THE WARNER AIRCRAFT CORPORATION

20263 Hoover Avenue

Detroit, Michigan

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SERVICE LETTER NO. A-13

To all owners of Warner Engines,
All authorized Warner Aircraft
Service Representatives.

Subject:
I. Pistons-Procedure of Inspection and Replacement.
II. Exhaust Valve-Procedure of Inspection and Replacement.
III. Cylinder Attaching Stud-Proper Inspection and Assembly Procedure.
IV. Link Rod-Proper Fit of Wrist Pin.

The Civil Aeronautics Administration urges that these inspections be conducted at least on all applicable engines used in pilot training or in unusually severe service.

I. Pistons-Procedure of Inspection and Replacement.

The following are recommended steps to be taken to guard against piston failures:

(1) The Warner 165 H.P. engines equipped with 7939, 3-ring pistons should be top overhauled every 300 hours which will bring the top overhaul periods between the major overhaul periods. The Warner 145 H.P. engines, which are equipped with either the 7590, 3-ring piston or the 8274, 4-ring pistons, and the 125 H.P. Scarab engine should be top overhauled every 400 to 450 hours. These instructions do not apply to the latest 165 H.P. Super Scarab engines, which are equipped with considerably heavier 4-ring pistons, Warner Part No. 8549 and heavier piston pins, Warner Assembly No. 8605. These pistons and heavier piston pins can be installed in all older 165 H.P. Super Scarab engines, but this requires either the installation of a new crankshaft assembly in the engine or the return of the old crankshaft assembly and connecting rod complete assembly to the Warner Aircraft Corporation, where new counterweights must be installed to the shaft and the shaft must be re-balanced.

(2) During all overhauls the pistons are to be carefully inspected for incipient cracks after the pistons are completely clean and all carbon has been removed, which is preferrably done by immersing over night in a cold undiluted solution of Super Chemaco concentrate, manufactured by the Chemical Products Company, Box 88, Mineola, New York. After removing the parts from the tank, drain all surplus chemical off, then immerse in a boiling soap solution consisting of 1/2 lb. of Permag soap #58, manufactured by the Magnuson Products Corporation, 55 Third Street, Brooklyn, New York, for each gallon of water. Both the concentrate and the soap solution can be used over and over again until they lose their effectiveness. The pistons should be left in this boiling solution for approximately 15 minutes. After this, they are removed from the soap solution and sprayed with cold water, which, in most instances, will knock most of the carbon off the piston. It may be necessary to use a stiff brush to remove some of the carbon which will not come off with a water spray. All

1. (2) Continued

carbon that will not come off by this method must be scraped off with a scraper and all machined surfaces of the pistons polished with crocus cloth dipped in kerosene. The unmachined surfaces of the piston may be cleaned by a motor driven wire brush.

(3) It will often be found impossible to detect cracks in the piston, when inspecting pistons even with a powerful magnifying glass. The most satisfactory method of detecting cracks is by means of the Zyglo method developed by the Magnaflux Corporation. This is a new method for checking non-magnetic materials for cracks, which was developed by the Magnaflux Corporation and which method of inspection can be used after signing a separate license agreement with the Magnaflux Corporation, since this process is entirely different from the Magnaflux process. The Warner Aircraft has taken out a license for the Zyglo system recently and can perform these inspections. Where the Zyglo system is not available the pistons should be inspected for cracks by means of the penetrating oil-chalk method, which is carried out as follows:

(a) After the pistons have been thoroughly cleaned of all traces of carbon and have been permitted to dry thoroughly, they should be soaked for approximately one hour in preferably hot penetrating oil.

(b) Immediately after they are removed from the penetrating oil they should be given a light wash with washing spirits or gasoline in order to wash the oil off the exterior surfaces, but not long enough to soak the oil out of a possible crack into which it has possibly penetrated.

(c) All exterior surfaces of the piston should then be dusted with precipitated chalk, which can be purchased at any drug store.

(d) The piston should then be left standing to permit the chalk to absorb oil out of the crack where a crack exists.

(e) The excess chalk should then be blown off with compressed air by first having the air nozzle quite a distance away from the piston and gradually bringing it closer, watching all the time for a definite line of chalk forming on the surface of the casting. It will be found that, especially on the unmachined casting surfaces, it takes quite a bit of air pressure to blow off the excess chalk and that even a strong air stream does not remove readily chalk lines indicating cracks.

It is very important that all pistons on which incipient cracks are detected by either of these methods be replaced.

(4) The pistons which, after the above examination have been found free of cracks, should then be placed in a furnace the temperature of which is accurately controlled by some recording instrument. The temperature of the furnace

(4) Continued.

when the pistons are put in should be 450°F. and the pistons should be left in the furnace for one hour and forty minutes from the time 450°F. furnace temperature is again indicated after loading of the pistons. After removal from the furnace the pistons are left to cool in air at room temperature. This operation, which is called over-aging, eliminates the brittleness which exists in conventionally aged pistons, according to the latest researches of the Aluminum Company. It is recommended that this over-aging operation be carried out even on old pistons which have been in service, due to the fact that on pistons in service, only the dome is subjected to high temperatures and loses its brittleness, whereas the skirt of the piston is not subjected to sufficiently high temperatures in the engine to lose the brittleness from its conventional aging. The over-aging operation should only be carried out only once on a piston, that is to say, a piston which has been over-aged during a previous overhaul should not be over-aged again during a subsequent overhaul. Any piston for the 125 H.P. and 145 H.P. engines and any 3-ring piston for the 165 H.P. engine furnished by the Warner Aircraft Corporation from now on will be in the over-aged state and will not require further over-aging. In order to avoid repeated over-aging of the piston the letter "S" must be stamped on the piston head after the over-aging operation has been carried out and all pistons furnished by the Warner Aircraft Corporation in the over-aged stage from now on will carry the letter "S" on the head of the piston.

2. Exhaust Valve-Procedure of Inspection and Replacement.

(1) Exhaust valve failures are most often due to corrosion on the valve stem and in the valve guide interfering with the proper operation of the valve. This corrosion or valve warpage, due to improper warming-up or cooling-off the engine, causes exhaust valves to leak. On a leaking exhaust valve a hot flame almost continuously blows past the valve, which in turn causes such high temperatures of the valve head that the material loses its strength causing the valve to break. To detect exhaust valve corrosion or leaking valves at an early stage, it is recommended that the cylinder compressions be checked frequently so that the cause of malfunctioning can be corrected by cleaning the guide and stem. In order to guard against valve corrosion it is imperative that the instructions contained in the CAA Safety Regulation Release #148 be carried out.

(2) The exhaust valves used during the original manufacture of the 125 and 145 H.P. engines are dimensionally identical but these valves are made from two different materials. In the 125 H.P. engine valve #7739 is used, which can be instantly recognized by touching it with a magnet and finding the valve magnetic. Since the valve is magnetic this valve can be subjected to Magnaflux inspection. In the 145 H.P. engine, valve #7610 is used, which, when touched with a magnet, does not attract it since the austenetic steel used in these valves is not magnetic. The following instructions are only applicable to the #7610 austenetic exhaust valve which cannot be Magnaflux inspected.

II. (2) Continued

(a) On this exhaust valve regularly used on the 145 H.P. engine and possibly used on some 125 H.P. engines, it may be advisable to check the hardness of the stem. Austentic steel valves are not heat-treated and the hardness found is the inherent hardness of the steel. In order to avoid stress concentration, due to a deep rockwell penetration, these valves are checked at our factory with a special Superficial Rockwell hardness machine on the 30-N scale for which 30 kilogram load and the diamond penetrator is used. As a precautionary measure, it may be advisable to discard exhaust valves on which the hardness is found below 39 Rockwell 30-N, since the fatigue resistance of the softer valve is slightly lower. This hardness inspection is not recommended for the austenetic valves used on the 165 H.P. engine, due to the fact that the valve stem on the 165 H.P. engine is larger in diameter resulting in lower stresses in the exhaust valve of the 165 H.P. engine.

(b) The exhaust valve should be inspected for incipient cracks. This can either be done by means of the Zyglo method described above in Section I, Paragraph 5, or by means of a light acid etch in accordance with instructions contained in Paragraph 4 of Service Letter A-10.

(3) The 7610 valve may be used in the 125 H.P. engine but the 7739 valve should never be used in the 145 H.P. engine. The 7739 valve is more susceptible to corrosion from leaded gasoline. It is very important that engines be carefully prepared for storage when they are not in operation, since otherwise the corrosion on the valve will cause sticking of the valve with the resulting high temperatures of the valve head which will lead to valve failures.

(4) When a new valve is installed in a cylinder, without changing the valve guide, the valve seat in the cylinder should be recut with a refacing tool or reground. In either case the tool must be piloted by an arbor which fits the valve guide closely, so that the valve seat in the head will be concentric with the valve guide. It is very important that the least amount possible be cut away from the valve seat in the cylinder head since otherwise the life of the cylinder head will be greatly reduced. If the seat obtained is wider than 1/8, it should be reduced in width by the proper use of a 75° and a 15° cutter an explained in the instruction book. After the valve seat has been so cut the new valve must be ground in using Grade D grinding compound. After all the compound is washed off and the springs are installed, the valves must be tested for leaks by pouring gasoline into the exhaust and intake ports and then re-oiling the valve stems thoroughly.

(5) If a new valve guide has been installed in the cylinder head, the hole in the valve guide must first be reamed to the size stated below after the guide has been installed in the cylinder head, and after the cylinder head has been allowed to cool off completely. After the valve guide has been reamed the

II. (5) Continued.

seat must be recut as explained in the preceeding paragraph, in order to obtain perfect concentricity between the guide and the seat, and the valve must then be ground in.

Valve Guide Reaming Dimensions

Engine	Intake	Exhaust
125 H.P.	.3445 - .3435	.4535 - .4525
145 H.P.	.4065 - .4055	.4535 - .4525
165 H.P.	.4065 - .4055	.5005 - .4995

III. Cylinder Attaching Stud-Proper Inspection and Assembly Procedure.

The following precautions are to be carefully observed in order to prevent failures of the cylinder attaching stud.

(1) To avoid cylinder attaching stud failures it is imperative that the nuts be tightened with a torque wrench in accordance with the instructions contained herein, when cylinders are being re-installed after an overhaul. It is further imperative that the cylinder hold down nuts be checked again 10 to 15 hours after a cylinder has been installed with a new gasket. When installing a cylinder, a tightening torque of 200" lb. should be applied and at no time should a torque exceeding 225" lb. be applied to the nut. When checking cylinder base nuts for tightness 10 to 15 hours after installation and periodically thereafter, a torque of only 180" lb. should be applied to the wrench and a torque of 200" lb. should never be exceeded. It is imperative to watch that when tightening with a torque wrench, the wrench does not bind on any part of the engine and that the torque wrenches be checked regularly by clamping the wrench horizontally in a vice on the square end to which the sockets are attached. When suspending 10 lb. on the handle 10" from the socket which is clamped in the vice, the wrench should read 100" lb. and proportionally higher for higher weights suspended on the wrench.

(2) The nut on the cylinder hold down stud should never be checked for tightness, or tightened, or loosened, when the crankcase and the cylinder are hot. These operations should only be undertaken after the engine has cooled off.

(3) On some 125 and 145 H.P. model engines graphited paper gaskets have been used between the crankcase and the cylinder barrel. These gaskets had a tendency to squash out during operation of the engine. This squashing out has a tendency to reduce the pre-loading on the studs which is obtained by the proper tightening of the nut. This reduction of pre-loading greatly increases the stresses in the studs when the engine is running. On later engines, fibre gaskets are used between the crankcase and the cylinder which do not squash out and which can be recognized by not being graphited and being homogeneous throughout. These fibre gaskets are dark colored, which must not be mistaken for being graphited.

III. (3) Continued.

It is recommended that on engines where squashing out of the gaskets is observed, the tension of the cylinder hold down stud be inspected more often without exceeding the torque value given above. Furthermore, these squashed out gaskets should be replaced by fibre gaskets as early as possible. The number of the fibre gaskets are:

125 H.P. engine	No. 7153	Change C or D
145 H.P. engine	No. 7520	Change None or A

(4) Whenever a cylinder is removed from a crankcase the studs should be carefully inspected for being truncated and replaced, if necessary, as follows:

(a) The 5/16-24 thread, which is the thread on which the cylinder hold down nut is screwed on, should be very carefully inspected with a magnifying glass, if necessary, for any indication of truncation and increased pitch at the lower end of the thread approximately where the bottom face of the nut is when installed. This stretching of the stud coupled with reduction of the diameter (truncation) is due to the stud having been over-stretched during previous tightening of the nut.

(b) If a stud is found truncated but not pulled out of the crankcase, it must be removed either by using a stud driver or by screwing two nuts on the stud and tightening them against each other and then unscrewing the stud from the crankcase by applying the wrench to the lower nut.

(c) When installing a new stud into an undamaged thread in the crankcase, a stud with a pitch diameter of -.3579 to -.3559 on the 3/8-24 thread must be used, which, according to the old oversize designation, was S-506-0 studs and, according to the new oversize designation, is designated as S-506 + .005. The standard stud which is originally installed at the factory has a pitch diameter of .3529 to .3509, which is from .003 to .005 over the standard pitch diameter. Due to the fact that the aluminum thread in the crankcase is expanded after a standard stud has once been screwed into the hole, the oversize studs must be used. If standard P.D. studs are available and are too loose in the crankcase, and oversize studs are not available, a standard stud can be converted into an oversize stud by having the 3/8 thread only cadmium plated or copper plated approximately .002 to .0025 thick which will result in the thread being the desired amount oversize. If a stud driver is not available the new stud can be installed by screwing two nuts onto the stud tightly against each other, and then screwing the studs into the case by using the wrench on the upper nut.

(d) The torque applied when installing a stud must not exceed 150" lb. Higher torques overstress the stud, which will lead to subsequent failures.

(5) Whenever a cylinder is removed from a crankcase, the studs should be inspected for being partially pulled out of the crankcase and replaced, if necessary, as follows:

(a) When properly installed, the cylinder attaching stud will protrude from the crankcase on all engines 23/32". Any studs which have been partially

III. (5) (a) Continued.

pulled out of the crankcase due to tightening the studs while the crankcase is hot, will be found to protrude considerably more. The cylinder base studs have a 3/8-24 thread by means of which they are screwed into the crankcase and on most crankcase studs, a pulled stud can be recognized by the 3/8 diameter of the stud protruding above the surface of the crankcase.

(b) If the stud has been pulled so that the thread in the crankcase is damaged, the hole must be drilled out with a 21/64" drill and the hole must then be tapped 7/16-20 using a ground tap. The pitch diameter of the tap should be .4050 - .4063, which corresponds to No. 4 tolerance. If only No. 3 tolerance taps are available, the pitch diameter of the tap must be measured and a tap used which corresponds to the above pitch diameter limits. Oversize shoulder studs, S-506-05, according to the old oversize designation, or S-506 + .062, according to the new oversize designation, must be installed which stud has a 7/16-20 thread instead of the 3/8-24 thread at the large end.

(c) When installing the studs the torque must again not exceed 150" lb.

IV. Link Rod-Proper Fit of Wrist Pin.

(1) It has recently come to our attention that some operators have cut Hacksaw slots starting from the wrist pin hole in the link rod toward the piston pin hole so that the wrist pin locking bolt, when drawn, would clamp the wrist pin tightly into the rod, which pin would otherwise be loose. This practice is not permissible since it results in excessive stresses in both the link rod and the wrist pin bolt which will ultimately lead to the failure of either or both.

(2) The wrist pin must be a hard push or light drive fit in the link rod. Wrist pins which are found loose in the rod can be salvaged by having the pin hard chrome plated on the exterior surfaces the necessary amount to obtain from .0002 to .001 press fit of the wrist pin in the link rod. After the pin has been plated it must be carefully polished with crocus cloth and any build-up of the plating on sharp edges must be removed. The wrist pin must then be tried in the bushings of the master rod, where it must be from .0007 to .0015 loose which can be determined by slipping a feeler of the above thickness with the wrist pin into the bushing. If the bushing is found too small, it must be carefully reamed out with an expansion reamer. It will be found that on the master rod the link rod bushings are not flush with the inner surfaces of the master rod, since they are pressed in to a distance of .875 + .001 to .0000 between the bushing, as indicated in Figure 2 on Page 9, in order to locate the link rod for side clearance. In order to prevent dislocation of these bushings when the wrist pin is pushed in or out of the link rod, a wedge shape tool, as shown in Figure 1, must be made and this tool is to be inserted between the link rod and the master rod as shown in Figure 2, so that the force transmitter to the wrist pin is transmitted from the link rod directly to the master rod without dislocating the wrist pin bushing in the master rod. Due to the fact that the wrist pin bushing may protrude from the outer surface of the rod, it is important that the support for the master rod be made so that it clears the outer end of the lower wrist pin bushing as shown in Figure 2.

IV. (2) Continued.

Before driving or pressing the wrist pin in, the groove in the wrist pin must be carefully lined up with the hole for the wrist pin bolt in the link rod. One end of the wrist pin is slotted to assist in lining up the groove and the hole with a suitable tool. The groove and the hole must line up well in order not to damage the wrist pin bolt. The instructions for the proper installation of the wrist pin bolt are contained in Service Letter A-9.

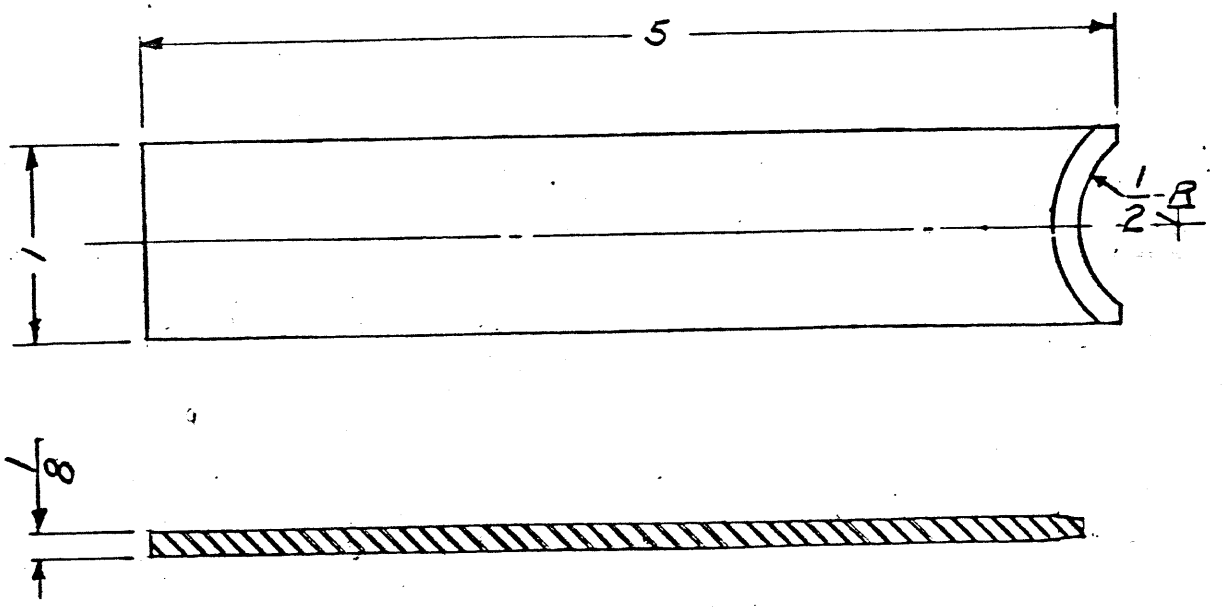

FIGURE 1

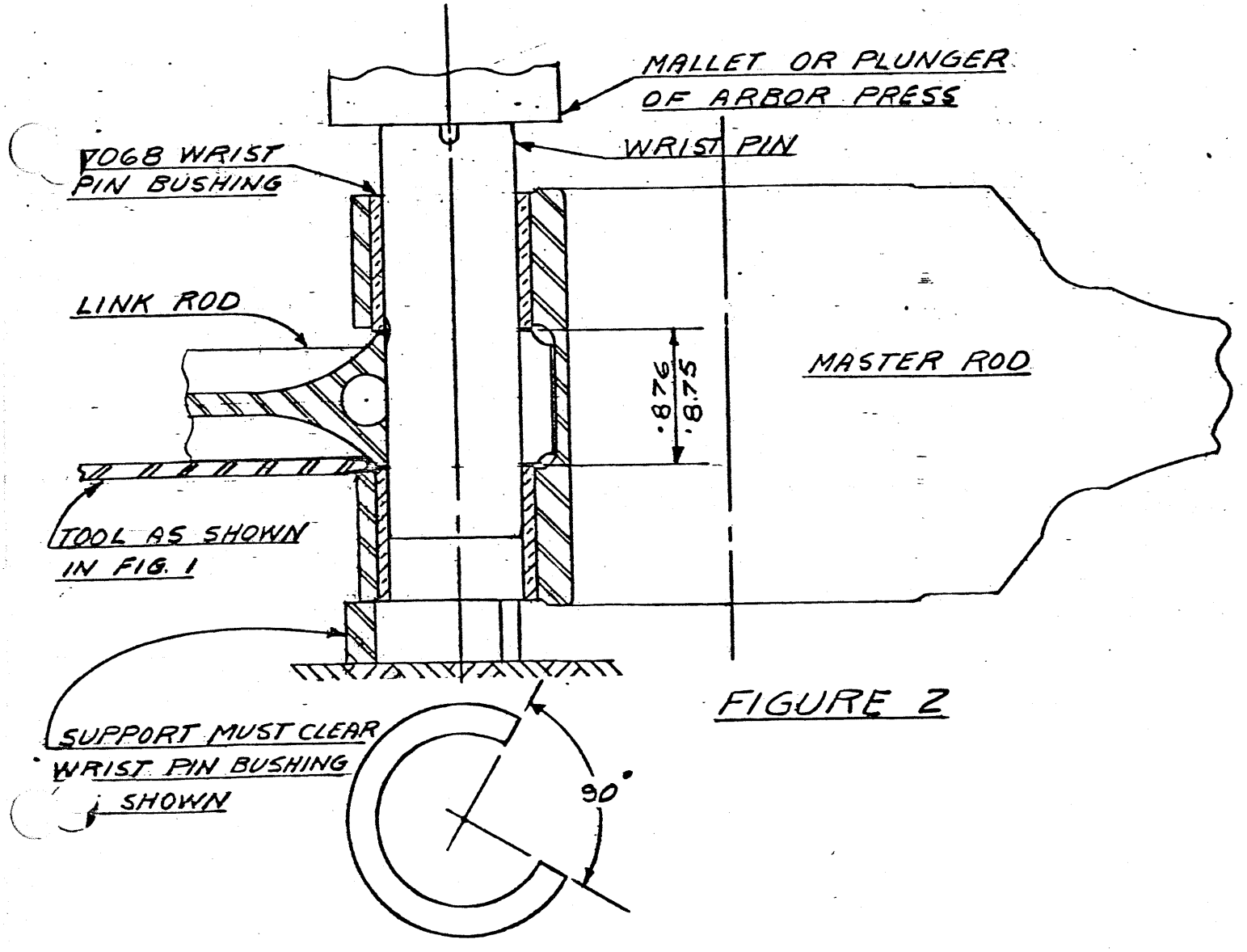

FIGURE 2