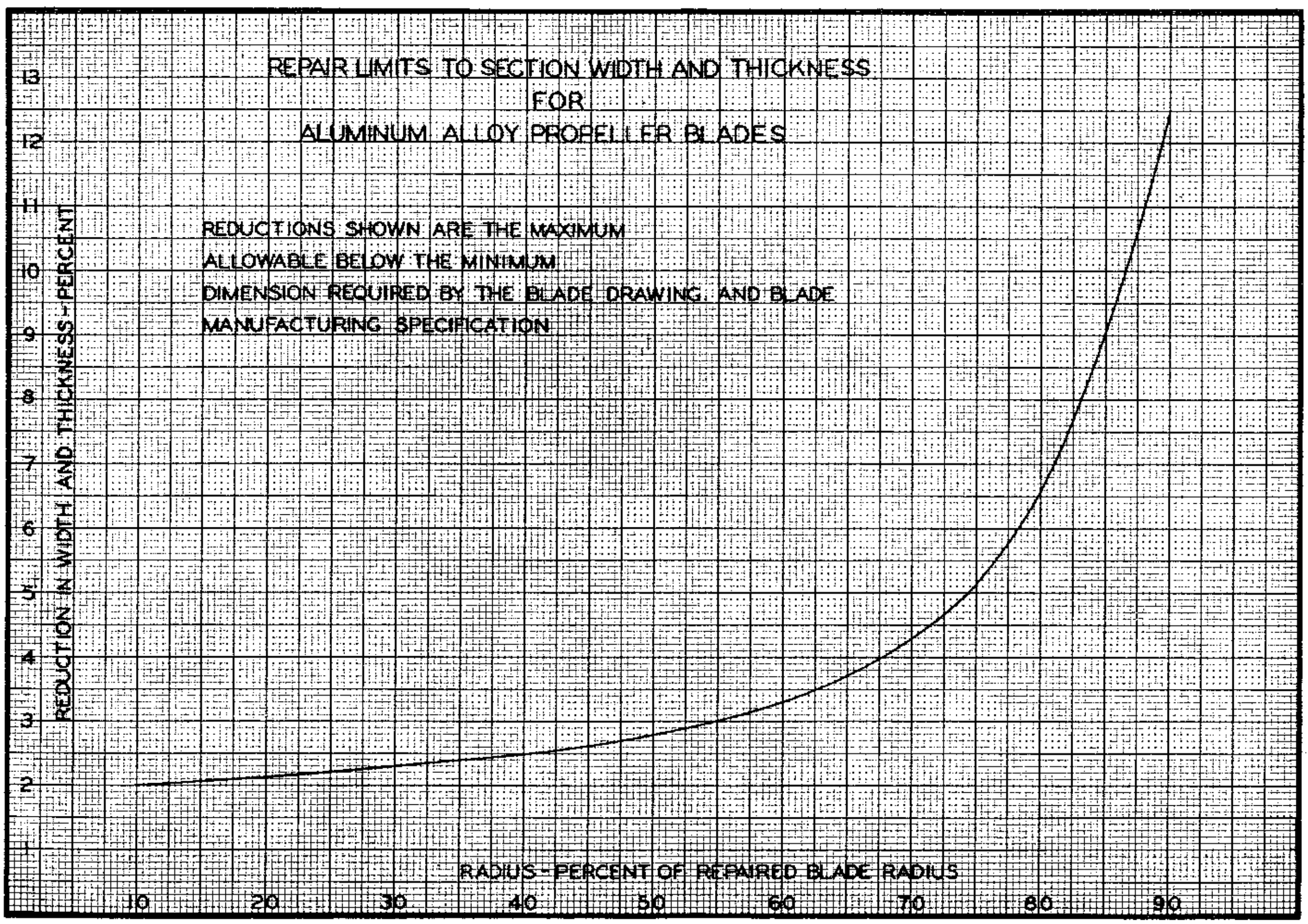


Figure 80 — Blade Repair Limit Curve

(*b*) Repaired blades shall be balanced vertically against the blade selected as the master within a tolerance of .006 inch times the weight of the blade being balanced at two angles, 90 degrees apart. The angles recommended are 0 and 90 degrees.

(5) BLADE MARKING.

(*a*) When the blades have been repaired, the following shall be stamped with 1/16-inch stencils on the base of the blade, just outside the perimeter of the bushing.

Repaired At.........*Ser. No.*.........*Mates Ser. No.*.........
and Ser. No............................*Date*.......................

On blades that have been straightened, stamp a letter "C" if straightened without annealing, or the letter "H" if straightened after annealing. A separate "C" or "H" is to be added for each overhaul involving these operations. No stamping is to be closer than 1/8 inch to the edge of the blade butt face or bushing flange.

(*b*) Each blade shall have the following information stamped with a rubber stamp on the camber side of the blade between the 18- and 24-inch stations. One-half inch letters and numerals should be used. On unpainted blades, use black Matthews Vulcan ink or equivalent, and cover the lettering with a coating of clear lacquer. On blades painted black, Matthews White No. 550 ink or equivalent should be used.

TABLE XXV

Basic Diameter Less Than 10′6″	Shank to 24″ Station (Inch)	(Inch)	30″ Station to Tip (Inch)
Edge Alignment	1/8		1/8
Face Alignment	1/8		1/8
Blade Width	3/16		1/8
Blade Thickness	3/32		3/32
Section Shall Conform to Templates Within	1/32		1/32
Blade Length		1/8	
Track		1/8	
Basic Diameter More Than 10′6″			
Edge Alignment	3/16		3/16
Face Alignment	3/16		3/16
Blade Width	1/4		5/32
Blade Thickness	7/64		3/32
Section Shall Conform to Templates Within	3/64		1/32
Blade Length		1/8	
Track		3/16	

1. Drawing number (preceded by the letter "R" in the case of repaired blades).

2. Serial number.

3. Surface inspection date.

(6) ANNEALING AND HEAT TREATMENT.—This specification covers the general heat treatment of bent propeller blades made from AMS 4130 (HSP-5) and HSP 26 aluminum alloys. It should be used in conjunction with the blade repair specification. The heat treatment of these blades shall include annealing, solution heat treating, quenching, and precipation hardening.

Note

Blades used in Counterweight type propellers are listed according to alloy in table XXVIII. It should be noted that AMS 4130 and HSP-5 designate the same alloy.

(*a*) HEATING.—During all heating operations, the blades must be heated slowly enough to maintain a substantially uniform temperature throughout each blade while coming up to the final temperature; that is light sections must not heat appreciably faster than heavy sections. The temperature of the furnace in the vicinity of the blades shall not be higher than the temperature required for the particular operation.

TABLE XXVI

Basic Diameter Less Than 10′6″	Column 1 (Degrees)	Column 2 (Degrees)
Shank to 18″ Station	±1.0	±1.0
24″ to 30″ Station	±0.5	±0.5
36″ Station to Tip	±0.4	±0.4
Basic Diameter More Than 10′6″		
Shank to 24″ Station	±1.0	±1.0
30″ Station to Tip	±0.5	±0.5

TABLE XXVII

Blade Shank Size	Maximum Weight of Lead (Pounds)
B	2.00
D	2.25
E	2.50

TABLE XXVIII

AMS 4130 (HSP-5) Alloy Blade Designs			HSP 26 Alloy Blade Designs
6091A	6105A	6135A	6227A
6095A	6109A	6157A	6237A
6101A	6111A	6165A	6241A
6103A	6127A	6167A	6249A

(*b*) LOADING.—The blades should preferably be loaded in such a manner that they are suspended from the shank with the tip down. If facilities do not allow this method of racking, the blades may be charged horizontally; however, they must be placed so that no portion of one blade rests on another, and must be so laid that there is a minimum of stress in each blade due to its own weight.

(*c*) ANNEALING.

1. All AMS 4130 alloy blades to be annealed must be heated to 399-427° C. (750-800° F.) and held in this temperature range for a period of two hours. The blades must then be furnace cooled at a rate not faster than 28° C. (50° F.) per hour to 260° C. (500° F.). After reaching 260° C. (500° F.), the blades should be removed from the furnace and allowed to cool in the air.

2. HSP 26 alloy blades must be heated to 343-371° C. (650-700° F.) and held in this temperature range for a period of two hours. The blades are then furnace cooled to 204° C. (400° F.) at a rate which must not exceed 28° C. (50° F.) per hour. The blade may be removed from the furnace and air cooled after reaching 204° C. (400° F.).

3. A type of heat-treating furnace on which accurate and even heat control can be obtained is satisfactory for the annealing operation.

(*d*) SOLUTION HEAT TREATING.

1. After annealing, the bent blades are straightened.

2. To re-establish maximum physical properties, a solution and aging heat treatment must follow. The solution heat-treating process for blades is listed in table XXIX.

TABLE XXIX

Blade Alloy	Temperature	Time at Heat
AMS 4130	510-521° C. (950-970° F.)	4 to 6 hrs.
HSP 26	454-466° C. (850-870° F.)	4 to 6 hrs.

3. After fulfilling this cycle, blades of AMS 4130 alloy are quenched in water which is at a temperature of 66° C. (150° F.), and blades of HSP 26 alloy are quenched in vigorously boiling water, 100° C. (212° F.). A maximum time of one minute may elapse between removal of the blades from the furnace and entry into the quenching bath. The blades should be quenched tip first to minimize the possibility of cracking the thrust bearing races. A further check on the straightness of the blades should be made at this point. The furnace for this operation must be a high quality recirculating type capable of delivering and maintaining a uniform heat. Electric or gas fired radiant tube furnaces are recommended.

(*e*) PRECIPITATION HARDENING TREATMENT.—The solution heat treatment is followed by precipitation hardening as outlined in table XXX. Following this treatment, the blades may be removed from the furnace and cooled in the air. The same equipment used for the solution heat treatment may be used for precipitation hardening treatment.

Note

After the blades have been reheat-treated, the thrust washers shall be magnetically inspected according to the procedure outlined in paragraph 4.c. of this section.

TABLE XXX

Blade Alloy	Temperature	Time at Heat
AMS 4130	168-174° C. (335-345° F.)	8 to 12 hrs.
HSP 26	118-124° C. (245-255° F.)	12 to 16 hrs.

(*f*) CONTROL.

1. All reheat-treated AMS 4130 alloy blades must have a Brinell reading of 100 minimum.

2. All reheat-treated HSP 26 alloy blades must have a Brinell reading of 140 minimum.

3. A scrap blade shall accompany each furnace charge of repaired blades which have been given the solution and precipitation treatments. A section, of a size which will permit machining a standard tensile test specimen, shall be cut from this test blade, marked with the heat number it represents, and tested at a metallurgical laboratory. Approval of the reheat-treatment performed will be based on this representative test piece and the subsequent metallurgical laboratory report. The scrap test blade may be used repeatedly to represent other batches of reheat-treated blades.

(*7*) ANODIZING.

(*a*) When it is desired to anodize a blade, the anodizing shall be performed in accordance with Specification No. AN-QQ-A-696a.

(*b*) After overhaul of a blade that incorporates a fairing, it may be necessary to anodize the tip section before the blade is again put into service. Fairings are not generally affected by the chromic acid anodizing solution; however, in order to protect them completely, an approved stop-off lacquer should be applied to that portion of the fairing which comes in contact with the solution. To protect the bond between the fairing and the blade, the coat of lacquer should be extended about 1/4 inch onto the blade at the section where the fairing tapers off on the blade shank. This quarter-inch strip on the blades will not then be anodized, but the metal will be protected by both the lacquer and any paint subsequently applied over it. In case the fairing has the built-in type de-icing system, the outlet holes along the leading edge should first be plugged up with small wooden pegs (lacquered over) or with stop-off lacquer. Any leak in the seal at these points would affect the brass tubing since this metal is attacked by the chromic acid in the anodizing solution.

(*c*) The anodizing procedure to be followed is outlined in Specification No. AN-QQ-A-696a. Special care should be taken before anodizing to thoroughly clean the blade with a cleansing agent that will not harm the rubber fairing. Carbon tetrachloride is recommended for this purpose. Any oil or grease on the blade surface will seriously impair the anodizing at that section. Natural pores in the anodizing surface are usually sealed by immersing the blade for 1/2 hour in a bath of hot water 82°-100° C. (180°-212° F.). This procedure should not be followed on a blade with a fairing since the hot water might affect the rubber. Good surface sealing can be obtained by rinsing the anodized section with cold water, and then allowing the blade to seal in air for 24 hours before painting. Blades can be suspended in the anodizing tank by wrapping two or four strands of a .125 inch diameter aluminum wire around the blade butt diameter, and twisting them together at the butt face. The number of strands used depends upon the weight of the blade to be anodized. After the blade has been reanodized, it can be painted.

(8) PAINTING OF BLADES.

(*a*) GENERAL.—Blades may be painted while assembled in the propeller hub if facilities for disassembly, balance, and reassembly are not available. Some provision should be made to seal off the blade bore during the painting operation.

(*b*) MATERIALS.—The following materials (to the latest revision) or their equivalent shall be used. Substitute materials covered by appropriate Army-Navy Aeronautical specification shall be considered equivalent materials. Materials shall be prepared in accordance with applicable technical instructions. Care shall be taken that materials are thoroughly mixed when being applied.

1. Primer-zinc chromate conforming to Specification No. AN-TT-P-656a-1. Thinner-toluene conforming to Specification No. AN-R-T-541.

2. Topcoat lacquer, non-specular, conforming to Specification No. AN-L-21, black and identification yellow. Thinner, cellulose nitrate, dope and lacquer to Specification No. AN-TT-T-256-3.

(*c*) APPLICATION.

1. PREPARATION OF BLADES.—Prior to painting, blades shall have been balanced and shall have been given the standard satin finish, unless otherwise specified.

2. CLEANING.—In order to insure that the paint materials will adhere properly to the blades, it is imperative that all surfaces to be painted shall be thoroughly and carefully cleaned directly before application of the priming coat. Likewise, for the application of the topcoat, care shall be taken that the priming coat does not become soiled.

3. EXTENT OF APPLICATION.—In general, except for the additional application of topcoat lacquer to achieve balance, the blade shall be given a two-coat application, one priming coat and one lacquer topcoat. Those portions of the blade which are not to be painted shall be shielded or masked by any appropriate method. The entire blade, including molded shank fairing, but excluding the thrust washers and chafing ring, shall be painted on both sides with zinc chromate primer and black lacquer topcoat. Blade roots shall not be painted in the region listed in table XXXI. Four inches of the blade tip on both sides shall be painted with yellow lacquer topcoat unless otherwise specified. A stripe of either non-specular or glossy orange yellow paint shall be applied on the blade face side at the reference station. This stripe shall be painted over one coat of zinc chromate primer if the surface is not already painted, or over the last coat if the surface is already painted. The stripe shall be $1/8 \pm 1/32$ inch wide and $2 \pm 1/4$ inch long. The difference in distance from the blade reference station to each edge of the stripe shall not be more than 1/8 inch. The difference from the blade center line (projected perpendicularly to the blade face) to each end of the stripe shall not be more than 1/2 inch.

4. METHOD OF APPLICATION.—The application of the paint materials may be accomplished by any standard procedure. The priming coat shall be applied lightly so that a semi-transparent greenish coating is obtained. A heavy full-yellow

Figure 81 — Painting Propeller Blades

TABLE XXXI

Shank Size	Distance From Blade Butt (±0.1 inch)
B	2.5
D	2.8
E	3.1

priming coat shall be avoided. The topcoat shall be applied so that it covers the priming coat completely, and a uniform deep black (or yellow on blade tips) is obtained. The liberal use of topcoat lacquer is permitted, but not to the extent that streaking occurs.

5. DRYING TIME.—Before applying the topcoat, the priming coat shall be permitted to set for at least 30 minutes at normal room temperature, or an equivalent time at elevated temperature, in a dust-free atmosphere. Before handling, the topcoat shall be permitted to set for at least 45 minutes at normal room temperature, or an equivalent time at elevated temperature, in a dust-free atmosphere, and for at least two hours at normal room temperature or its equivalent before assembly into the hub is attempted. The topcoat shall not be considered fixed and ready for service until 48 hours at normal room temperature, or its equivalent, after painting.

(*d*) BALANCE.

1. The use of paint to obtain balance of the assembled propeller is permitted when the blades are painted while assembled in the hub. The operation of propellers which are painted while assembled shall be checked on an engine for smooth running and shall be corrected by adding paint as required.

2. The balance of painted blades may be corrected by the use of paint only. When thoroughly dry, all painted blades shall be balanced horizontally against a master or against an adjustable balance weight set by a master. Where elevated temperatures have been used to accelerate drying, balance shall not be attempted until after the blades cool to approximately room temperature.

3. The balance of painted blades shall be ascertained by the use of stands, balancing ways, bushings, mandrels, and other necessary equipment. The condition and adjustment of the balancing equipment shall be checked for accuracy and correctness at frequent intervals, and shall be immediately corrected when any errors are discovered. Final balance shall be done on a balancing stand in an enclosure which minimizes the effects of air currents. Blades shall be assembled securely in the hub or balancing fixture used, care being taken that the inboard surface of the blade end is properly seated against the locating surface of the hub or fixture.

(*e*) ACCEPTANCE.—In addition to the detail requirements of this specification, acceptance of the finished blades shall be based on the final appearance which shall be smooth and uniform in color density throughout. No surface irregularities such as those resulting from uneven application of the paint materials shall be permitted, nor shall the paint show evidence of poor adhesion.

(9) REPAIR OF BLADE FAIRING.

(*a*) Molded blade fairings are sometimes damaged by accidents in handling or by stones which are picked up by the propeller on the flying field. Such damage may be repaired by means of a stick type Fairing Patching Compound No. 31-9428 made by Dennison Manufacturing Co., Framingham, Mass. The repair of areas greater than 3 square inches is not recommended. To repair a blade fairing, remove all loose particles from the damaged area and undercut the cover stock slightly. The resulting cavity must be dry and free from oil.

(*b*) Insert the stick compound in the cavity as shown in figure 82. A hot soldering iron may be used conveniently, but if flame is used, be careful not to ignite the fairing itself. Be sure the patching compound is really molten in the cavity so that it may fill small pores and adhere well to the cavity surface. A hot nail or knife blade will help in accomplishing this.

(*c*) Fill the hole completely with molten patching compound and then allow it to cool. After the patch has cooled, file and sand the patching compound into a surface which blends with the fairing itself. This compound is resistant to hot oil and gasoline, but will be attacked slowly by hot solvent degreasers and lacquer thinners.

(*d*) Repaint the blade in accordance with the procedure outlined in the preceding paragraph 5.b.(8) of this section.

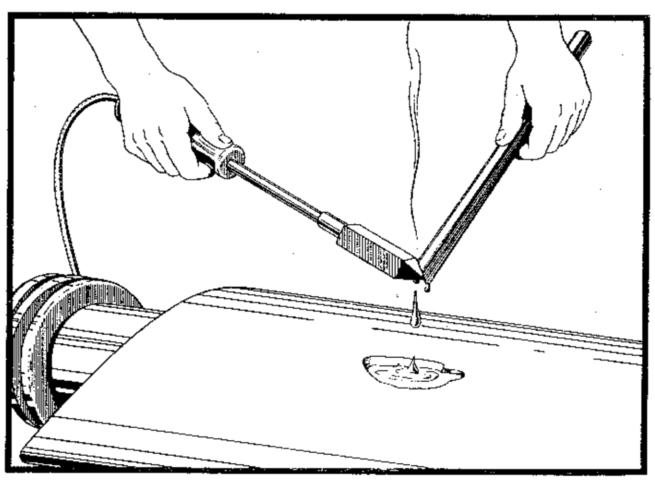


Figure 82 — Patching Blade Fairing

6. REASSEMBLY.

a. MODEL 2D30.—The tools used to assemble the propeller are listed in paragraph 1. of this section.

(1) ASSEMBLY OF BLADE.—To protect the blades from being damaged by the thrust washers during the assembly operations, place a protective wrapping of paper around the blade shanks.

Note

Blades of standard (AMS 4130) and hard (HSP 26) alloys cannot be used together in the same propeller assembly. See table XXVIII in this section for a listing of the various blade designs according to alloy.

(*a*) BLADE BALANCING PLUG.—Place the blade plug in the taper bore of the blade and seat it by hammering against a hollow bar fitted over the plug stud as shown in figure 84. Install one 3/32 inch thick balancing washer, the lock washer, and nut on the blade plug stud and tighten the nut securely. The present style blade plug can be put in either before or after installation of the blade bushing, while the old style plug cannot be installed with the bushing in place. These old type plugs are identified by part numbers 51372, 50787, and 50751 for "B", "D", and "E" shank blades, respectively.

(*b*) BLADE BUSHING.—Insert the drive pins in the blade bushing. These pins are provided in seven different sizes from standard to .031 inch oversize in diameter. If the pins fit loosely, use oversize bushing drive pins. (See section VI, paragraph 5.b. (2) (f).) To facilitate installation of the blade bushing, first heat the blade for one to 1-1/4 hours in boiling water and/or chill the bushing to —34° C. (—30° F.). Do not heat blades which have a fairing covering the shank portion. Line up the bushing drive

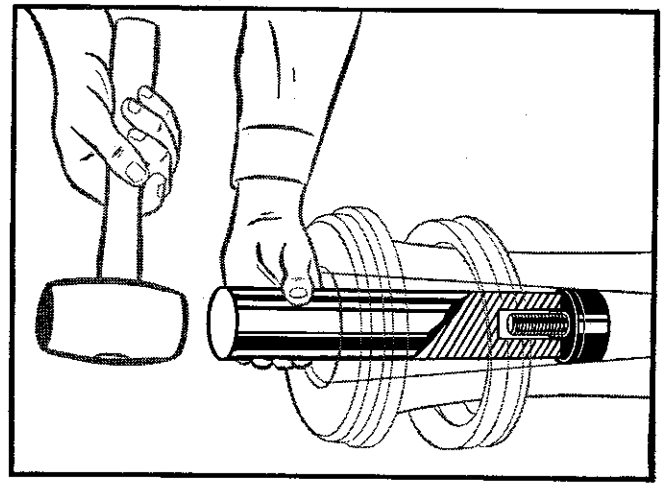


Figure 84 — Inserting Blade Balancing Plug

pins with the drive pin holes in the blade and attach the bushing inserter tool listed in paragraph 1. of this section. Press the bushing into the blade by hammering against and turning the bushing inserter bolt as shown in figure 85. Clearance between the bushing flange and the blade butt face may not exceed .004 inch. Seat the drive pins by hammering against a drift rod of a material which will not damage the pins. Install the two blade bushing screws and tighten them firmly in place. Using a tool similar to that shown in figure 87, stake each screw adjacent to one of the slots and at a location about half way across the bushing flange face. Care should be used in this operation to avoid damaging the bushing flange. Remove any high spots caused by the staking with a fine stone. Using the indexing chart shown in figure 89, determine the location of the semi-circular hole in the bushing corresponding to the desired high angle base setting of the propeller. Consult applicable tech-

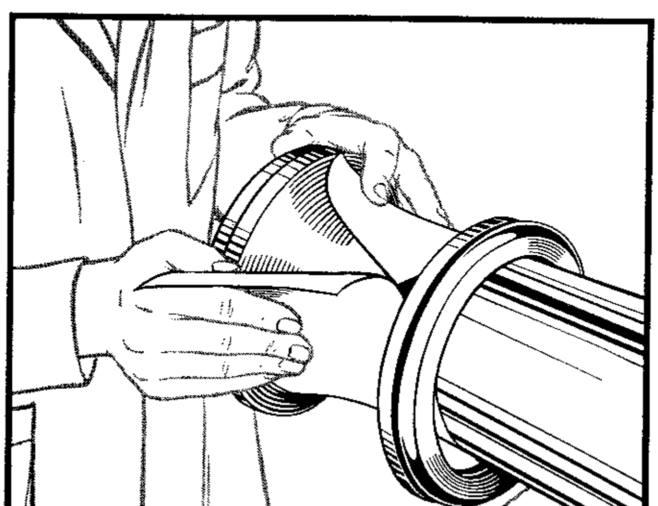


Figure 83 — Wrapping Paper Around Blade Shank

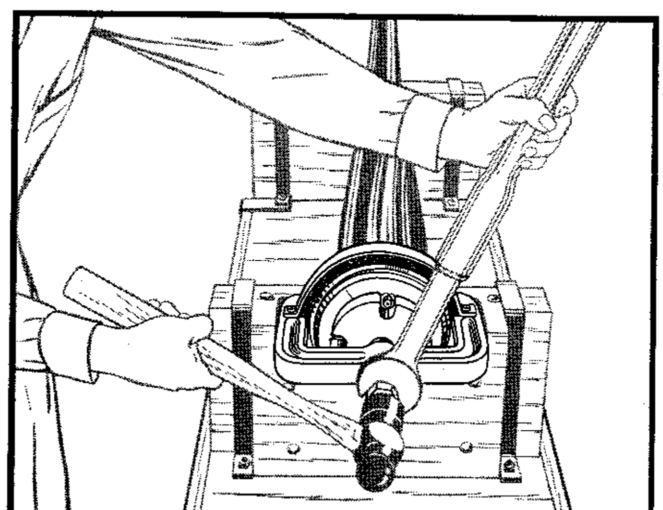


Figure 85 — Installing Blade Bushing

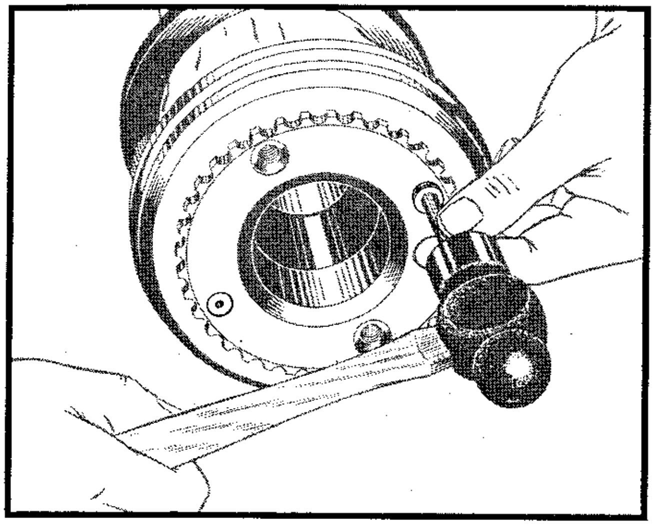


Figure 86 — Seating Blade Bushing Drive Pin

nical publications for the correct base setting of the propeller. This base setting is also stamped on the lead pitch setting plug located adjacent to the cam slot in the counterweight. The setting stamped in the counterweight should be restamped if any change in the base setting is made. Stamp this angle setting opposite the proper hole using a 1/16-inch steel stencil stamp and also identify the bushing hole to the left and to the right of this position. For example, if the basic high pitch setting is 29 degrees, the bushing should be stamped 28, 29, and 30 with the numbers increasing in a counterclockwise direction.

(*c*) CHAFING RING.—Install a chafing ring on each blade between the beveled thrust washer and the blade shank fillet. To properly lock the ring together, note the bevel on the joint edges prior to assembly on the blade shank. Chafing rings should be ink stamped numbered to correspond with the blade position number stamped on the blade butt OD. To correct for wear and rework of the blade parts, chafing rings are provided in thicknesses from .020 inch undersize to .020 inch oversize from a standard thickness in steps of .005 inch. Standard rings for "D" shank blades are .047 inch thick. The required thickness of the chafing ring is determined by measuring the distance from the blade butt face to the outboard surface of the flat thrust washer without the bearing retainer assembly or chafing ring installed. Select a chafing ring of a thickness which, when installed, will bring this dimension within 2.090 to 2.096 inch. If necessary, a .035 inch thick steel spacer may be used between the flat thrust washer and the barrel, together with the proper size chafing ring, in order to bring this dimension within 2.090 to 2.096 inch. This steel spacer is part number 50372 for "D" shank blades. See section VI, paragraph 5.b.(2)(a). If a spacer is used, it should be installed on the blade by springing it just sufficiently to permit installation over the blade shank using care to prevent damaging the spacer or blade. The shoulder on the spacer should face toward the blade butt. Chafing rings cannot be used on "D" shank blades having a change letter (following the part number) prior to those in table XIX since the radius of the beveled thrust washer is larger than the outboard radius of the chafing ring. On an old type blade which does not incorporate a chafing ring, the overall distance from the blade butt face to the outboard surface of the flat thrust washer (without a bearing retainer assembly) should not be less than 2.039 inch for "D" shank blades, and all blades used in the same propeller should be within .010 inch of each other with regard to this dimension. In assembly, one or two spider shims having a total thickness of .040 inch or less, and if

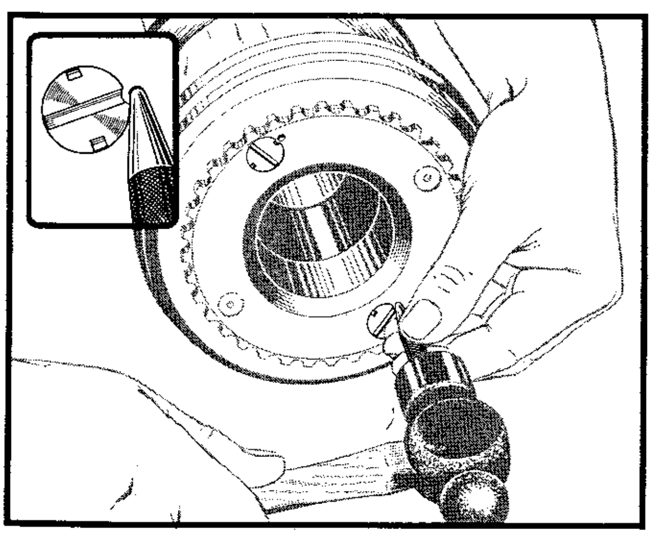


Figure 87 — Staking Blade Bushing Screw

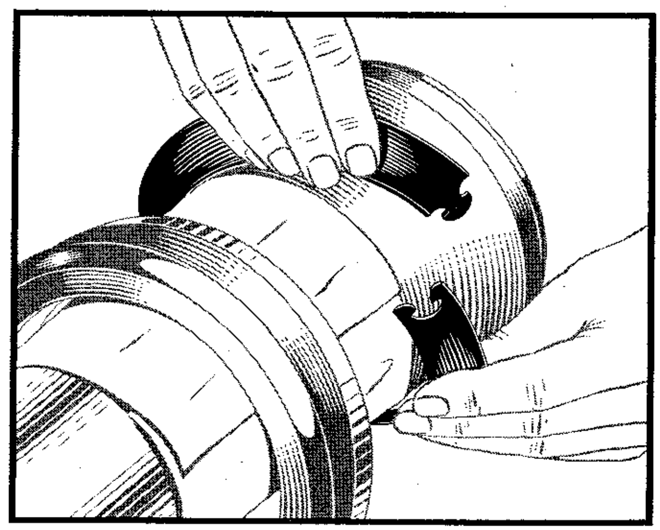
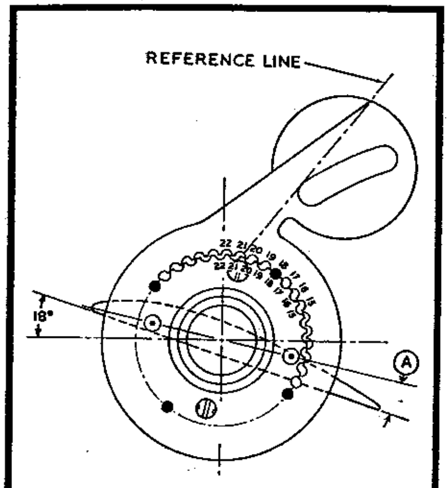


Figure 88 — Installing Split Chafing Ring on Blade Shank



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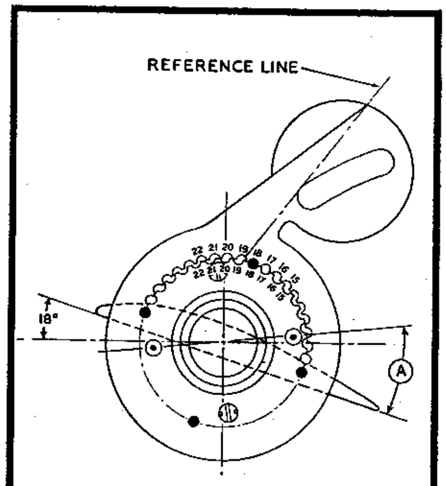

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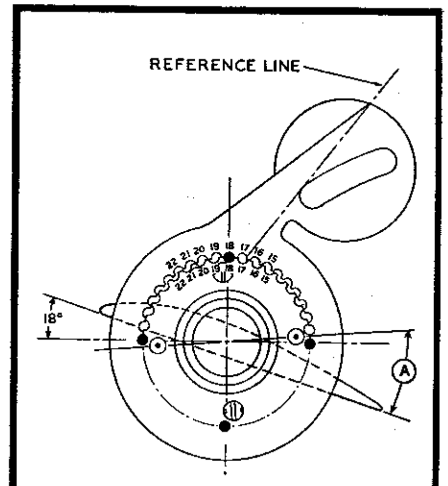

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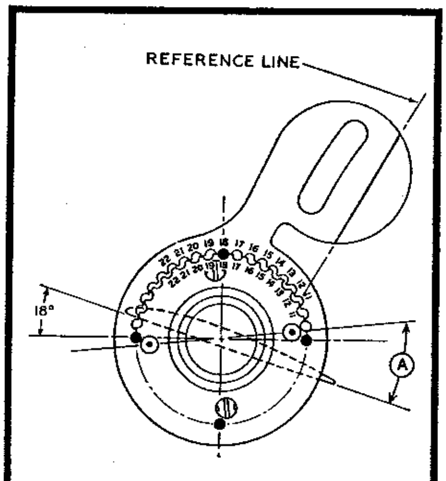

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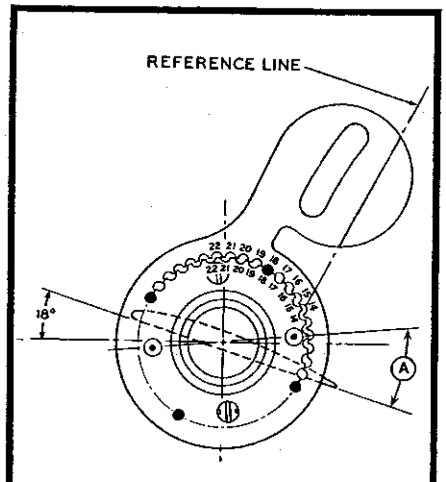

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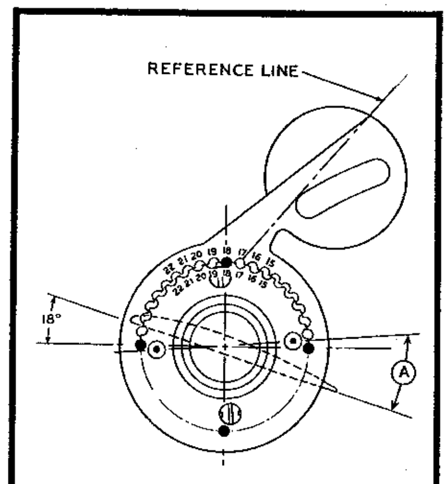

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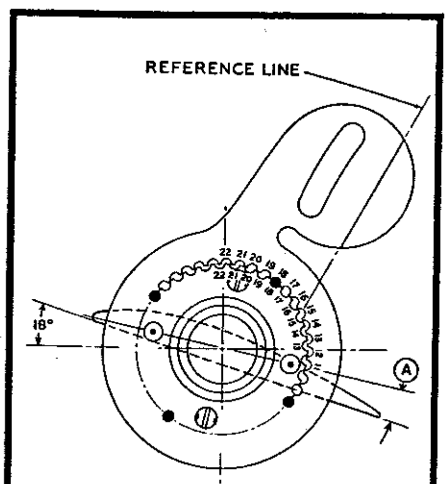
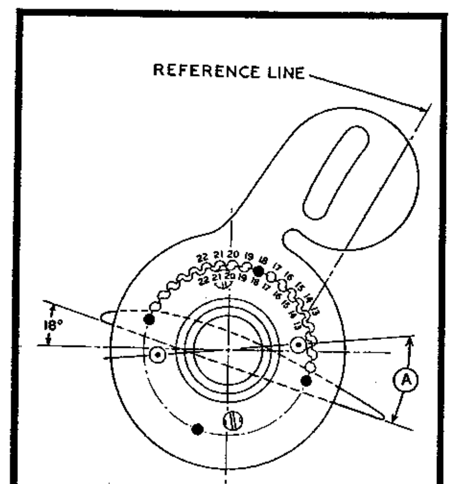


REF. NO. 7

Ref. No.	Bracket No.	Degree Movement	Blade Shank	Drive Pin Angle "A"
1	*50524	20°	E	5°
2	*50524	20°	E	23°
3	†50524	20°	E	23°
4	50390	10°	D	23°
4	51430	15°	D	23°
5	50390	‡11°	D	23°
5	51430	‡16°	D	23°
6	50605	20°	D	23°
7	50213	10°	E	5°
8	50213	10°	E	23°

*Change "C" and after
†Before change "C"
‡When used in 12D40 propellers



REF. NO. 8

Figure 89 — Basic Angle Setting for Bushing and Bracket

necessary the .035 inch thick steel spacer, may be used in order to compensate for any decrease in the overall distance from the butt face to the outboard surface of the flat thrust washer. Blades with and without a chafing ring may be used together in an assembly provided their overall dimensions from the butt face to the outboard surface of the flat thrust washer (including the chafing ring and spacer, if used) are within .010 inch of each other.

(*d*) COUNTERWEIGHT BRACKET.—By means of the indexing chart, figure 89, determine the location of the semi-circular hole in the bracket corresponding to the desired high angle base setting which was used for the blade bushing. Stamp this angle setting opposite the proper hole using a 1/16-inch steel stencil stamp. Also number the bracket hole to the left and to the right of this position in the same manner as the blade bushing. Install a counterweight bracket on the butt end of each blade. Match up the position number on the extreme end of each bracket arm with the corresponding position number of the blade on which it is to be installed. Line up the proper semi-circular hole in the bracket with the corresponding hole in the bushing to give the desired base setting and insert an index pin in this position. Install index pins at the three other points where the holes line up. These points will be 90 degrees apart. Index pins are provided from .0005 to .010 inch oversize in .0005 inch increments. The four pins used in any one blade should all be the same size and should be selected to be a light drive fit in the bushing and bracket holes.

(2) ASSEMBLY OF HUB GROUP AND BLADES.—Install the correct size assembly & balance sleeve on the assembly post. See paragraph 1. of this section. Thoroughly clean the sleeve, and then apply a thin film of clean engine oil. Place the inboard half of the barrel over the assembly & balance sleeve letting it rest on a heavy pad at the base of the assembly post.

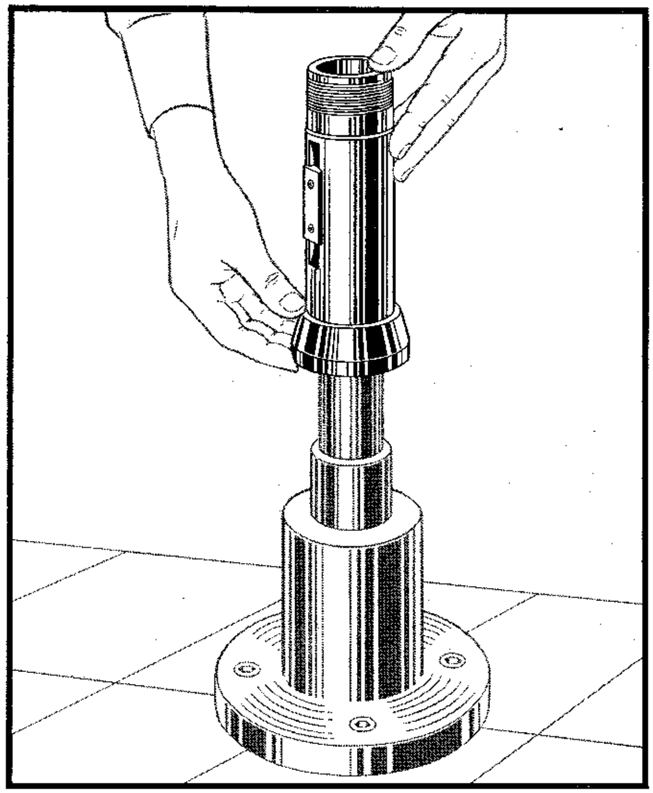


Figure 91 — Installing Assembly & Balance Sleeve on Assembly Post

(*a*) SPIDER AND SPIDER RING.—Tap the two shim plate dowels into the holes in the shim plate bearing faces of the spider and seat them with a brass drift. These pins are provided in two sizes, standard and .006 inch oversize, to establish the required tight fit. If it is necessary to use the oversize pin, see section

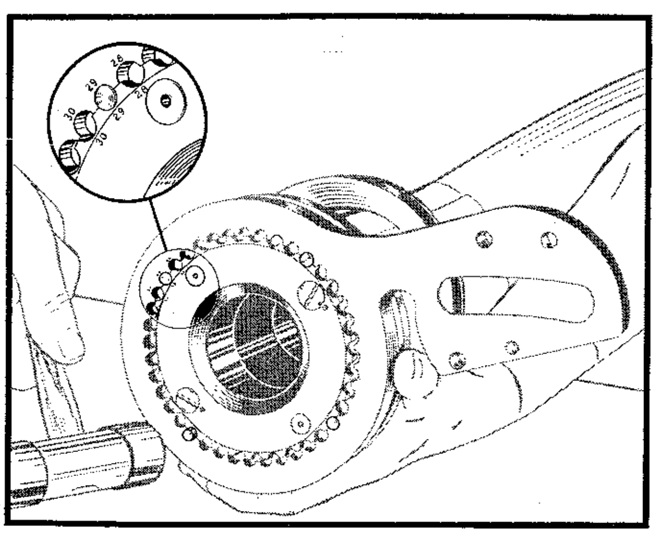


Figure 90 — Assembling Bracket and Index Pins

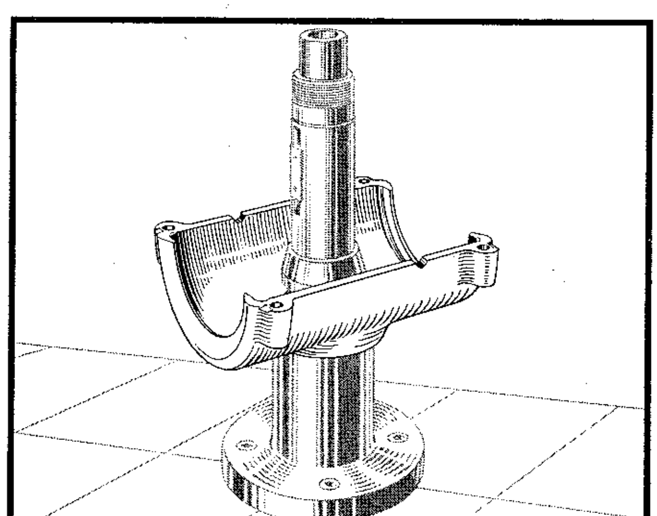


Figure 92 — Inboard Barrel Half On Assembly Post

VI, paragraph 5.a.(2)(c). Clean the front and rear cone seats of the spider, and then place it on the assembly & balance sleeve with the wide spline of the spider meshing with the key of the sleeve. Care should be used to prevent the splines or rear cone seat of the spider from being damaged. Install the two halves of the phenolic spider ring in the groove at the base of the spider. A light film of grease to Specification No. AN-G-4-2 (such as Mobilgrease No. 3) may be applied to the inside surface of the ring halves to aid in holding them in place.

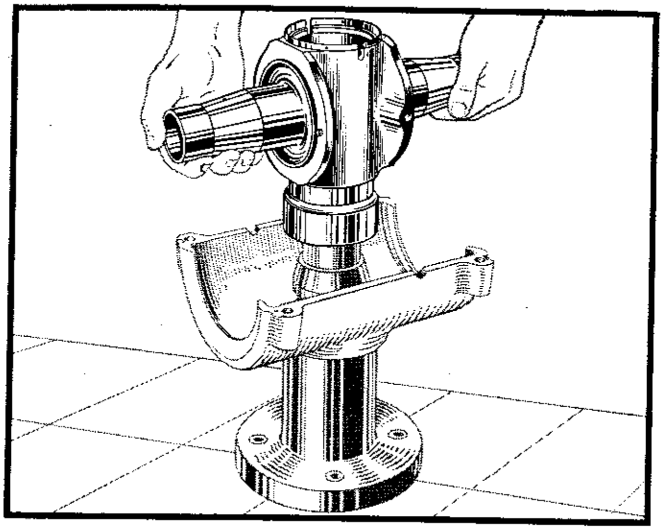


Figure 93 — Installing Spider on Assembly & Balance Sleeve

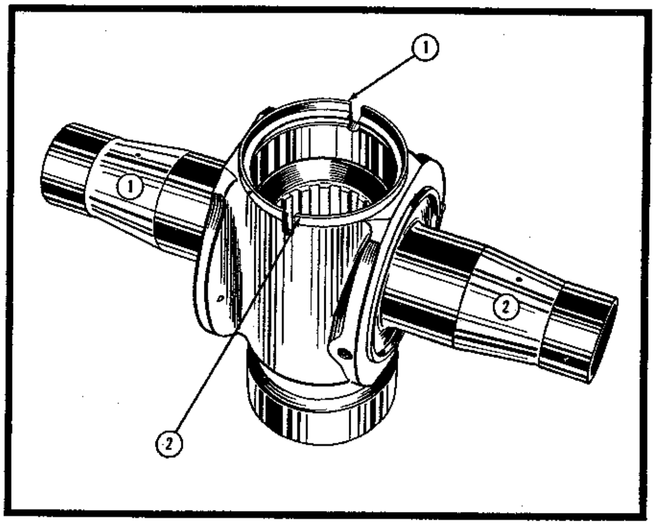


Figure 94 — Correct Spider Arm and Support Seat Numbering

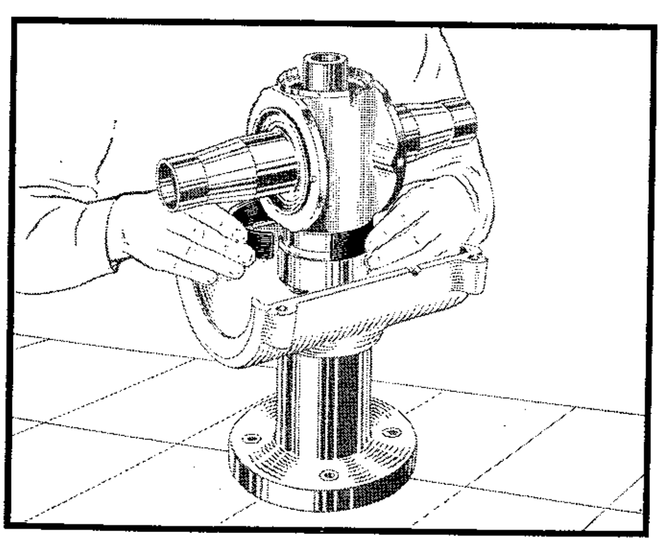


Figure 95 — Installing Phenolic Spider Ring on Spider

(*b*) SPIDER SHIMS AND SHIM PLATES.— Clean the spider shims and shim plates and lightly coat both sides with a grease meeting Specification No. AN-G-4-2. Fit the shim and then the shim plate onto the shim plate dowel in the spider. Make certain that the position numbers stamped on the shims and shim plates agree with the position number on each spider arm. If the shim plates incorporate a phenolic chafing ring around their outside diameter, as in the case of the 2D30-29, they should be installed with the shoulder formed by the chafing ring facing the spider. One edge of this type shim plate is cut off to form a flat straight edge. This flat edge should be placed at the top of the spider. Spider shims range in thickness from .005 to .023 inch in increments of .001 inch. Only one shim may be used with each shim plate if the propeller incorporates blade chafing rings; however, in the case of old type blades which do not use phenolic blade chafing rings, one or two shims having a total thickness of .040 inch, or less, may be used.

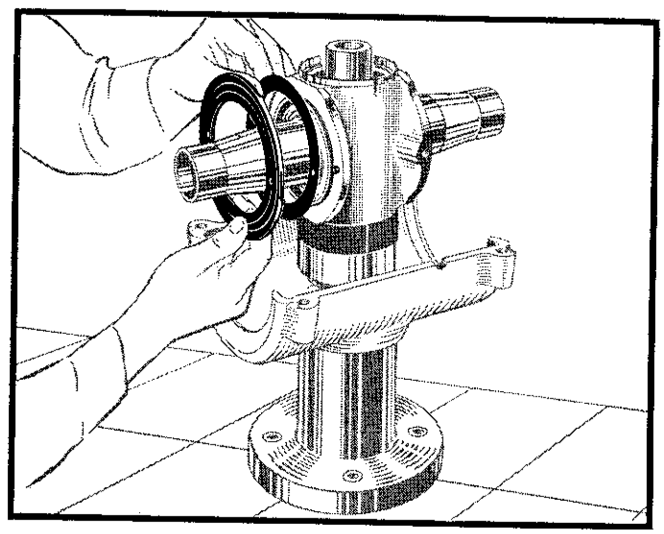


Figure 96 — Assembling Spider Shim and Shim Plate on Spider

(*c*) GREASE RETAINERS AND FITTINGS. —Place a leather grease retainer in the recess at the inboard end of each spider arm with the curved face of the retainer contacting the spider. A light film of grease may be applied to the spider recess, if necessary, to aid in holding the retainers in place. Grease retainers cannot be used in some early models and should be omitted in such assemblies.

(*d*) BLADES.—Clean the spider arms and then thoroughly coat the arm bearing surfaces with a grease to Specification No. AN-G-4-2. Install the blade assemblies on the spider arms carefully noting that the position number stamped on each blade butt OD agrees with the spider arm number. Make sure that the spider shims, shim plates, and leather grease retainers are in place, then press the blades into position against the shim plates. Turn the blades so the bracket arms are vertical.

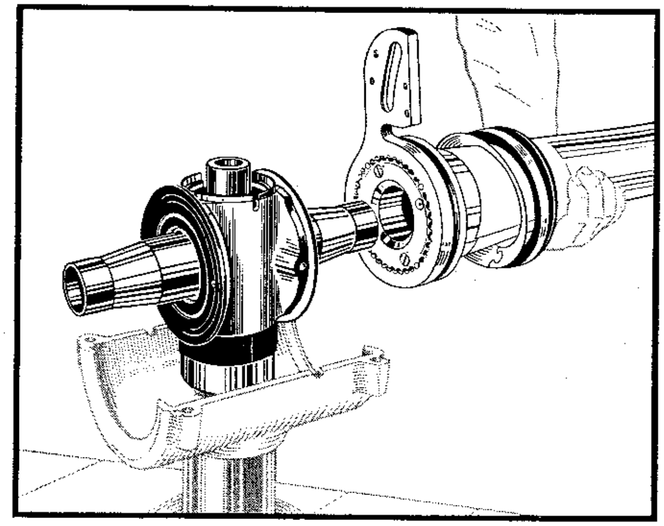


Figure 98 — Installing Blade on Spider

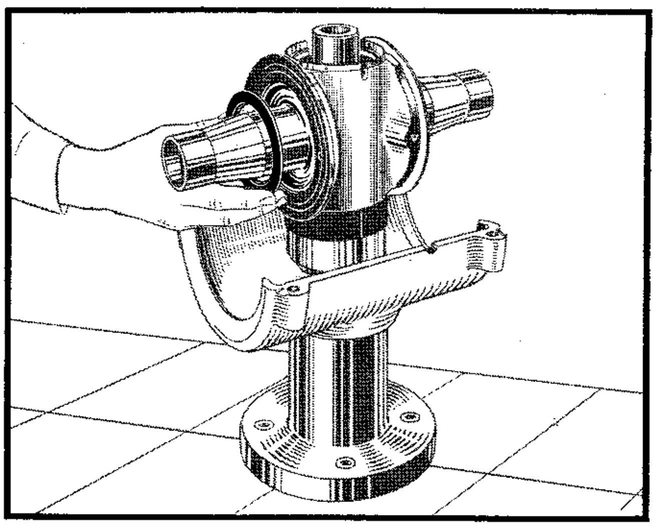


Figure 97 — Installing Grease Retainer on Spider

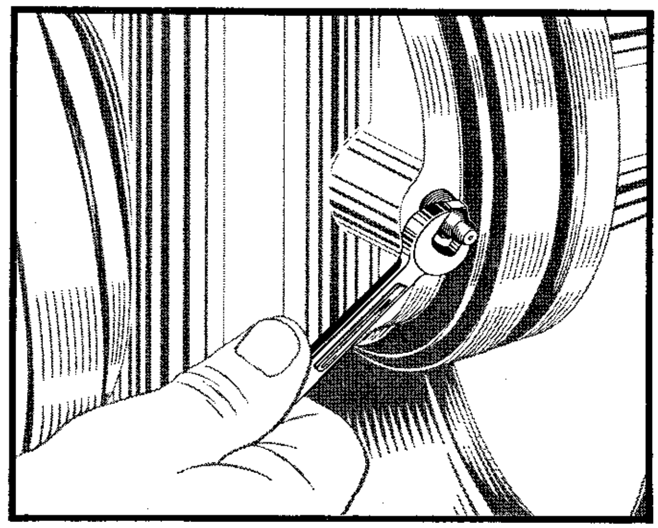


Figure 99 — Installing Grease Fitting in Spider

Note

Blades with and without chafing rings may be used together in a propeller provided their overall dimensions from the butt face to the outboard surface of the flat thrust washer (including chafing ring and spacer, if used, but excluding the bearing retainer assembly) are within .010 inch of each other.

Install and tighten the two grease fittings into the threaded holes located in the side of the flange at the inboard end of the spider arms.

(*e*) BARREL SUPPORTS.—If the barrel supports incorporate means for installation of the lead washers used to obtain vertical propeller balance, insert the buttonhead screw and one washer through the hole in the support with the screw head facing toward the outside of the support. Add another washer and the self-locking nut on the screw

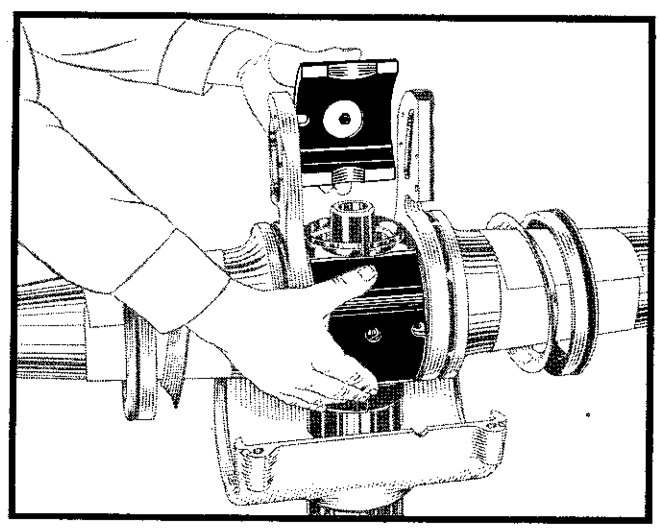


Figure 100 — Installing Barrel Support Assemblies on Spider

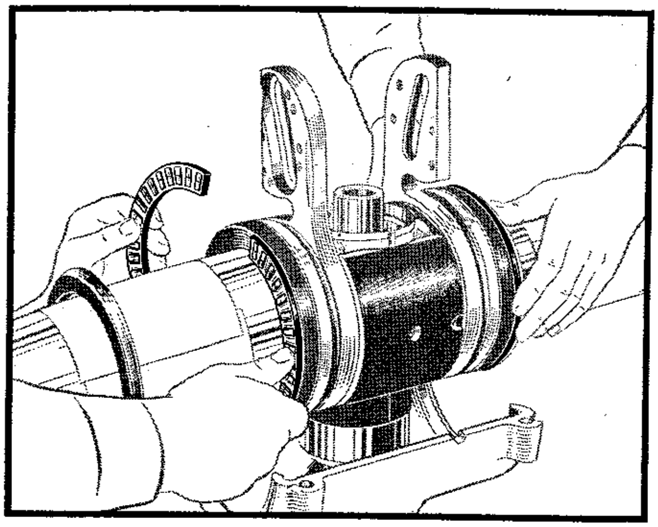


Figure 101 — Inserting Thrust Bearing Retainer Assemblies

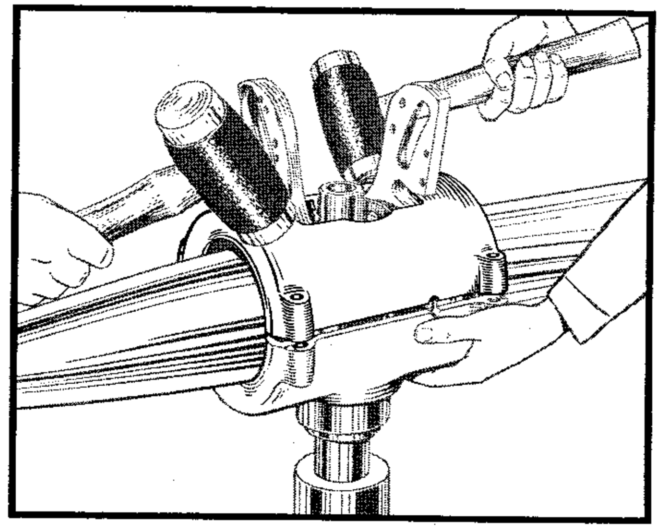


Figure 103 — Driving Outboard Barrel Half Into Position

and tighten the nut. Barrel supports, which do not incorporate provisions for installation of balance washers, can be reworked to take these washers as described in this section, paragraph 5.a.(4). Some early models, such as the 2D30-29, do not incorporate barrel supports. If supports are used, set them in position on the spider. The slot cut into one side of the supports allows the grease fitting in the spider to protrude partially through the barrel support. The supports are numbered at the top to indicate their position on the spider. The support seats on the spider are also numbered at the top of the spider between the arms. Looking at the outboard end of the spider, No. 1 support seat is on the clockwise side of No. 1 spider arm, and No. 2 support seat is on the clockwise side of No. 2 spider arm.

(*f*) BLADE THRUST BEARING RETAINER ASSEMBLIES.—Line up the interlocking joint of the blade chafing ring (if used) and the "0" mark on the outside diameter of the beveled thrust washer with the "0" mark on the outside diameter of the blade butt. Clean the thrust bearing retainer assemblies, and then apply grease to Specification No. AN-G-4-2. Install the retainer assemblies around the blade shank, between the flat and beveled thrust washers, with the split between the two halves in the vertical position. Hold the chafing rings, retainers, and thrust washers in place against the butt end of the blades.

(*g*) BARREL.—Turn the inboard barrel half so that the arm bore identifying numbers stamped on the barrel parting surface close to the arm bores agree

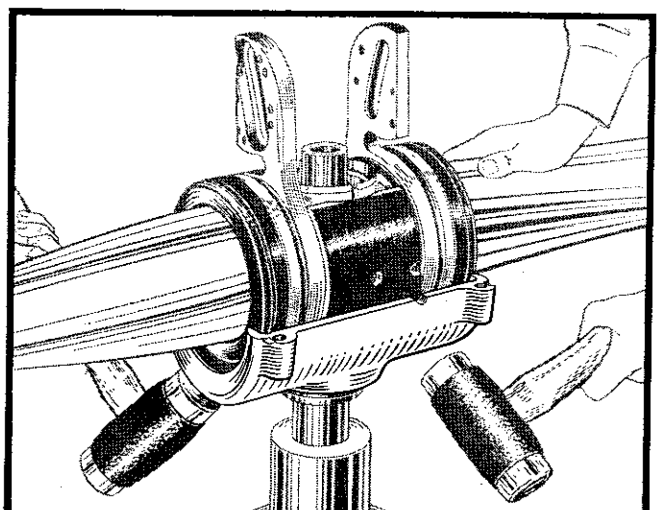


Figure 102 — Driving Inboard Barrel Half Into Position

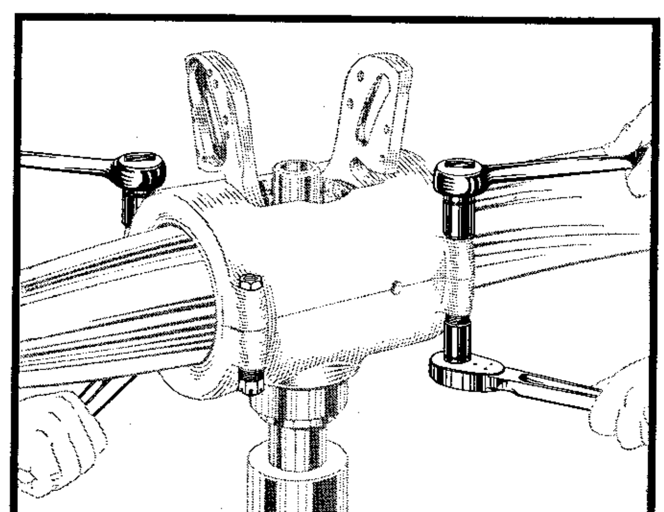


Figure 104 — Tightening Barrel Bolt Nuts

with the position numbers stamped on the blade butts. Raise the barrel half and, while holding the thrust bearing retainers in place on the blades, position the barrel squarely against the flat thrust washers so the barrel thrust shoulders contact the washers evenly. Using rawhide mallets, tap the barrel evenly into position over the blades and barrel supports. Lightly tap the flat thrust washers and thrust bearing retainer assemblies downward to center them with respect to the blade shanks. Remove the protective paper wrapping from the shanks of the blades. Check the pair number stamped on the parting surface of the outboard barrel half to make sure it agrees with the pair number stamped on the parting surface of the inboard barrel half. Line up the arm bore identifying numbers on the parting surface of the outboard half with the corresponding numbers on the inboard half and carefully place the barrel half over the counterweight bracket arms onto the flat thrust washers. Position the outboard barrel half so the shoulders engage the flat thrust washers squarely and evenly. Lightly tap the barrel downward over the flat thrust washers and barrel supports. As the barrel is tapped down into position, it will be necessary to move the bracket arms toward the high pitch position in order to keep the barrel from hitting the bracket arms. Insert the barrel bolts into the barrel bolt bosses making sure that the position number on one of the hexagon flats of each bolt agrees with the position number near the top of the outboard side of the barrel bolt bosses on the outboard barrel half. The bolt bosses of the outboard barrel half are numbered in a counterclockwise direction around the barrel so that bosses Nos. 1 and 2 are on either side of blade No. 1. When the number on the hexagon flat of the bolt head is placed directly over the position number on the barrel bolt boss, the cotter pin hole in the bolt will be parallel to the blades. Install six washers and a nut on each bolt. Tighten the nuts firmly with a short handle wrench using another wrench on the barrel bolt heads to keep them from turning. Care should be used not to tighten the bolts to excess and thereby cause the bolts to take a permanent stretch. The final tightened bolts should have the cotter pin hole approximately parallel to the blades.

(3) BLADE TORQUE CHECK.—Check the pair numbers stamped on the two halves of the front cone for agreement. Assemble the cone halves around the flange of the piston and tighten the piston onto the assembly & balance sleeve. If the propeller is for a shaft breathing engine, the piston from a crankcase breath type propeller should be used in place of the regular piston, since the piston gasket nut used with the regular piston does not have sufficient clearance in the center for the balancing arbor which will later be used. Blade frictional torque for all counterweight propellers should be within 20 to 40 pound-feet.

(*a*) SEPARATE SCALE TORQUE FIXTURE.—When a spring scale type torque measuring fixture is used, these limits are equal to 10 to 20 pounds on the spring scale since the torque fixture has a lever arm two feet long. With the blades in low pitch, install the torque fixture on a blade between the 18- and 30-inch stations with the bar end of the fixture

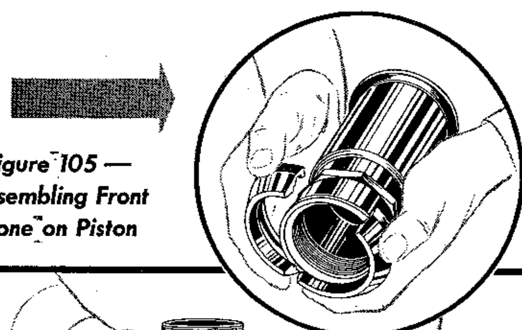


Figure 105 — Assembling Front Cone on Piston

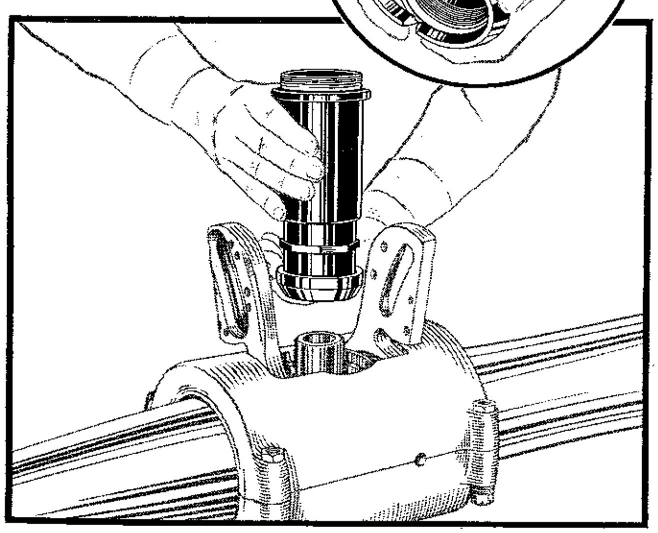


Figure 106 — Installing Piston and Front Cone Into Hub

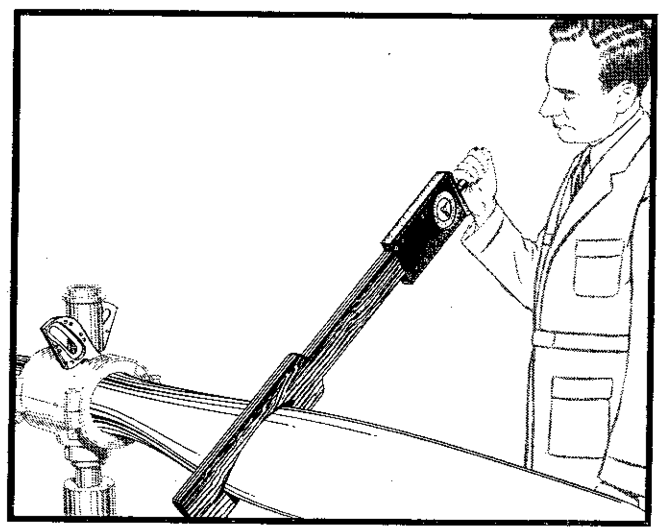


Figure 107 — Checking Blade Torque

on the leading edge side of the blade. Clamp the fixture firmly to the blade with the tightening screw on the blade center line. Attach the fixed end of the spring scale to the end of the bar. With the fixture in the horizontal position and the spring scale hanging freely, the pointer on the scale should read "zero". Turn the blade toward high pitch as far as it will go. Turn the blade slowly and evenly toward low pitch by pulling on the movable end of the spring scale. Keep the spring scale as closely as possible at a right angle to the bar. Observe the scale reading after the blade has started to move. Do not read the initial pull since this includes starting friction. Check the frictional torque of the other blade. If the torque readings are not within limits, disassemble the propeller and select a spider shim of a thickness which will establish the required torque. Spider shims range in thickness from .005 to .023 inch in increments of .001 inch. Only one shim, of the required thickness, may be used with each shim plate. In the case of old type blades which do not incorporate phenolic chafing rings, however, one or two shims having a total thickness of .040 inch, or less, may be used to compensate for any reduction in the overall distance from the blade butt face to the outboard surface of the flat thrust washer due to wear or rework. After changing the spider shims, reassemble the propeller and recheck the blade torque.

(*b*) BUILT-IN SCALE TORQUE FIXTURE.—If the torque fixture (listed in paragraph 1. of this section) having a built-in scale and reading directly in pound-feet is used, a slightly different procedure is to be followed. Pull the blade from high pitch to low pitch, and then from low pitch back to high pitch. Take the average of the two readings which will be in pound-feet and should be within the allowable limits of 20 to 40 pound-feet. Establish the correct blade torque by selecting spider shims of the correct thickness.

(4) BLADE TRACK CHECK.—The track check is a measure of how closely the blades of an assembled propeller rotate in the same plane. Blades should track within 1/8 inch if the propeller diameter is 10 feet 6 inches or less, and within 3/16 inch for propellers of larger diameter. Turn the blades toward low pitch and set them so the face side of each blade at the tip is approximately parallel to the surface of the assembly table. Using a square, height gage, or a straight edge, measure the distance from the assembly table surface to the center line of the face side at the blade tip. These distances must all be within the proper track limit specified. If the blades are out of track by an amount greater than the specified limit, the blades should be removed and the face alignment of each blade checked. See paragraph 5.b. of this section.

(5) PRELIMINARY BALANCING.—After the specified blade torque has been obtained and the track of the blades checked and found within limits, balance of the hub & blades shall be checked. The following balancing should be done with the propeller dry and in a room known to be free from air currents. The propeller should be centered on its cone seats and mounted on a hardened and ground arbor on a balancing stand which is known to be in accurate alignment. See paragraph 1. of this section. Using a protractor such as listed in paragraph 1. of this section, set each blade at the 42-inch reference station to the specified high pitch angle setting of the propeller. The

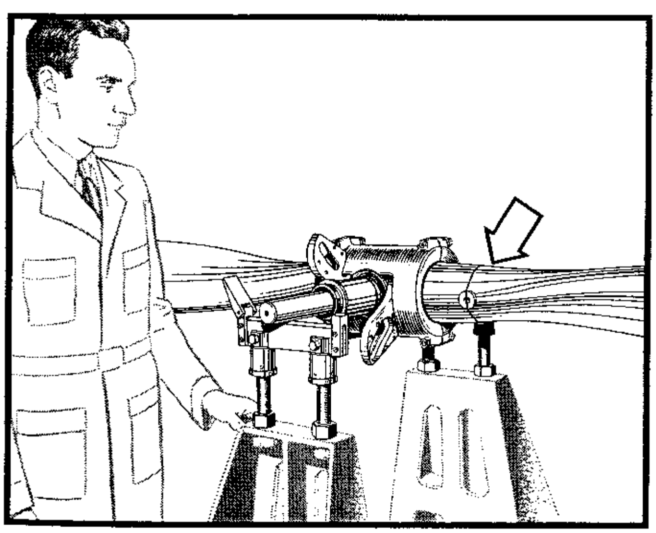


Figure 108 — Checking Horizontal Balance of Hub & Blades

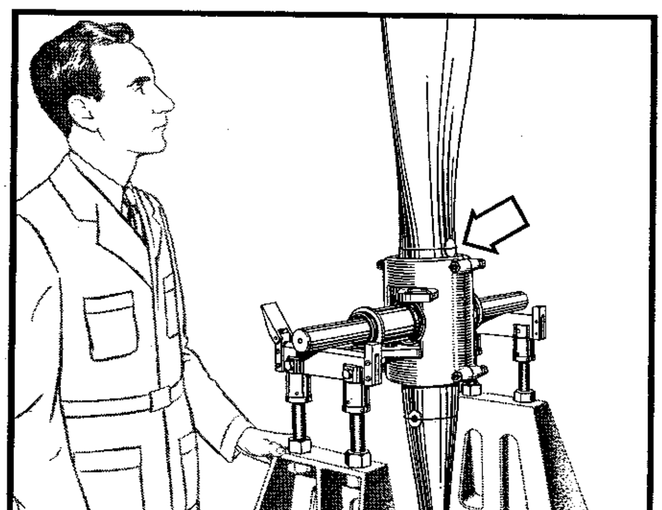


Figure 109 — Checking Vertical Balance of Hub & Blades

reference station of blades having a basic diameter of 14 feet or less is the 42-inch station. Attach a hoisting sling to each blade and carefully hoist the propeller off the assembly post. Wipe the balancing arbor clean and lubricate it with a light coat of clean oil. Insert the correct size arbor (see paragraph 1. of this section) into the assembly & balance sleeve from the inboard end of the propeller. Lower the propeller slowly until the arbor contacts the balancing way protectors and then allow it to roll easily onto the ways. Square the arbor with the ways by rolling it against the stops and then return the assembly to approximately the center of the stand. Turn the balancing way protectors up from the ways. Free the balancing arbor in the assembly & balance sleeve by rolling the arbor back and forth without allowing the propeller to rotate. Place each blade successively in the horizontal position and, in each case, arrest any rotation until the propeller remains momentarily motionless. Note whether the assembly shows a persistent tendency to rotate in one direction. If the propeller shows a persistent tendency to rotate, determine the least number of balancing washers required on the light blade to bring the assembly into the best possible balance. These washers should be placed, in each case, on the center line of the face or camber side of the blade at the approximate position they will occupy inside the blade bore on the blade balancing plug stud. The washers can be held in place temporarily by means of elastic bands or tape. Balancing washers are provided in two thicknesses, 3/32 and 3/64 inch. Any number of washers which can be fitted on the blade balancing plug stud, together with the lock washer and nut, can be used to obtain balance. If the propeller has barrel supports which incorporate means for installing lead washers for obtaining vertical balance, the vertical balance should be checked. Place each blade successively in the vertical position and check the vertical balance in the same manner as the horizontal balance. If the assembly shows a persistent tendency to rotate, determine the least number of balancing washers required on the light side of the assembly to bring it into the best possible balance. The washers should be placed on the side of a blade or on top of one of the barrel bolt lugs as close as possible to the position they will occupy when installed on the barrel support. The washers can be held in place temporarily by means of elastic bands or tape. A total of four lead balancing washers can be used on one barrel support. After the closest possible balance has been obtained, hoist the propeller off the balancing stand, remove the balancing arbor, and place the assembly back on the assembly post. If balancing washers are to be added, disassemble the propeller to remove the blades. Add the required number of washers to the blade balancing plug of the proper blades and then tighten the nut. Install the required number of lead washers on the proper barrel support. Reinstall and tighten the self-locking nut. Reassemble the hub and blades in the same manner as previously described. Remove the piston and the front cone from the assembly.

(6) FINAL ASSEMBLY.

(*a*) CYLINDER, PISTON, AND FRONT CONE.—Using a hollow bar similar to the one shown in figure 112, press or tap the inner races of the counterweight thrust bearing assemblies into the counterweight bearing shaft bushings of the cylinder with the ball bearing groove of the races facing away from the cylinder. The inner race is identified by a "—1" immediately following the part number. Some early

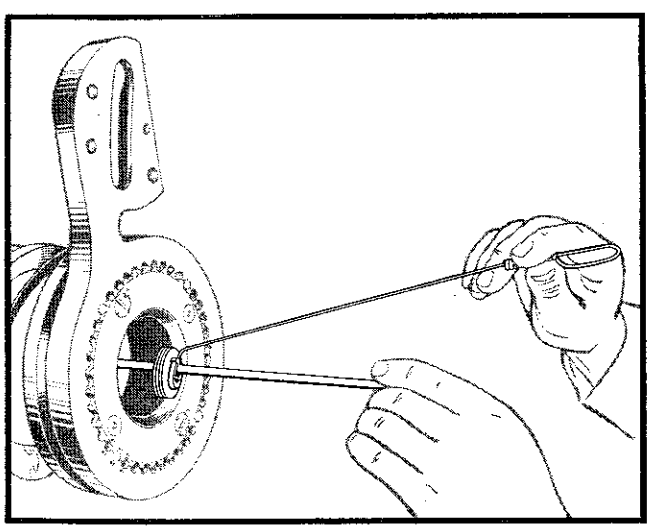


Figure 110 — Adding Balancing Washers to Blade Balancing Plug

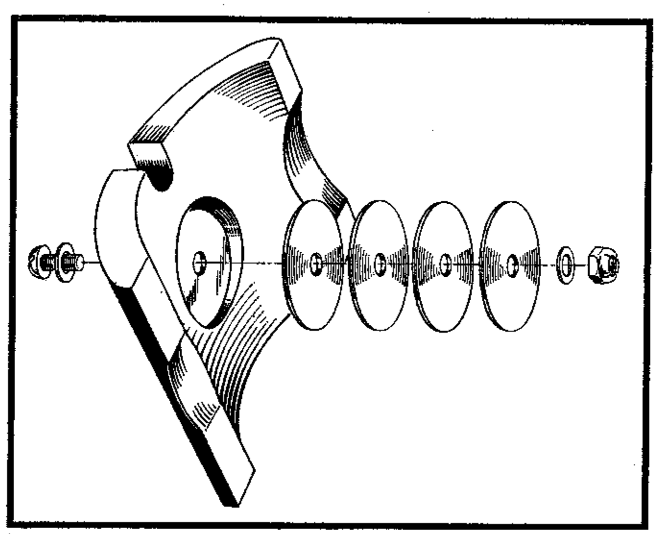


Figure 111 — Barrel Support Assembly — Extended View

propeller models do not incorporate counterweight thrust bearing assemblies. Using a protractor, set the blades at the 42-inch reference station to the high pitch angle setting of the propeller. This will facilitate installation of the counterweight bearing shafts later. Insert the piston through the cylinder and assemble the cone halves around the flange of the piston. Place this assembly between the bracket arms making sure that the position number on the cylinder bosses adjacent to the bushings agree with the position numbers on the end of the bracket arms. Tighten the piston onto the assembly & balance sleeve. Place the inboard piston gasket over the end of the piston and seat it on the piston shoulder. The inboard piston gasket can be identified by the 45-degree chamfer on the extreme end of its outside diameter and on the smallest inside diameter. It should be installed with the chamfered end facing downward toward the spider. Install and tighten the piston gasket nut.

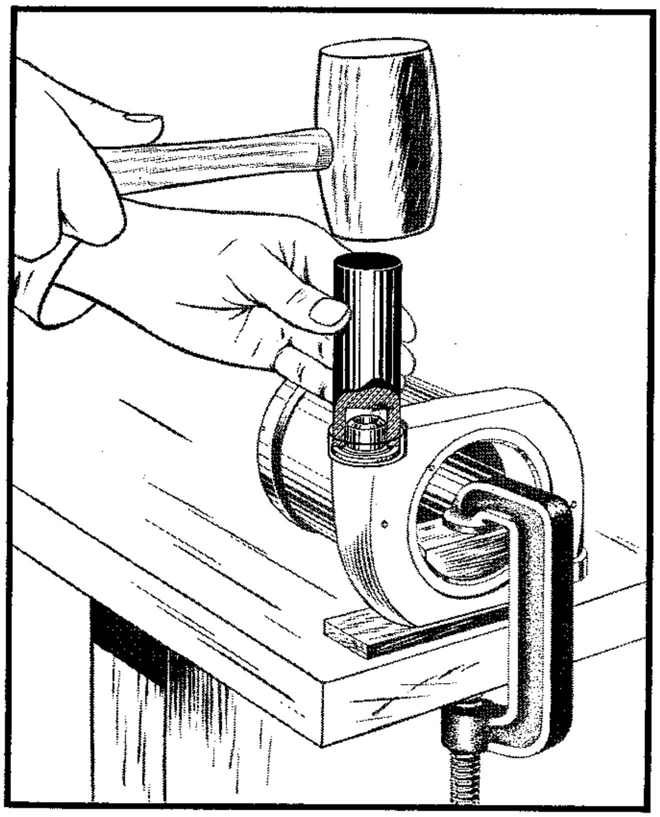


Figure 112 — Installing Counterweight Thrust Bearing Inner Race

Note

On propellers for shaft breathing engines, the piston and piston gasket nut from a crankcase breathing type propeller should be used in place of the regular piston and nut. This is necessary since the regular piston gasket nut does not have sufficient clearance in the center to allow the balancing arbor to be inserted.

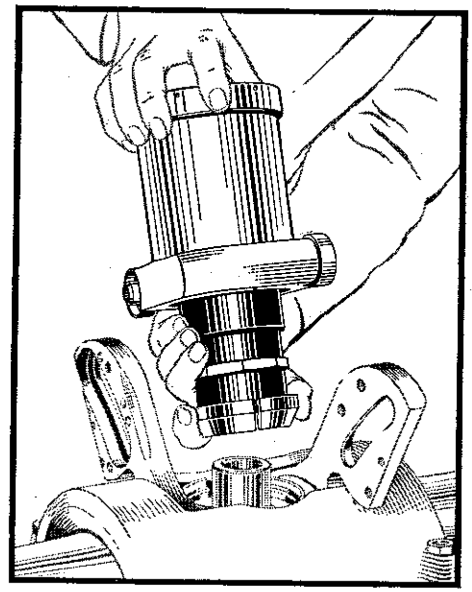


Figure 113 — Installing Cylinder, Piston, and Front Cone

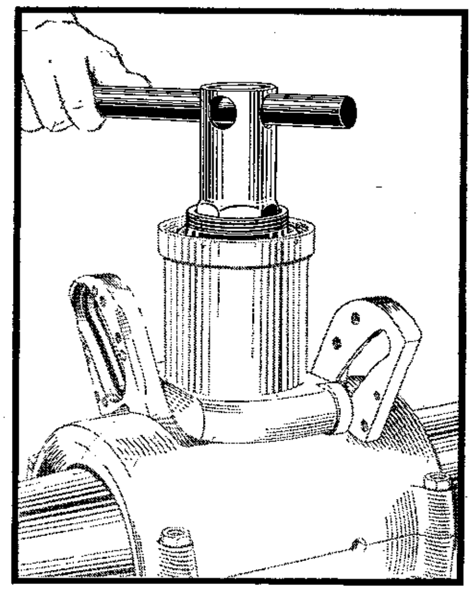


Figure 114 — Tightening Piston

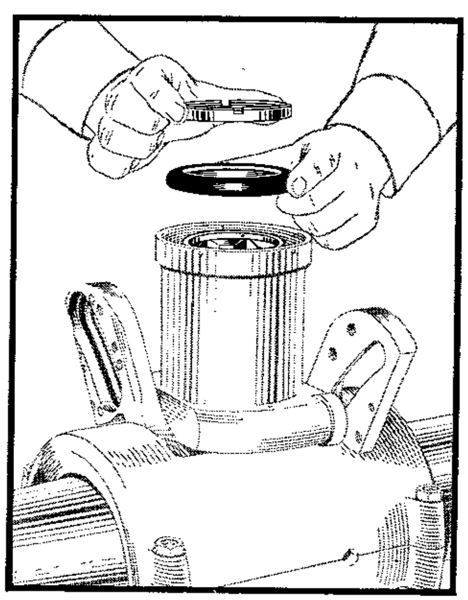


Figure 115 — Installing Inboard Piston Gasket and Nut

(*b*) COUNTERWEIGHT THRUST BEARING ASSEMBLY.—If the propeller incorporates counterweight thrust bearing assemblies, grease the outer race and the bearing retainer assemblies with a grease meeting Specification No. AN-G-4-2. Turn and lift the cylinder so the counterweight bearing shaft bushings are away from the bracket arms and rest it on the brackets. Install the bearing retainer assemblies and the outer races into the bushings. The bearing retainer assemblies are identified by a "—2" immediately following the part number while the outer races are stamped with a "—3" after the part number. The outer races should be installed so the position numbers on the flat face agree with the position numbers on the cylinder bosses, and so that the ball bearing groove faces the cylinder.

(*c*) THRUST WASHERS.—Install the thrust washers against the outer races of the counterweight thrust bearing assemblies making certain that the position numbers agree with the position numbers of the cylinder bosses. Some early model propellers which do not incorporate counterweight thrust bearing assemblies also do not incorporate these thrust washers. Holding the thrust washers and thrust bearing assemblies in place, turn the cylinder back into position between the brackets and set it so the bushing bores are in line with the bracket slots. The cylinder boss position numbers should correspond with the bracket arm position numbers.

(*d*) COUNTERWEIGHT BEARING ASSEMBLY.—Coat the counterweight bearing races and bearing retainer assemblies with a grease to Specification No. AN-G-4-2. The races and bearing retainers are marked with a position number corresponding to the bracket arm position numbers and they should be

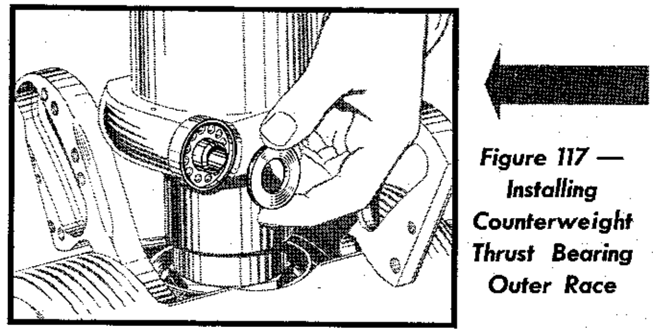


Figure 117 — Installing Counterweight Thrust Bearing Outer Race

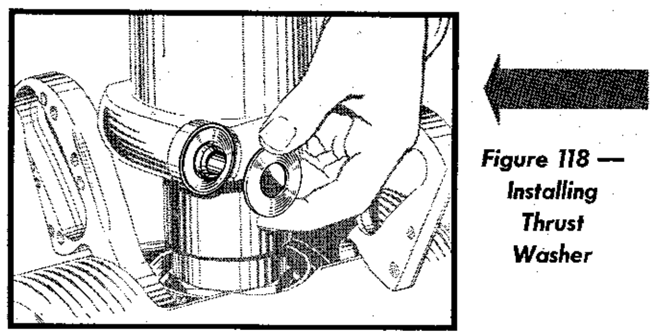


Figure 118 — Installing Thrust Washer

installed so that the position numbers of the bearings and brackets agree. Press the long counterweight bearing inner races into the bracket slots with the ball bearing grooves facing away from the cylinder. Install the bearing retainer assemblies against the inner races making sure that the curvature of the retainer conforms with the curvature of the inner race. Place the circular outer races in position against the bearing retainers so the curvature of the ball bearing grooves conforms with the curvature of the retainers. To facilitate proper assembly of this race, a short curved line is stamped on the flat face indicating the curvature of the ball bearing grooves.

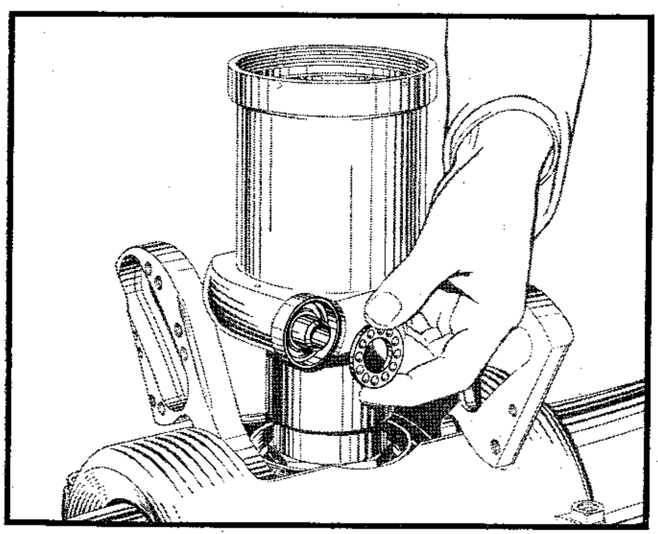


Figure 116 — Installing Counterweight Thrust Bearing Retainer Assembly

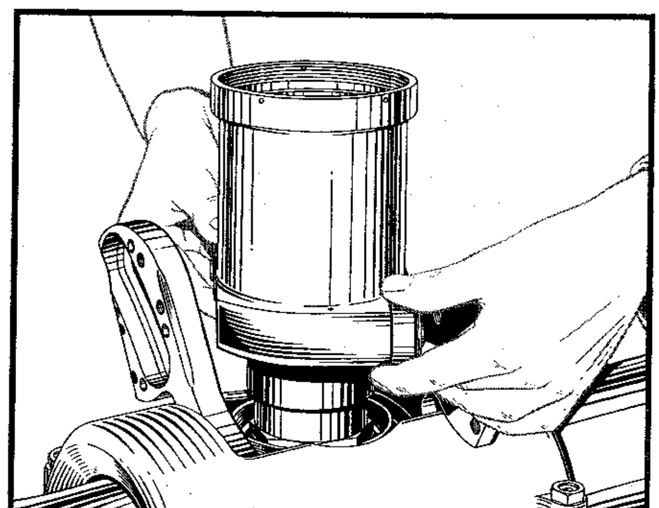


Figure 119 — Turning Cylinder Into Line With Brackets

(*e*) COUNTERWEIGHT BEARING SHAFTS. —Insert the counterweight bearing shafts through the thrust washers and thrust bearing assemblies and tighten them into the cylinder until they bottom firmly on the bearing shaft stop pins. Each shaft is identified by a position number on the flat outer surface of the head, and should be installed so this number conforms with the bracket arm and cylinder boss position number. Line up the cotter pin hole in the shafts with the cotter pin hole in the cylinder bosses. Install the cotter pins through the shafts with the heads pointing upward and lock them into position. Check the clearance between the counterweight brackets and the thrust washers. This clearance should be between .003 and .006 inch at the tightest point in the angular range of the brackets. To check the clearance, insert a .003 inch thick horseshoe shaped shim between one of the brackets and its thrust washer, and check the clearance between the other bracket and thrust washer. The clearance is satisfactory if, with the .003 inch thick shim in place between the first bracket and thrust washer, it is possible to insert a .003 inch thick shim and impossible to insert a thicker shim than .006 inch between the second bracket and thrust washer. Repeat this check in the same way with the first bracket. Should the clearance between the brackets and thrust washers not be within the limits, the clearance should be readjusted by replacing excessively worn thrust washers or by the use of oversize thrust washers. See paragraph 5.a.(14) of this section. If the bracket to thrust washer clearance is too small, first partially loosen the bearing shafts and recheck the clearance as previously described. The shafts should be replaced if the clearance is within limits with the shafts loose. Grinding or lapping one or both thrust washers as required will also increase the clearance. In the event new counterweight bearing shafts are used, stamp a position number on the flat face of the shaft heads corresponding to the bracket position numbers. Install the shafts into the cylinder and tighten them firmly against the stop pins. Check the bracket to thrust washer clearance. If the clearance is not within the proper limits, remove the shafts and file or grind the ends as required. Repeat this operation until the proper clearance is obtained. Reinstall the shafts and, using the cotter pin hole in the cylinder boss as a guide, spot the location of the cotter pin hole on the shafts. Remove the shafts and drill a 1/8 inch diameter hole through each shaft at the spotted point. Carefully remove any burrs and reinstall the shafts in their proper positions. Safety the shafts with the cotter pins. If a new cylinder is also used, the same procedure should be followed except that after the proper clearance is obtained by filing or grinding the ends of the shafts, the piston, front cone, shafts, and cylinder should be removed and the shafts retightened in the correct cylinder bosses. The location of the cotter pin holes on the shafts should be spotted using the cylinder hole as a guide and the shafts removed,

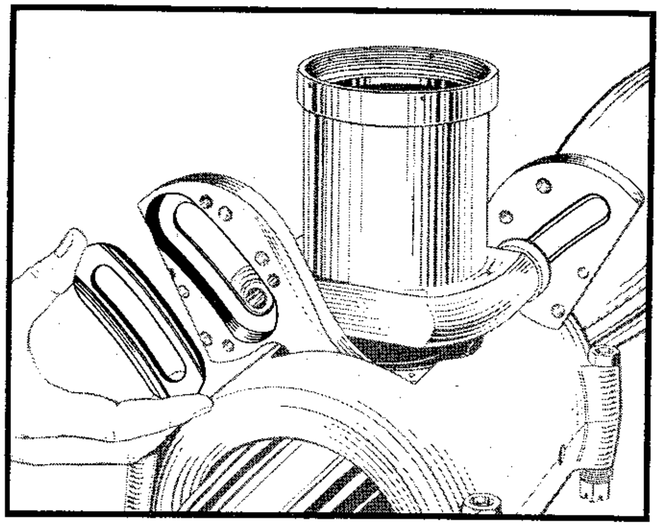


Figure 120 — Inserting Counterweight Bearing Inner Race

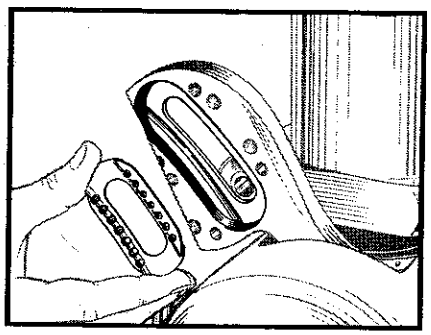


Figure 121 — Inserting Counterweight Bearing Retainer Assembly

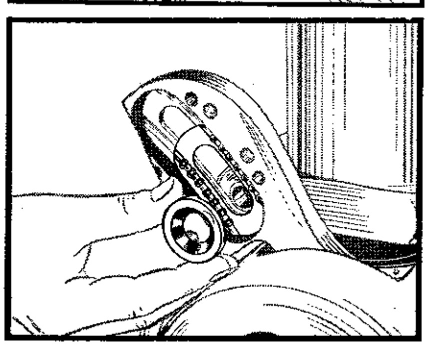


Figure 122 — Installing Counterweight Bearing Outer Race

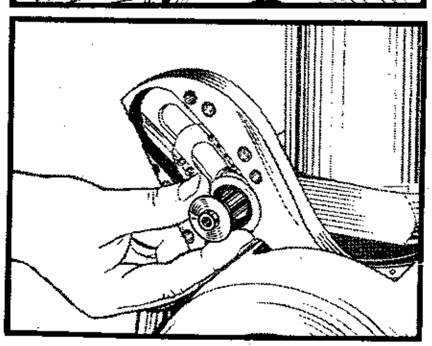


Figure 123 — Installing Counterweight Bearing Shaft

drilled and burrs removed. Since the cotter pin holes in new cylinders are not drilled completely through the cylinder bosses, the shafts should be reinstalled and these holes finish drilled before reinstalling the cylinder. Reassemble the cylinder, shafts, piston, and front cone and safety the shafts.

(*f*) BEARING RETAINER SPACERS AND COUNTERWEIGHTS.—Place the split counterweight bearing retainer spacers into the bracket arm slots. These spacers should be installed with the split facing away from the blades and the stepped side against the counterweight bearing retainer assemblies. If the counterweight dowels or the lead counterweight pitch setting plug were removed, they should be replaced with new parts at this time. The dowels are a drive fit in the counterweight and should be tapped into place with a soft drift or hammer to avoid damaging them. The small ends of the dowels are hollow and after the dowels are driven into the counterweight the hollow ends should be upset slightly with a steel punch in order to rivet them in place. The lead pitch setting plug should be tapped into the hole adjacent to the high pitch end of the counterweight slot and then faced off flush with the face of the counterweight. Whenever this plug is replaced, the correct high angle base setting should be stamped on the face of the plug. Assemble the counterweights on the bracket arms and tap them into place against the brackets with a soft hammer, using care not to damage the counterweights. The counterweights should be assembled so the position number on their outer diameter agrees with the bracket arm position number. Install the four counterweight bracket screws and tighten them firmly in place. The two screws on each side of the counterweight slot should be safety wired together as pairs.

(*g*) COUNTERWEIGHT ADJUSTING SCREW ASSEMBLIES.—Using blade turning devices such as shown in paragraph 1. of this section, turn the blades slightly toward low pitch in order to move the counterweight bearing shafts away from the end of the counterweight slots. This will prevent interference between the ends of the bearing shafts and the counterweight adjusting screw nuts. Install the adjusting screw assemblies in the counterweight slots so the pin in each screw fits in the two recessed semicircular holes in the counterweight and the flat face of the screw is facing toward the bracket arm. Check the position of the two adjusting screw nuts relative to the graduated scale stamped on one side of the counterweight slots. The numbers on the graduated scale in the counterweight denote blade angle range and not actual blade angles. If the numbers run from 0 to 15, this means that the propeller has a maximum

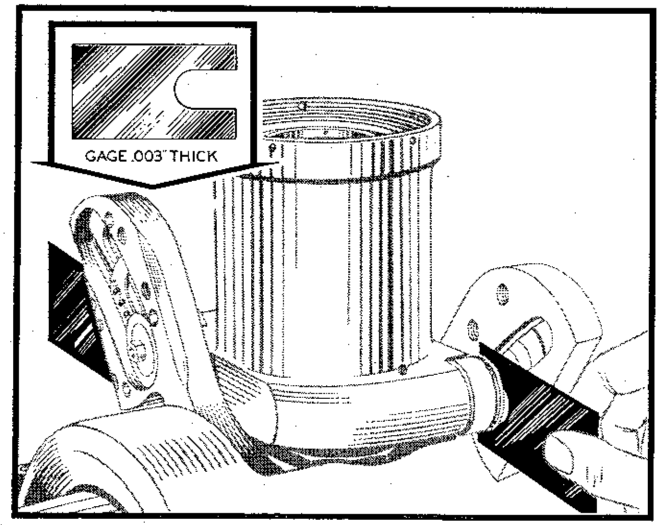


Figure 124 — Checking Clearance Between Bracket and Thrust Washer

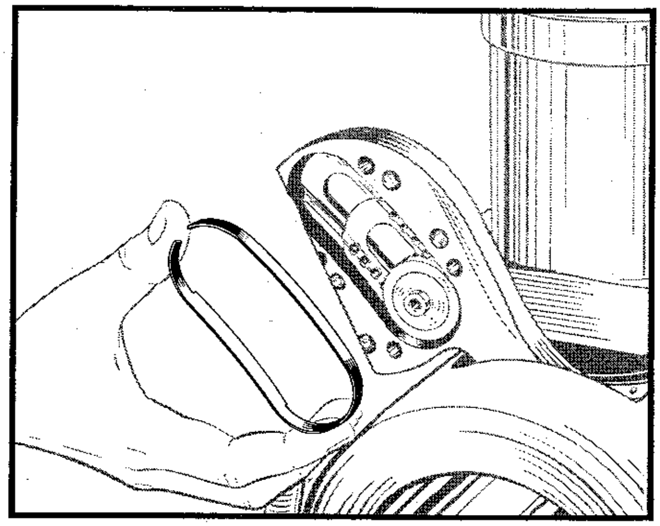


Figure 125 — Installing Counterweight Bearing Retainer Spacer

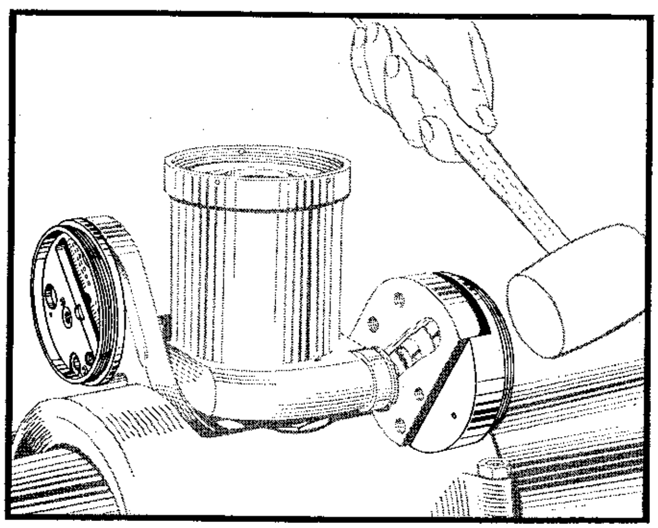


Figure 126 — Installing Counterweight on Bracket

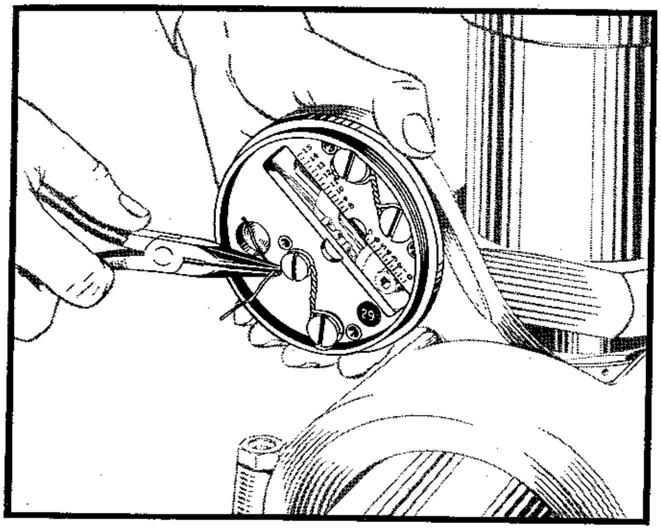


Figure 127 — Safetying Counterweight Screws

range of 15 degrees. Adjust the position of the nuts so the flat faces are in line with the particular graduations which correspond to the desired high and low blade angles at the blade reference station. For the correct blade angle settings of the propeller, consult applicable technical publications. When adjusting the nuts, it is important to remember that the lower nut limits the high blade angle setting, while the upper nut limits the low blade angle setting. To determine how to set the nuts to obtain the desired high and low blade angle settings, first subtract the high angle setting desired from the base setting of the propeller. (This base setting is stamped in the lead plug adjacent to the slot in the counterweight.) Then set the flat face of the lower adjusting nut in line with the marking which indicates the difference between the desired setting and the base setting. For example, if the base setting of the propeller is 29 degrees and the desired high angle setting is 28 degrees, then the difference would be one degree and the flat face of the lower nut should be set in line with the "1" stamped on the counterweight. If the desired high angle is the same as the base setting, the lower nut should be set opposite the "0" mark. To adjust the low angle setting, subtract the desired low angle from the base setting and set the flat face of the upper adjusting nut opposite the number which represents this difference. Continuing the same example, the base setting is 29 degrees, and if the desired low angle setting is 14 degrees, the difference would be 15 degrees and the flat face of the upper adjusting nut should be set in line with the "15" stamped on the counterweight. When the blade angle settings are such that only a portion of the maximum pitch range is used, an additional adjusting screw nut should be used on one end of the screw in order to prevent the screw from cocking when the counterweight bearing shafts contact the nuts. When either nut is set two or more degrees from the end of the adjusting screw of a 10-degree range propeller, a third nut should be used on that end of the screw. In the case of a 15-degree range propeller, a third nut should be used on the screw when either nut is set three or more degrees from the end of the screw. However, when the nut on the high angle end of the screw is set more than 3 degrees from the high angle base setting, it is recommended that the counterweight brackets be reindexed on the blade bushings to the proper setting and the new base setting restamped on the counterweight pitch setting plug.

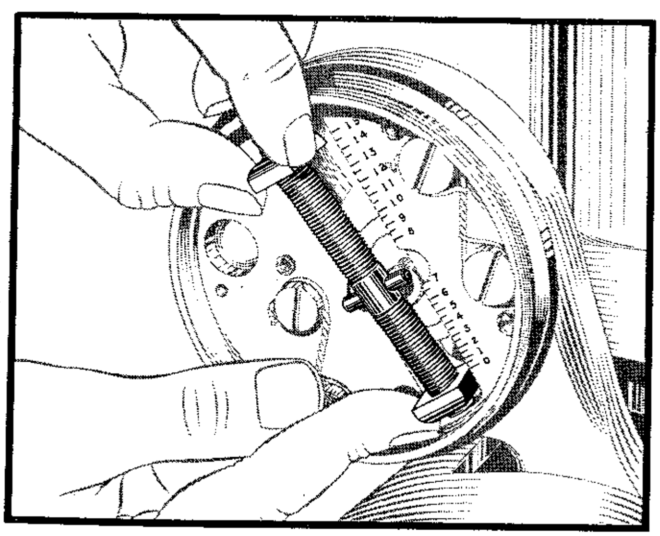


Figure 128 — Adjustment of Pitch Stop Settings

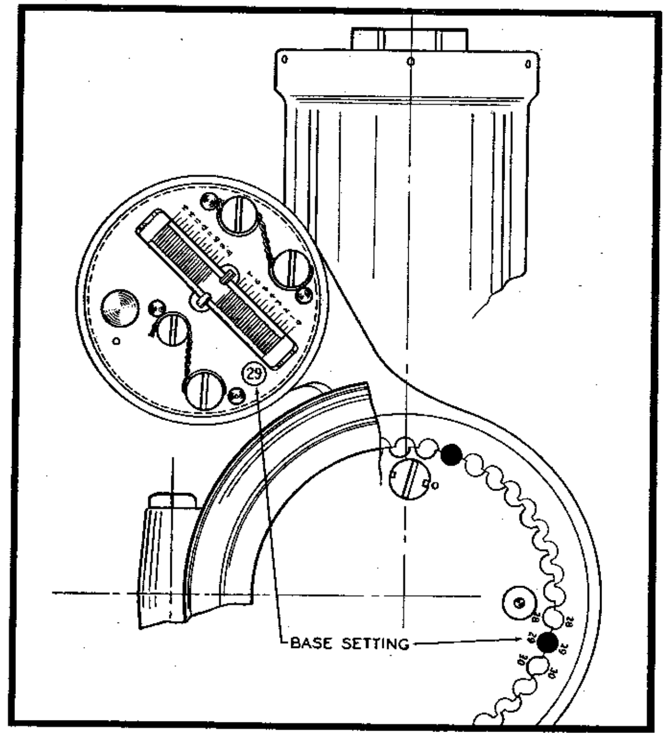


Figure 129 — Blade Bushing and Stop Setting Relationship

(*b*) COUNTERWEIGHT CAPS.—Assemble the counterweight caps on the counterweights using the correct cap wrench as listed in paragraph 1. of this section. Make sure that the position number on the inside face of the caps agrees with the position number of the brackets. If new caps are used, a clevis pin hole should be drilled. Using the clevis pin hole in the counterweights as a guide, spot the location of the clevis pin hole in the cap. Remove the cap and drill a 1/8 inch diameter hole through the cap at this point. Stamp the caps with position numbers corresponding to the bracket position numbers and tighten them firmly onto the counterweights using the proper cap wrench.

(7) BLADE ANGLE CHECK.—Using a blade turning device on each blade, turn the blades toward high pitch until the counterweight bearing shafts are firmly in contact with the adjusting screw nuts. Check the angle of each blade at the 42-inch reference station with a protractor. The high blade angles should be within 0.1 degree of the specified setting. Turn the blades to full low pitch against the adjusting screw nuts and check the low blade angles. The low blade angles should be within 0.3 degrees of the specified setting and within 0.2 degrees of each other. For the correct blade angle settings of the propeller, applicable technical publications should be consulted. If the blade angles are not within the specified tolerance, the counterweight caps should be removed and the position of the adjusting screw nuts corrected as required until the blade angles are brought within the specified tolerance. When adjusting the nuts, it is important that the nuts at the high angle end of the adjusting screws be placed as closely to the same distance from the end of the counterweight slots, and the nuts at the low angle end of the screws also be placed as closely to the same distance from their end of the slots as is possible and still maintain the blade angles within the blade angle tolerance. This will insure that the bearing shafts contact the nuts at the same time and will prevent the cylinder from cocking during operation. When the high angle setting of the blades is more than 3 degrees from the high angle base setting of the propeller, it is recommended that the counterweight brackets be reindexed on the blade bushings to the proper base setting.

(8) PROPELLER ASSEMBLY BALANCE.—Balancing of the complete propeller should be done with the propeller dry and in a room free from air currents. The propeller should be centered on its cone seats and mounted on a hardened and ground arbor on a balancing stand which is known to be in accurate alignment. The propeller is to be considered in satisfactory balance if it has no persistent tendency to rotate in one direction, or if any persistent tendency to rotate is stopped or reversed by the application of a moment equal to .0005 inch times the total weight of the propeller. This moment is to be considered as an unbalance tolerance and should be applied, in each case, to the light side of the assembly. Make sure the piston is firmly tightened on the assembly & balance sleeve. For shaft breathing type propellers, the piston and piston gasket nut from a crankcase breathing type propeller must be used to allow the balancing arbor to be inserted. Turn the blades to the full high pitch position by means of blade turning devices. Hoist the propeller off the assembly post and install the correct size balancing arbor through the assembly & balance sleeve. Carefully lower the assembly onto the balancing stand. Place each blade successively in the horizontal and vertical positions and note whether the assembly has a persistent tendency to rotate in

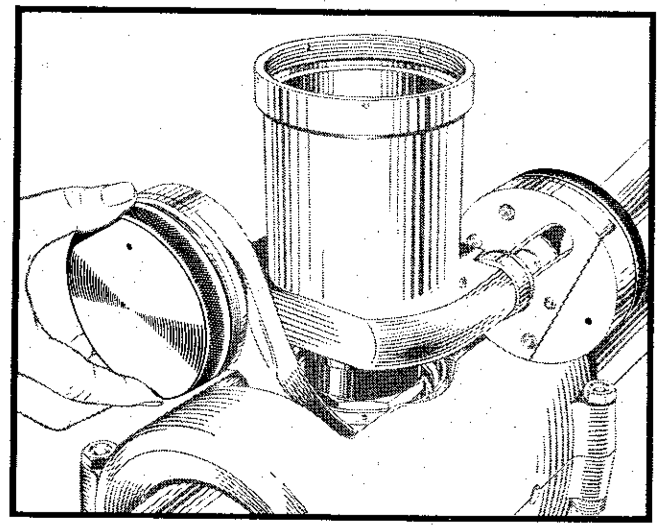


Figure 130 — Installing Counterweight Cap

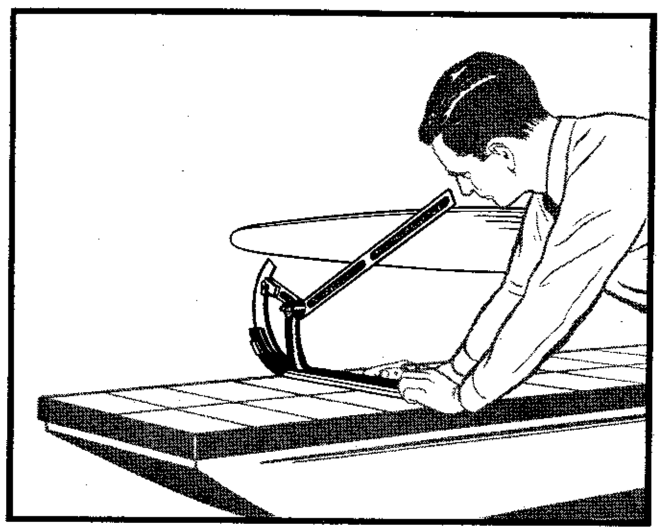


Figure 131 — Checking Blade Angle Setting With Protractor

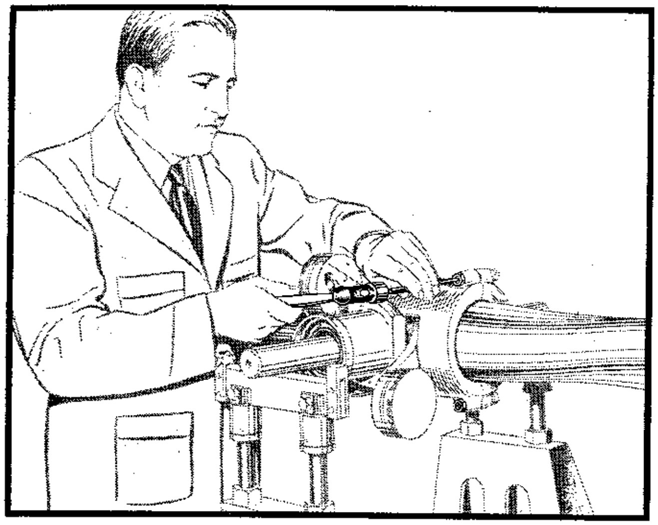


Figure 132 — Hammering Lead Wool Into Barrel Bolt

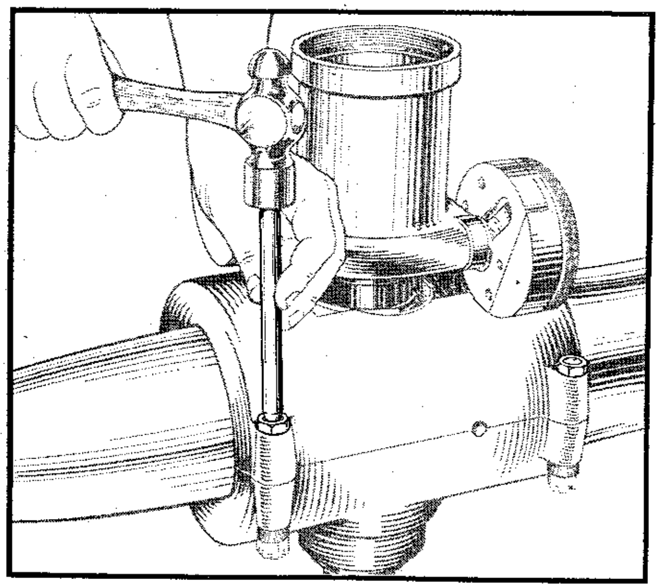


Figure 133 — Installing Welch Plug in Barrel Bolt

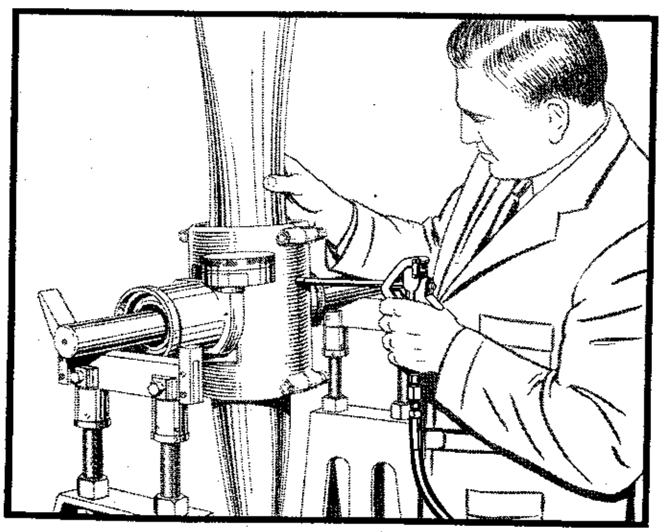


Figure 134 — Greasing Propeller on Balancing Stand

one direction. If such is the case, apply the unbalance tolerance amount of .0005 inch times the total propeller weight to the light side of the assembly and if, in each case, the tendency to rotate is stopped or reversed by this moment, the propeller is in satisfactory balance. In the event any persistent tendency to rotate is not arrested or reversed by the unbalance tolerance moment, the propeller should be brought into balance by adding or removing lead wool from the hollow barrel bolts as required. The welch plugs in the barrel bolts should be removed at this time, if this has not already been done. Bring the propeller into horizontal and vertical balance by inserting trial amounts of lead wool in the bolts on the light sides of the assembly, or, if necessary, by removing lead wool from the bolts on the heavy sides. When adding lead, it should be divided equally between the bolts above and below the horizontal center line of the propeller. This also applies when removing lead from the bolts. Hammer the lead wool into the proper barrel bolts with a drift rod of small enough diameter to enter the bolt holes. Recheck the balance and, if satisfactory, remove the propeller from the balancing stand. Take out the balancing arbor and place the assembly back on the assembly post. Install new welch plugs in the barrel bolt heads and seat them with a drift rod.

(9) LUBRICATION AND GREASE BALANCE.—Following the balancing of the propeller assembly, the spider arms and the taper bore of the blades should be filled with grease. For this lubrication a grease meeting Specification No. AN-G-4-2 should be used. If the propeller is to operate at extremely low temperatures, a grease to Specification No. AN-G-3a-1 is to be used. Using a power or hand type grease gun, together with the grease gun extension listed in paragraph 1. of this section, force grease through each of the grease fittings in the spider and partially fill the spider arm and blade bore. Repeat this operation alternately between the blades until the spider arms and blade bores appear to be completely filled with grease. This method of alternately forcing grease into the blades allows time for any air trapped in the spider arms or blade bores to escape, thus making it possible to completely fill them with grease. When a hand grease gun is used, there will be a sudden increase in the force required to move grease through the fitting when the spider arms and blades become filled with grease. If a power type grease gun is used, it should be set to cut out at 2000 pounds per square inch. This pressure is sufficient to force enough grease into the spider arms and blades to fill them and will prevent any possible damage to the leather grease retainers. In no case should excessive pressures be used to try to force in more grease when it appears that the blades and spider arms are filled.

In order to make certain that the spider arms have been properly filled with grease, the horizontal balance of the propeller should be rechecked. Make sure the blades are in the full high pitch position. Place the propeller back on the balancing stand and check the horizontal balance of the assembly. If the unbalance does not exceed the unbalance tolerance moment of .0005 inch times the total propeller weight, the balance is satisfactory. Should the unbalance exceed the unbalance tolerance, this is an indication that one of the spider arms has less grease than the other. The propeller should be brought into satisfactory balance by adding more grease in the light side by means of the grease gun. Balance should be obtained only with grease and in no case should lead wool be added or removed from the barrel bolts during this balance. After satisfactory grease balance has been obtained, place the propeller back on the assembly post.

(10) SAFETYING AND FINAL OPERATIONS.—Make sure the barrel bolt nuts are properly tightened and that the cotter pin hole in the barrel bolts is approximately parallel to the blades. Line up one of the locking slots of the nuts with the cotter pin hole in the bolts and install and safety the cotter pins in position. Using the proper counterweight cap wrench listed in paragraph 1. of this section, tighten the caps and line up the clevis pin hole in the caps with the clevis pin hole in the counterweights. Install the correct size clevis pins with the heads of the pins facing the cylinder. Insert the cotter pins through the hole in the clevis pin ends and safety them in position. Remove the piston gasket nut and the inboard piston gasket from the piston. By means of blade turning devices, move the bades to an intermediate angle and remove the piston and front cone from the assembly. Install the cylinder head in the cylinder and line up one of the locking holes in the head with one of the holes in the top of the cylinder. Insert the cylinder head lock ring and snap it into position in the undercut groove in the cylinder head. Remove the propeller from the assembly & balance sleeve. Attaching parts such as the piston, piston gasket nut, piston gaskets, piston lock ring, rear and front cones, front cone spacer, hub snap ring, cylinder head gasket, etc. are not assembed until the propeller is installed on the engine. All these parts should be kept with the propeller until it is ready to be installed.

b. MODEL 2B20.—The reassembly procedure for the model 2B20 propeller is similar to that described for the model 2D30 propeller. Any variations are discussed in the following paragraphs.

(1) ASSEMBLY OF BLADE.—A chafing ring is not used on a "B" shank blade. The overall dimension from the blade butt face to the outboard surface of the flat thrust washer excluding the thrust bearing retainer assembly shall not be less than 1.820 inch, and this dimension shall be maintained within .010 inch on both blades in the same propeller. Compensation can be made on blades that have been reworked so that this overall dimension is reduced below the nominal dimension of 1.873–1.875 inch by the use of one or two spider shims having a total thickness of .040 inch or less, or by adding a .035-inch steel spacer part number 50374 on the blade so that in the propeller assembly it will fit between the flat thrust washer and barrel shoulder. See paragraph 5.b.(2)(a) in this section for complete instructions.

(*a*) BLADE BUSHING.—As the bushing in a "B" shank blade does not have a flange, no drive

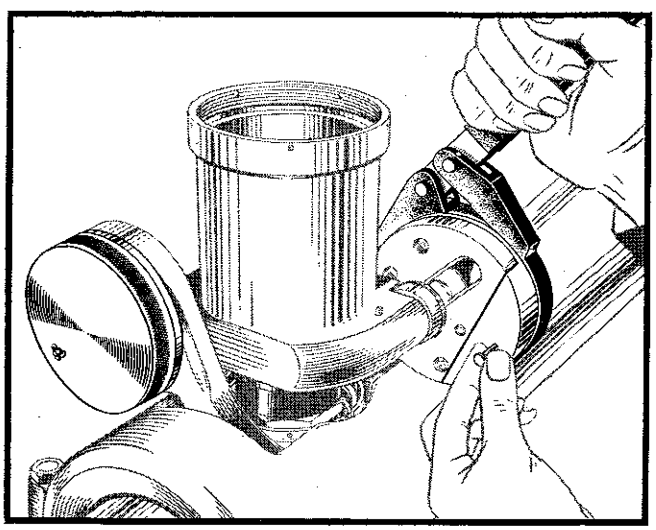


Figure 135 — Installing Counterweight Cap Clevis Pin and Cotter

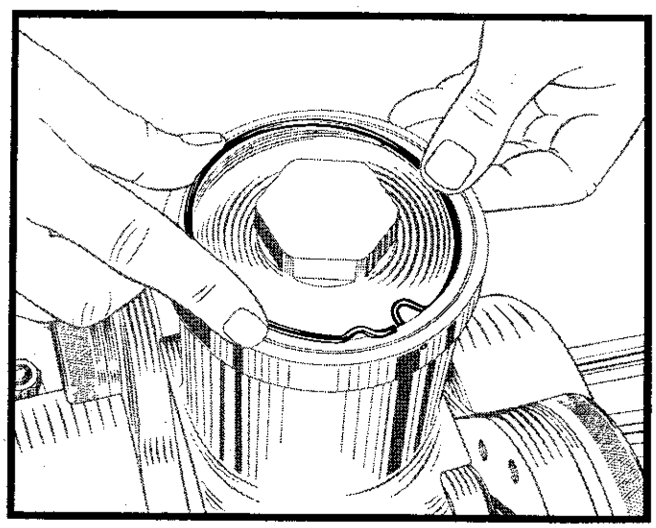


Figure 136 — Installing Cylinder Head Lock Ring

pins are used. Install the bushing with the inserter listed in paragraph 1. of this section. As shown in figure 62, the end of the bushing must be flush with the blade butt face.

(*b*) BLADE KEYS.—Using table XXXII, select the blade keys for the desired base setting, and attach them to the blade butt with screws. Stake the screws to secure them in the blade. Blade key No. 50140 is the neutral key because the center line of the indexing portion lies on the center line of the body portion. On all other blade keys, the center line of the indexing portion varies 1/2 to 5-1/2 degrees from the center line of the body portion, and the faces of the key are marked accordingly. Depending upon which face of the key is installed adjacent to the blade butt surface, the center line of the indexing portion is shifted either above or below the center line of the body portion. With the exception of the neutral key, this makes possible two base settings with each key.

(*c*) COUNTERWEIGHT BRACKET.—Install the counterweight bracket onto the blade butt so that the two slots in the inner circumference of the bracket fit over the indexing portion of the blade keys.

(2) ASSEMBLY OF PROPELLER.—Follow the 2D30 assembly procedure with the following minor changes. No barrel bolt washers are needed in the 2B20 models, and the spider shims used to obtain the required blade torque of 20–40 pound-feet vary in thickness from .008 to .020 inch in .001 inch increments. None of the 2B20 models have counterweight shaft thrust bearing assemblies. Instead, the earlier models had bronze bushings which were replaced on later models by steel bushings and bronze thrust washers. See paragraph 5.a.(13)(f) of this section for complete instructions. The counterweight screws in 2B20 models are secured by lock washers (in place of safety wire), and bearing retainer spacers are not used. When the blade angle settings are such that only a portion of the maximum pitch range is used, an additional counterweight adjusting screw nut should be used on one end of the adjusting screw in order to prevent the screw from cocking when the counterweight bearing shafts contact the nuts. When either nut is set two or more degrees from the end of the adjusting screw of an 8-degree range propeller or three or more degrees from the end of the screw of a 15-degree range propeller, a third nut should be used on the end of the screw. However, when the nut on the high angle end of the screw is set more than three degrees from the high angle base setting, it is recommended that the counterweight brackets be indexed to the proper base setting and the new base setting restamped on the lead pitch setting plug in the counterweight.

TABLE XXXII

Blade Key Part Number	Key Face Marking	Base Setting
50140	None	23.0°
52425	+1/2°	23.5°
	−1/2°	22.5°
50261	+1°	24.0°
	−1°	22.0°
50262	+2°	25.0°
	−2°	21.0°
50263	+3°	26.0°
	−3°	20.0°
50264	+4°	27.0°
	−4°	19.0°
50265	+5°	28.0°
	−5°	18.0°
52359	+5-1/2°	28.5°
	−5-1/2°	17.5°

c. MODEL 12D40.—As previously explained in section II, the 12D40 is merely the 2D30 model modified to fit an SAE 40 propeller shaft. Since the only differences between these models are in the size of certain parts, the assembly procedure for both is the same. See paragraph 6.a. of this section for detailed instructions.

(1) When the blade angle settings are such that only a portion of the maximum pitch range is used, an additional counterweight adjusting screw nut should be used on one end of the adjusting screw in order to prevent the screw from cocking when the counterweight bearing shafts contact the nuts. When either nut is set two or more degrees from the end of the adjusting screw of an 11-degree range propeller or three or more degrees from the end of the screw of a 16-degree range propeller, a third nut should be used on the end of the screw. However, when the nut on the high angle end of the screw is set more than three degrees from the high angle base setting, it is recommended that the counterweight brackets be reindexed on the blade bushing to the proper base setting and the new base setting restamped on the lead counterweight pitch setting plug.

(2) Due to the difference between the location of the basic reference line shown on the blade blueprints and the actual center line of model 12D40 counterweight propeller hubs, a correction of 7/16 inch must be added when locating the position of the reference station, or any other blade station, on an assembled propeller. See table XVII.

d. MODEL 2E40.—In general, the reassembly procedure for the model 2E40 propeller is the same as that for the 2D30 propeller with the slight variations discussed in the following paragraphs.

(1) ASSEMBLY OF BLADE.—"E" shank blade parts used in model 2E40 propellers are identical with those used in "D" shank assemblies except that they are proportionately larger.

(*a*) Chafing rings for use on "E" shank blades range in thickness from .020 inch undersize to .020 inch oversize in increments of .005 inch. The standard ring is .063 inch thick. To determine the thickness of ring required, refer to paragraph 5.b.(2)(a) of this section.

(*b*) In order to establish the required fit between the blade and bushing drive pins, it may be necessary at reassembly to use oversize pins as outlined in paragraph 5.b.(2)(f) of this section.

(*c*) If the blade, bushing, or bracket is changed on an "E" shank blade, it is necessary to know at reassembly whether the angle formed by the center line of the drive pin holes and the chord line of the blade reference station is 5 or 23 degrees. Any "E" shank blade with a change letter following the design number prior to that shown in table XXXIII, has a drive pin angle of 23 degrees, and any "E" shank blade with the change letter listed or one alphabetically higher has a drive pin angle of 5 degrees.

TABLE XXXIII

Blade Design	Change Letter	Blade Design	Change Letter
6091A	AL	6111A	AC
6091A-10	V	6123A	D
6103A	AH	6143A	H
6105A	AD	6125A	L
6105A-14T	D	6151A	D
6105A-21T	E	6157A	E
6105A-33T	K	6169A	C

As the blade drive pin and screw holes may have been relocated 18 degrees depending on the blade design number change letter, an allowance must be made at reassembly. There are 40 semi-circles around the inner circumference of the counterweight bracket. Each semi-circle represents 360/40 or 9 degrees. As shown on the counterweight bracket indexing chart, figure 89, ref. 2, the reference line for an "E" shank blade having a drive pin angle of 23 degrees intersects bracket No. 50524 at a semi-circle which is given the index number of 19. Figure 89, ref. 1, shows an "E" shank blade having a drive pin angle of 5 degrees, and in this case the reference line intersects the same semi-circle of bracket No. 50524 but the semi-circle is given an index number of 21. Index number 19 semi-circle is two semi-circles away from index number 21 thus compensating for the 18 degrees drive pin angle difference between the two blades.

(2) ASSEMBLY OF PROPELLER.—Spider shims for blade torque adjustment range in thickness from .005 to .023 inch in .001 inch increments. A dummy piston, listed in paragraph 1. of this section, must be used for the balancing operations. The regular piston has an opening in the base (for the oil supply pipe) which is too small to permit the propeller balancing arbor to pass through. Model 2E40 barrel supports do not incorporate vertical balancing washers (see paragraph 5.a.(4) of this section). The counterweight screws are secured by means of lock washers.

(*a*) Parts such as the piston oil seal, oil seal nut and cotter pin, the vernier lock plate, clamp nut, clamp nut gasket, and lock ring are assembled in the propeller when it is installed on the aircraft. See section III, paragraph 5. for complete instructions.

(*b*) When the blade angle settings are such that only a portion of the maximum pitch range is used, an additional counterweight adjusting screw nut should be used on one end of the adjusting screw in order to prevent the screw from cocking when the counterweight bearing shafts contact the nuts. When either nut is set two or more degrees from the end of the adjusting screw of a 10-degree range propeller or three or more degrees from the end of the screw of a 20-degree range propeller, a third nut should be used on the end of the screw. However, when the nut on the high angle end of the screw is set more than three degrees from the high angle base setting, it is recommended that the counterweight brackets be reindexed on the blade bushing to the proper base setting and the new base setting restamped on the lead counterweight pitch setting plug.

(*c*) Due to the difference between the location of the basic reference line shown on the blade blueprints and the actual center line of model 2E40 counterweight propeller hubs, a correction of 1/8 inch must be added when locating the position of the reference station, or any other blade station, on an assembled propeller. See table XVII.

(3) ASSEMBLY OF SPRING RETURN UNIT.—A spring return is incorporated in model 2E40 propellers having a 20-degree pitch range. This unit is finally fitted into the propeller at installation. See section III, paragraph 5. To assemble this unit, first place the inner and outer springs on the spring puller

plate. Then, install the piston gasket nut over the springs. Add the puller bolt spring onto the spring puller bolt, and insert the spring puller bolt and spring through the piston gasket nut and the spring puller plate. Tighten the spring puller bolt nut onto the spring puller bolt and safety it with a cotter pin.

e. MODEL 3D40.—In general, the reassembly procedure for the model 3D40 propeller is similar to that described for the model 2D30 propeller. Any variations are discussed in the following paragraphs.

(1) ASSEMBLY OF PROPELLER.

(*a*) Some earlier model 3D40 propellers do not incorporate bearing retainer spacers, thrust bearing assemblies, or bronze thrust washers, but the specified clearance between the counterweight bracket and the bearing shaft bushing is the same as that for 3D40 propellers that incorporate thrust washers (L.003-L.006 inch). See paragraph 6.a.(6)(e) of this section for instruction on maintaining this clearance.

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(*b*) The barrel support seats on the spider are numbered beginning with No. 1 at the clockwise side of spider arm No. 1 looking at the outboard end of the spider, and continuing in a counterclockwise direction; that is, in a three-way spider, No. 1 barrel support lies between arms Nos. 3 and 1, No. 2 seat is between arms Nos. 1 and 2, and No. 3 seat is between arms Nos. 2 and 3. These numbers are stamped on the flat surface at the outboard end of the spider adjacent to the barrel support seats. The support blocks are stamped with a position number on the beveled outboard surface.

(*c*) None of the 3D40 propellers have vertical balancing washers with the barrel supports. Some models, such as the 3D40-57, do not have barrel supports, and on these models, the shim plates incorporate phenolic rings which are to be assembled with the cutaway portion at the top of the spider and the shoulder formed by the chafing ring facing the spider shoulder. These propellers also use a split phenolic spider ring. At assembly, the flat sections of the ring should be directly under each spider arm face.

(*d*) A dummy piston, listed in paragraph 1. of this section, must be used for balancing operations. The regular piston has an opening in the base (for the oil supply pipe) which is too small to permit the propeller balancing arbor to pass through.

(*e*) Due to the difference between the location of the basic reference line shown on the blade blueprints and the actual center line of model 3D40 counterweight propeller hubs, a correction of 5/16 inch must be added when locating the position of the reference station, or any other blade station, on an assembled propeller. See table XVII.

(*f*) When the blade angle settings are such that only a portion of the maximum pitch range is used, an additional counterweight adjusting screw nut should be used on one end of the adjusting screw in order to prevent the screw from cocking when the counterweight bearing shafts contact the nuts. When either nut is set two or more degrees from the end of the adjusting screw of a 10-degree range propeller or three or more degrees from the end of the screw of a 15-degree range propeller or four or more degrees from the end of the adjusting screw of a 20-degree

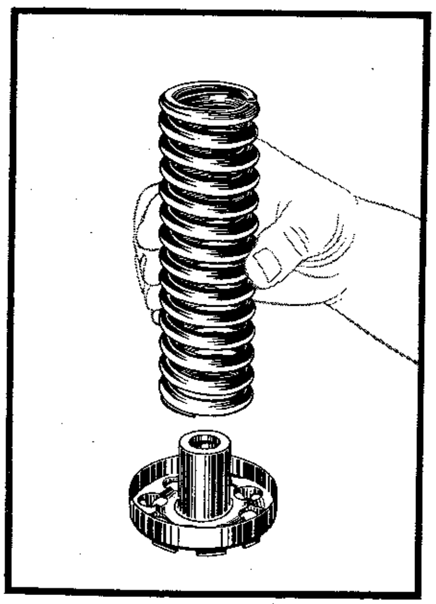

Figure 137 — Installing Inner Spring on Spring Puller Plate

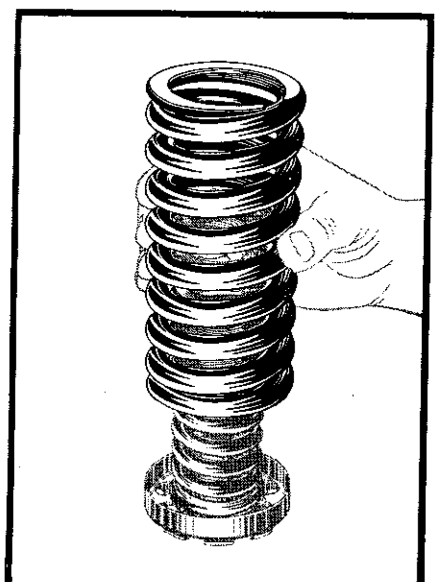

Figure 138 — Placing Outer Spring Over Inner Spring

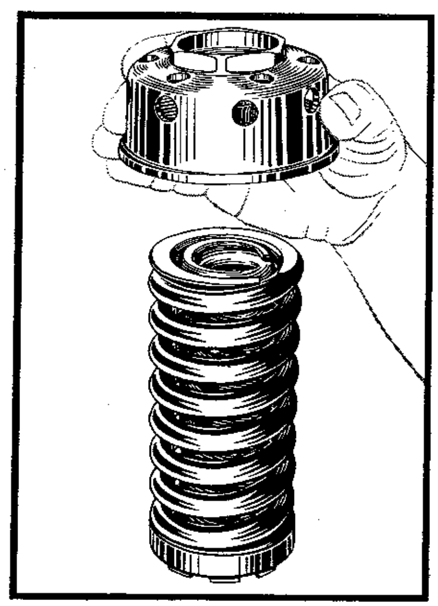

Figure 139 — Installing Piston Gasket Nut

range propeller, a third nut should be used on the end of the screw. However, when the nut on the high angle end of the screw is set more than three degrees from the high angle base setting, it is recommended that the counterweight brackets be reindexed on the blade bushing to the proper base setting and the new base setting restamped on the lead counterweight pitch setting plug.

(2) ASSEMBLY OF SPRING RETURN.—Model 3D40 propellers having a pitch range of 20 degrees incorporate a spring return assembly. Follow the assembly procedure for this unit as outlined for the model 2E40 propeller in this section, paragraph 6.d.(3).

f. MODEL 3E50.—In general, the reassembly procedure for the model 3E50 propeller is similar to the model 2D30 propeller. Any variations are discussed in the following paragraphs.

(1) ASSEMBLY OF BLADE.

(*a*) Chafing rings for use on "E" shank blades range in thickness from .020 inch oversize to .020 inch undersize in increments of .005 inch. The standard ring is .063 inch thick. To determine the thickness of ring required, refer to paragraph 5.b.(2)(a) of this section.

(*b*) In order to establish the required fit between the blade and bushing drive pins, it may be necessary at reassembly to use oversize pins as outlined in paragraph 5.b.(2)(f) of this section.

(*c*) If the blade, bushing, or bracket is changed on an "E" shank blade, it is necessary to know at reassembly whether the angle formed by the center line of the drive pin holes and the chord line of the blade reference station is 5 degrees or 23 degrees. Any "E" shank blade with a change letter prior to that in table XXXIII has a drive pin angle of 23 degrees, and any "E" shank blade with the change letter listed or one alphabetically higher has a drive pin angle of 5 degrees. As the blade drive pin and screw holes may have been relocated 18 degrees depending on the blade design number change letter, an allowance must be made at reassembly. There are 40 semi-circles around the inner circumference of the counterweight bracket. Each semi-circle represents 360/40 or 9 degrees. As shown on the counterweight bracket indexing chart, figure 89, ref. 2, the reference line for an "E" shank blade having a drive pin angle of 23 degrees intersects bracket No. 50524 at a semi-circle which is given the index number of 19. Figure 89, ref. 1, shows an "E" shank blade having a drive pin angle of 5 degrees, and in this case the reference line intersects the same semi-circle of bracket No. 50524 but the semi-circle is given an index number of 21. Index number 19 semi-circle is two semi-circles away from index number 21 thus compensating for the 18 degrees drive pin angle difference between the two blades.

(2) ASSEMBLY OF PROPELLER.

(*a*) Spider shims for establishing blade torque are available in thicknesses from .005 to .023 inch in increments of .001 inch.

(*b*) Some earlier model 3E50 propellers do not incorporate bearing retainer spacers, thrust bear-

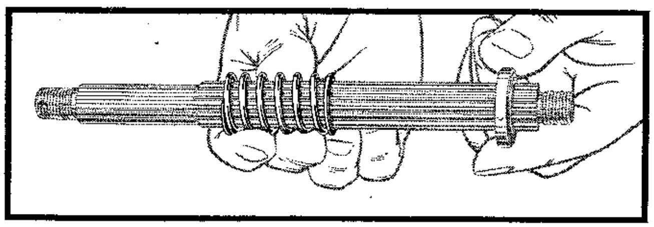

Figure 140 — Placing Spring Onto Puller Bolt

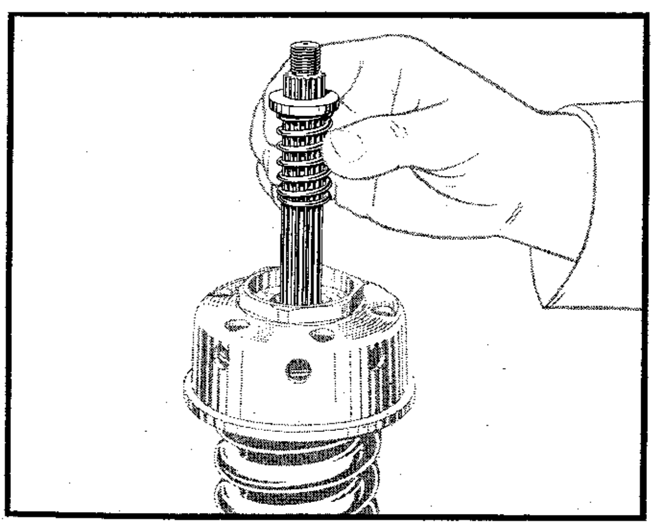

Figure 141 — Inserting Puller Bolt Into Spring Group

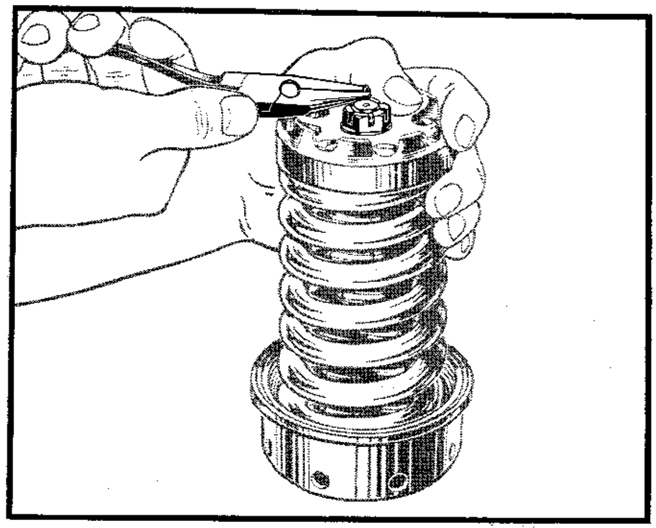

Figure 142 — Installing Cotter Pin in Puller Bolt Nut

ing assemblies, or bronze thrust washers, but the specified clearance between the counterweight bracket and the bearing shaft bushing is the same as that for 3E50 propellers that incorporate thrust washers (L.003-L.006 inch). See paragraph 6.a.(6) (e) of this section for instructions on maintaining this clearance. Another difference is that the counterweight screws are secured by lock washers.

(*c*) A dummy piston, listed in paragraph 1. of this section, must be used for balancing operations. The regular piston has an opening in the base (for the oil supply pipe) which is too small to permit the propeller balancing arbor to pass through.

(*d*) The barrel support seats on the spider are numbered beginning with No. 1 at the clockwise side of spider arm No. 1 looking at the outboard end of the spider, and continuing in a counterclockwise direction; that is, in a three-way spider, No. 1 barrel support lies between arms Nos. 3 and 1, No. 2 seat is between arms Nos. 1 and 2, and No. 3 seat is between arms Nos. 2 and 3. These numbers are stamped on the flat surface at the outboard end of the spider adjacent to the barrel support seats. The support blocks are marked with a position number on the beveled outboard surface.

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(*e*) The barrel supports do not incorporate vertical balancing washers. Some models, such as the 3E50-65, do not have barrel supports, and on these models, the shim plates incorporate phenolic rings which are to be assembled with the cutaway portion at the top of the spider and the shoulder formed by the chafing ring facing the spider shoulder. These propellers also use a split phenolic spider ring. At assembly, the flat sections of the ring should be directly under each spider arm face.

(*f*) Due to the difference between the location of the basic reference line shown on the blade blueprints and the actual center line of model 3E50 counterweight propeller hubs, a correction of 1/8 inch must be added when locating the position of the reference station, or any other blade station, on an assembled propeller. See table XVII.

(*g*) When the blade angle settings are such that only a portion of the maximum pitch range is used, an additional counterweight adjusting screw nut should be used on one end of the adjusting screw in order to prevent the screw from cocking when the counterweight bearing shafts contact the nuts. When either nut is set two or more degrees from the end of the adjusting screw of a 10-degree range propeller or four or more degrees from the ends of the adjusting screw of a 20-degree range propeller, a third nut should be used on the end of the screw. However, when the nut on the high angle end of the screw is set more than three degrees from the high angle base setting, it is recommended that the counterweight brackets be indexed to the proper base setting and the new base setting restamped on the lead counterweight pitch setting plug.

(3) ASSEMBLY OF SPRING RETURN.—Model 3E50 propellers having a pitch range of 20 degrees incorporate a spring return assembly. Follow the assembly procedure as outlined for the model 2E40 in this section, paragraph 6.d.(3).