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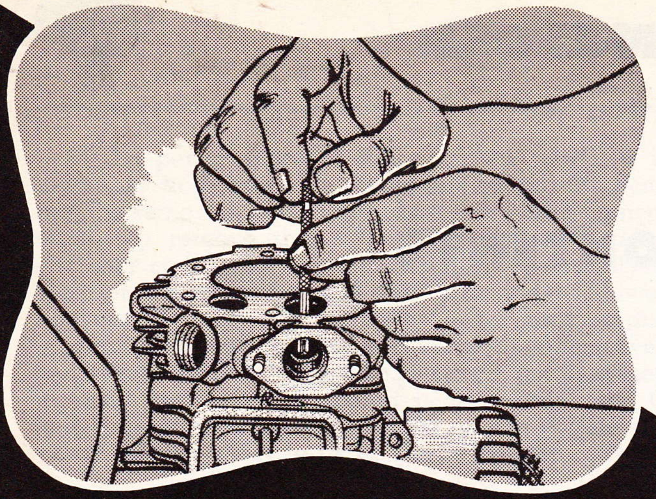

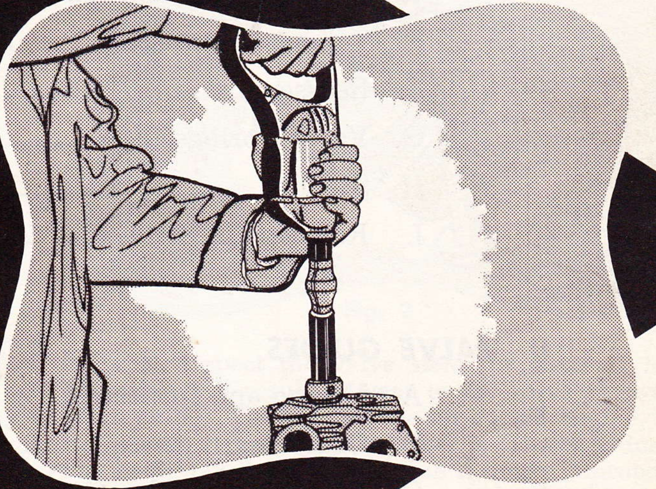

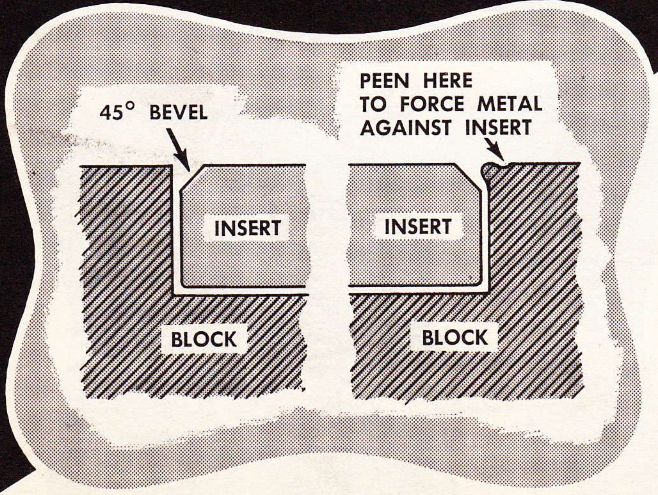


# VALVES, VALVE GUIDES

# VALVE INSERTS

# BREATHER ASSEMBLIES

PRINTED IN U.S.A.

CLINTON ENGINES CORPORATION, Maquoketa, Iowa

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In the performance of valve service work, it is necessary to disassemble the engine so that the head may be removed, and in most cases, it would be necessary to remove the carburetor, then the valve chamber cover and breather assembly. Generally it is easier to remove the head if the tank and/or blower housing are removed as well. After unit is disassembled so that the head and valve chamber cover and breather assembly can be removed, the next step in valve service work would be to remove the C lock, pin, or split lock depending on the engine the valve service work is to be performed on. These

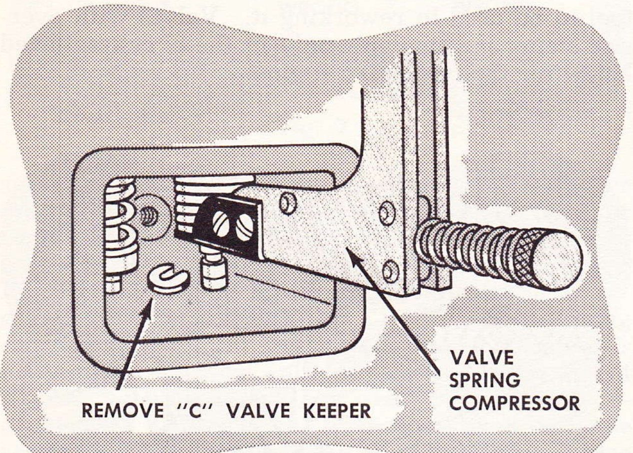


Fig. 1

locks can be more readily removed if a compressor is used to compress the spring such as TL 974 (Fig. 1). A screwdriver may be used if such a compressor is not available. After C lock, split lock, or pin is removed, the valve may then be removed. If the valve does not come out readily, do not force it, but remove valve spring washer and valve spring, and then check the valve stem for burr caused by long operation. Also check at the valve stem groove area to see if the C lock or split lock has caused a burr in this area. The valve spring washer may have caused a burred condition. Any burrs in this area may be removed by the use of a stone or file held against the valve stem rotating the valve stem

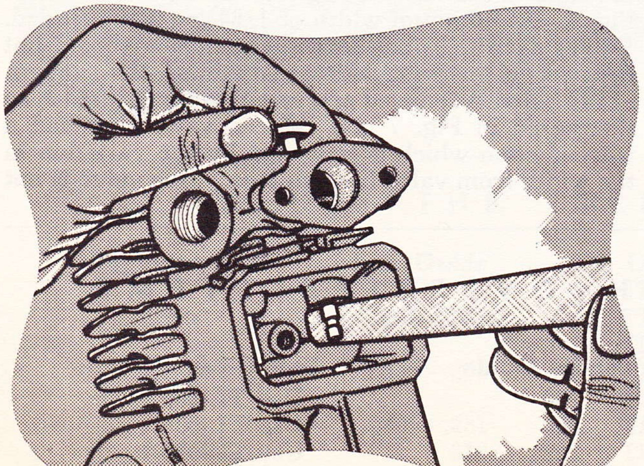

Fig. 2

by grasping the head (Fig. 2). *Caution should be used in valve removal as any burr in the stem area will damage the valve guide if it is forced through the guide.* If a valve is rusted or stuck tight, do not rotate crankshaft and try to use the camshaft to break the valve loose as this can cause possible damage to the camshaft, camshaft axle, tappet, and possibly the tappet guide. In the case of a stuck valve, use a steel plate across the top of the cylinder and pull the valve using this plate as support. Prior to pulling valve, check the condition of the stem in the valve chamber area to avoid guide damage. After

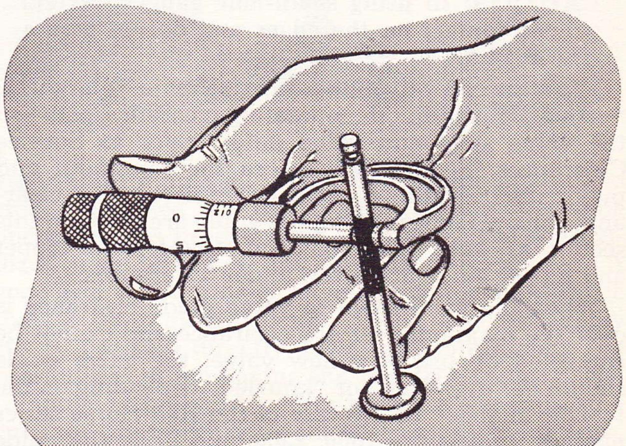

Fig. 3

removal, inspect the valve stem for wear as long operation will result in wear to the valve stem and valve guide. On the average air-cooled engine, the valve stem and valve guide wear is primarily due to dirt being taken into the engine through improperly serviced air cleaners and through loose carburetor mountings to manifold or block. Low oil supply or dirty oil supply would add wear in this area also. Clean carbon from valves, seats, ports, and block prior to checking and rework. To determine the condition of the valve stem, use a micrometer to check the valve stem, in area in which it operates in the guide (Fig. 3). Then compare this reading to that of a new valve stem. Refer to Section VI, Tolerances for

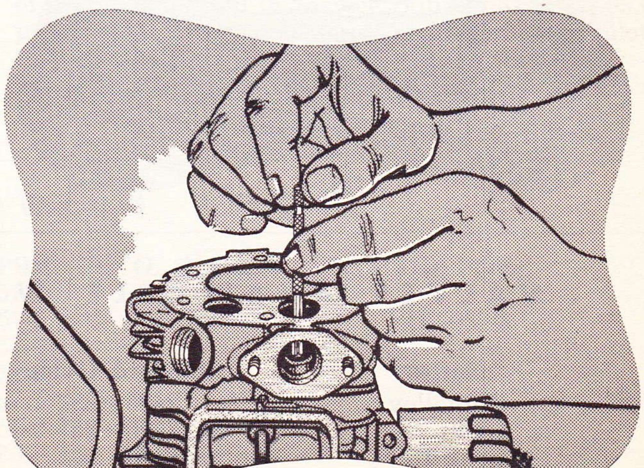

Fig. 4

the standard size stem. Any time the clearance of valve stem to valve guide can be reduced by more than .001 by replacing the valve, it is recommended that a new valve be used. If the previous check of the valve stem has indicated it is worn, it would indicate similar wear as well in the valve guide. A small-hole gauge can be used to check valve guide size (Fig. 4). In using the small-hole gauge, care should be used not to force it as it will misread as to the guide size. The guide should be checked at several points and rechecked at 90 degrees to check the guide for an "out-of-round" condition. Long usage with good maintenance can give this condition.

**CAUTION: In using small-hole gauges, certain gauges contact on the edges and do not give a true reading.**

For standard valve guide size, refer to Tolerances, Section VI, and for the operating clearance between the valve stem and valve guide, refer to Service Clearances, Section VI, where the minimum and maximum operating clearances are listed. The clearance for the tappet and tappet guide are given in this section as well. The standard sizes for the tappet and tappet guide are given under Tolerances.

When the valve stem to valve guide clearance is over the maximum service clearance and cannot be corrected by use of a new valve, the valve guide should be "oversized" or "knurled" depending on the tools available. In the case of the Red Horse series engines, that is the 1600, 2500, and 2790, the guide can be replaced. These operations will be covered further in this section.

If it appears on visual inspection that there is a carbon deposit in the valve guide, the guide should be cleaned by the use of a standard reamer (Fig. 5), TL 977, or a reamer of a size .250 to .2505 for all engines except the 1600, 2500 and 2790 which use a 5/16 reamer or .312. Use the reamer to clean out foreign material in the guide and then clean the guide with compressed air or a brush prior to checking guide diameter. If the valve was stuck, the reamer is used in all cases to clean the guide out prior to any rework. When the valve is stuck, the valve stem should be cleaned and polished with crocus cloth or the valve replaced. Listed below is the standard size of the valve guides, and also the oversize to which this guide can be reworked and the tool to be used in reworking it. Valves with oversize stems are available only in the oversizes listed below for the respective engine.

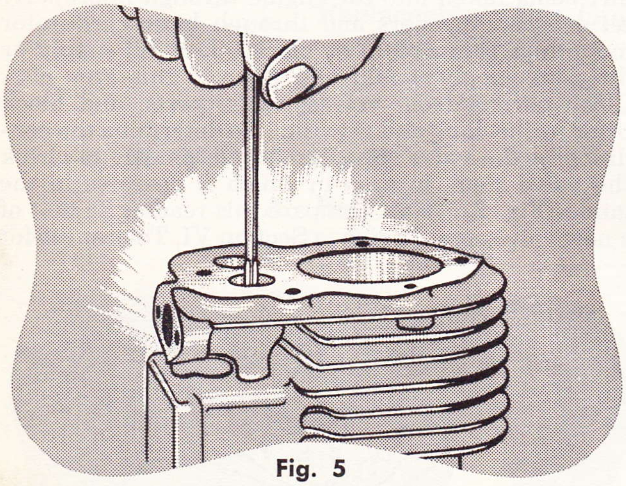

Fig. 5

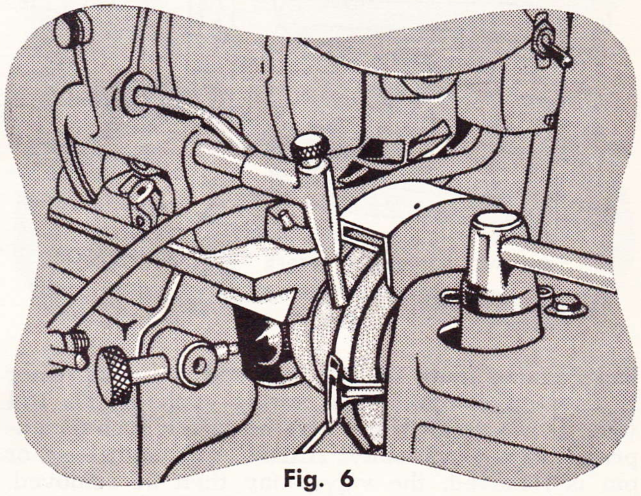

Fig. 6

If after checking this guide clearance it is determined that the old valve can be reused, then reface the valve by using an automotive type valve refacer to secure a 45 degree face (Fig. 6). If this type equipment is not available, replace with a new valve as it is not recommended that a valve be refaced other than with stones. In refacing a valve, it may be necessary to grind off too much metal in securing a smooth surface on the valve face, which will result in the edge of the valve being too thin as illustrated in Fig. 7. A minimum width of 1/64 is recommended. Valves narrower than this after refacing should not be used. If this width is not maintained, the strength of the valve is reduced and can give short life. Also illustrated in Fig. 7 is a refaced valve that had a warped stem which is indicated by the variation in the width from valve head to face. This valve is not

## VALVES AVAILABLE WITH OVERSIZE STEMS

| Series | Standard Guide | Oversize Guide | Tool Used |
|---|---|---|---|
| Clintalloy | .2495 - .251 | .260 | Use TL-939 |
| Gem | .2495 - .251 | .260 | Use TL-939 |
| Long Life | .2495 - .251 | .282 | Use TL-915-1 |
| Red Horse | .312 - .313 | | Guide is replaceable |

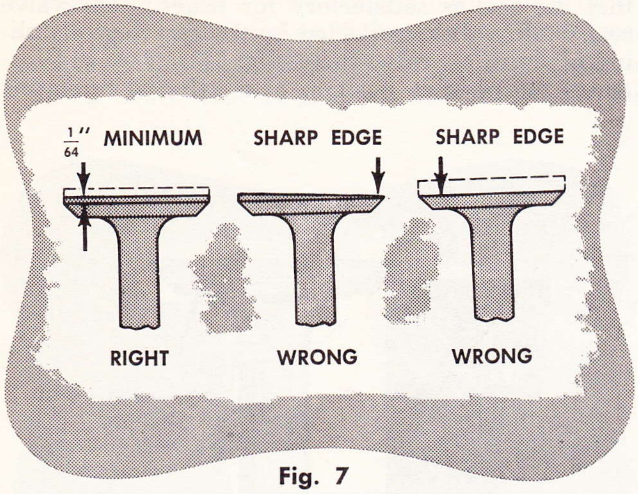


Fig. 7

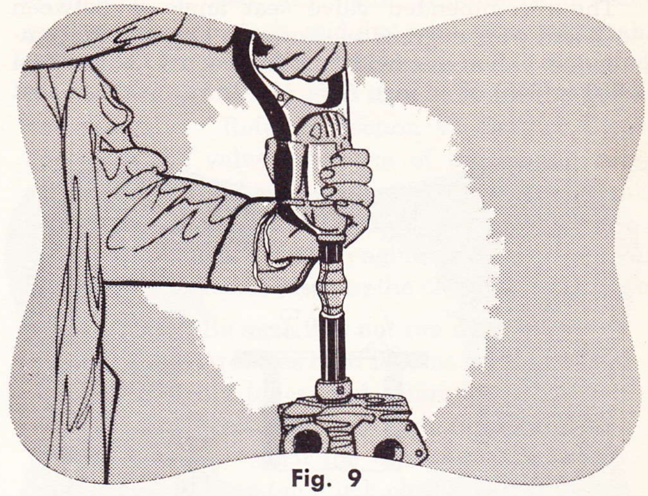

Fig. 9

suitable for reuse due to sharp edge. The valve seat must be reworked when the valve is refaced or replaced. Two tools are in common use for reworking valve seats, and either is acceptable. The cutter, TL 932 (Fig. 8), or commercially-available valve seat grinder (Fig. 9), may be used. Due to the seasoning characteristic of cast iron blocks, one or the other is necessary for rework. Fig. 8 illustrates the use of TL 932, which is the cutter used to secure a 44 degree seat. Automotive type equipment can be adapted to air-cooled engines if pilots of proper size are available for this equipment and hard seat grinders, Fig. 9, are being manufactured for use especially for air-cooled engines with the guides and stones designed for this usage. In the preceding operation it is necessary to cut away all of the oxidized metal until new and solid metal is exposed A good seat will normally have a brighter appearance than a surrounding metal. Using a cutter, apply steady pressure directly downward to minimize the possibilities of not having the seat true to the guide. In applying pressure, excess pressure can cause the cutter to chatter making the seat unsuitable for use, and it is difficult then to remove the irregularity caused by chatter and secure a seat suitable for sealing to the valve face. The pilot used in conjunction with the cutter or stone must be snug in the guide to secure a valve seat that will be true to the guide. Listed in Service Bulletin 54 is the TL 932 cutter to be used in conjunction with the following pilots which is the TL 957A pilot assembly. The TL 957-1 and the TL 957-2 are for use in the standard valve guides of the Gem, Clintalloy, and Long Life engines which have a standard size of .2495 - .251. The TL 957-2 is slightly larger than the TL 957-1 to compensate for some valve guide wear. The TL 957-3 is for use in the Gem series engine where valve guides have been oversized .010 or to a size of .260. The TL 957-4 is for usage with the Long Life engines when the valve guides have been oversized to a size of .282. Also listed in Service Bulletin 54 is TL 933 pilot for the Red Horse series engine where a pilot for a guide size of .312 to .313 is needed. All the preceding guides except the TL 933 are included with the TL 957A pilot assembly.

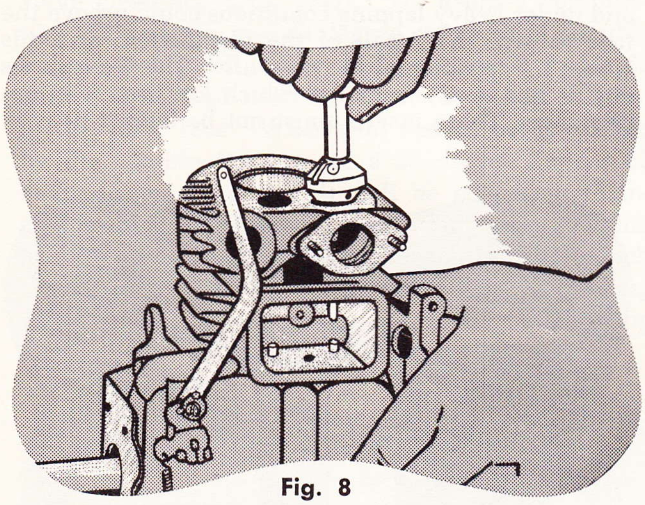

Fig. 8

## USE THE FOLLOWING PILOTS

| Engine | Std. Guide | Use Pilot | O. S. Guide | Use Pilot |
|---|---|---|---|---|
| Gem | .2495 - .251 | TL 957-1<br>TL 957-2 | .260 | TL 957-3 |
| Clintalloy | .2495 - .251 | TL 957-1<br>TL 957-2 | .260 | TL 957-3 |
| Long Life | .2495 - .251 | TL 957-1<br>TL 957-2 | .282 | TL 957-4 |
| Red Horse | .312 - .313 | TL 933 | Replaceable | |

**Note: TL 957A Pilot Assy. includes 957-1, 957-2,957-3, and 957-4.**

The recommended valve seat angle is between 43½ and 44½ degrees as shown in Fig. 10. Recommended valve seat width is between 1/32 to 3/64 (.030 to .045) of an inch (Fig. 10). In reworking a seat

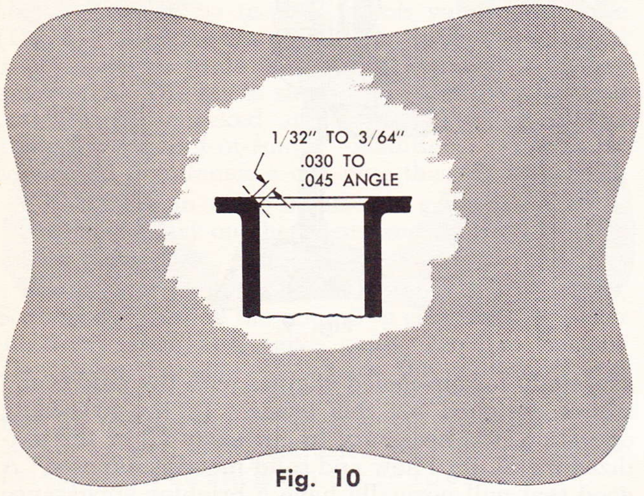


Fig. 10

it is common to secure a seat width wider than the maximum recommended and is then necessary in use of TL 932 to turn the cutter over to the opposite side and narrow the seat width, Fig. 14 and Fig. 8. After narrowing the seat, reverse the cutter to the seat cutting angle and turn cutter lightly one or two revolutions to remove the burrs that may have been turned into the seat from the previous operation. Where cutters stop, there will be burrs across the seat, and the valve will not be able to close and seal tightly unless these burrs are removed. By using a fine grade of lapping compound these burrs can be removed assuring a more satisfactory seal between valve face and

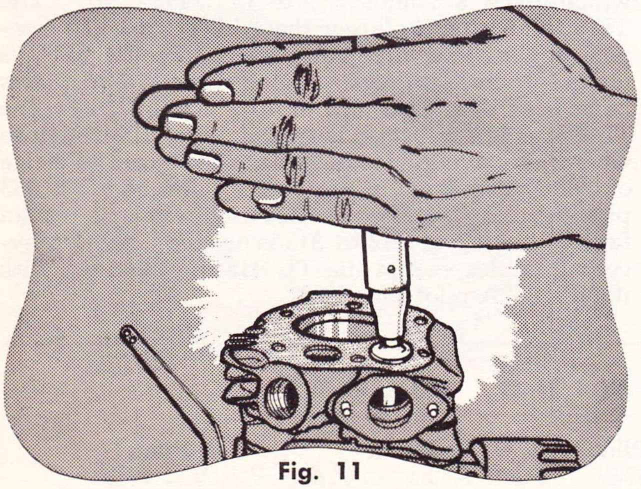

Fig. 11

valve seat. Fig. 11 illustrates the use of a TL 928 cup used in lapping operation. When deburring a valve seat by applying lapping compound to it and rotating the valve against the seat, move it around or rotate it a few times until the lapping compound produces a dull finish on the valve face which should indicate that the seat is satisfactory for usage. The valve seat width will be reflected by the scarring or dulling of finish on valve face (Fig. 12). Fig. 13 illustrates the possible position of a valve at operating

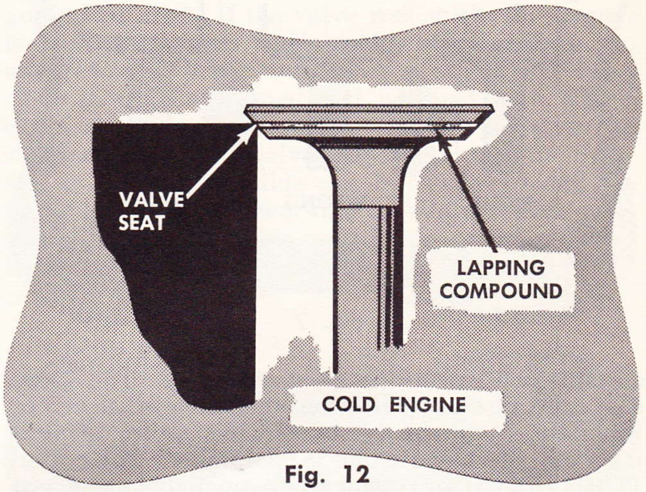


Fig. 12

temperatures after the valve and cylinder block have expanded. This would indicate that heavy lapping is not necessarily beneficial, and heavy lapping is *not* the way to rework the valve face and valve seat. It is *not* recommended (Fig. 13), that the valve faces and valve seats be reworked other than with cutter or stone for the seat, and a stone valve refacer for the valve as lapping compound can round off the seat, and under heavy lapping conditions could groove the face to give the result of the illustration, and this would be detrimental in valve life. The Gem series engine has inserts many of which are bronze in appearance. These inserts must not be lapped heavily

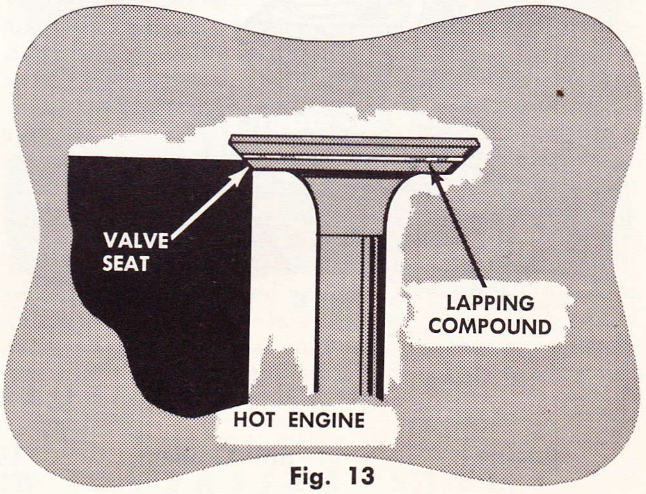


Fig. 13

as a lapping compound will round off the edges of the insert from that shape formed by the cutter, so actually the work preceding lapping is undone. When valves are refaced and the seat work is done with a hard seat grinder with stones properly dressed, it is not necessary to use a lapping compound for matching the two parts. When using a hard seat grinder, stones may be dressed at 25 degrees and 65 degrees to control the seat width (Fig. 14). If the seat is burned badly, reseating may make seat too wide.

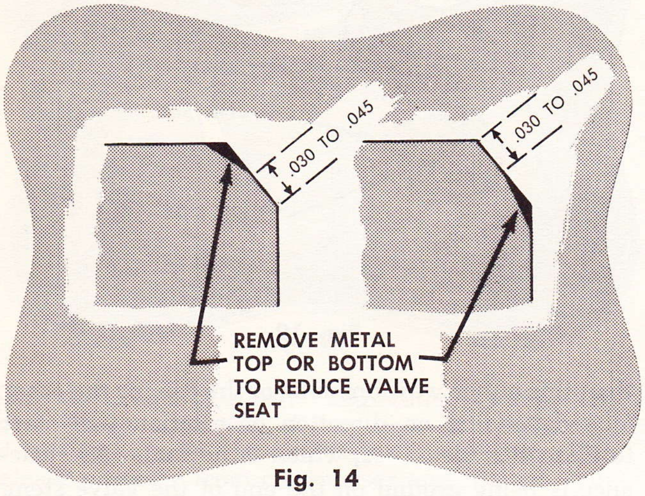


Fig. 14

Excessive use of the 25 degree stone or cutter to narrow the seat width will drop the seat too low, and as the seat is dropped lower into block, the valve stem will move further into the valve chamber reducing valve spring tension. This also requires much more of the end of the stem to be ground away for valve clearance (Fig. 18B). By using a combination of 25 degree and 65 degree stones, it is possible to hold seat width longer, but excessive use of a 65 degree stone will move seat out too far in relation to the valve face. When seat cannot be controlled by the combination use of a 25 degree and/or 65 degree stone or cutter, it will be necessary to install an insert to bring the seat to the proper position to maintain the valve spring tension and to match the valve seat to the valve face. After reworking valve seats, carefully clean with solvent all lapping compound, if used, and metal residue from seats, guides, cylinder block, and dry with compressed air. After the previous operations have been completed, it is necessary to check clearance between the tappet and the valve. Refer to Section VI, Service Clearances for the valve clearance of the engine being serviced. To set this clearance, first position the cam gear (Fig. 15) so that the lobes are down or away from the tappets. If the engine is assembled, this position is top dead center on the compression stroke.

**CAUTION: Be sure it is not top dead center on the exhaust stroke as both tappets would be held up by the cam lobes, and clearance set in this position will result in very wide tappet to valve stem clearance when the cam is in the proper position. Setting too much clearance will result in a noisy engine with valves opening too late and closing too soon. They will also cause short valve seat and/or valve face life.**

**CAUTION: do not set valve clearance on Gem series engines (the light weight four cycle series) and Clintalloy unless the base is in place to support the cam axle as valve stem to tappet clearance set in this position will result in lesser clearance as the base or bearing plate PTO side is installed to the engine block.**

After positioning cam gear and lubricating guides with clean oil, replace valves using caution to be sure that the exhaust valve is placed on the exhaust port side. An intake valve (Fig. 16) is never used in the exhaust side, but an exhaust valve may be used on intake side. In setting valve clearance, if the recommended setting happens to be .009-.011, it is faster and more accurate to use a .009 gauge and be sure that it will pass freely between tappet and valve (Fig. 17). If this gauge will not move freely between tappet and valve, it will be necessary to increase clearance by grinding off the metal from the

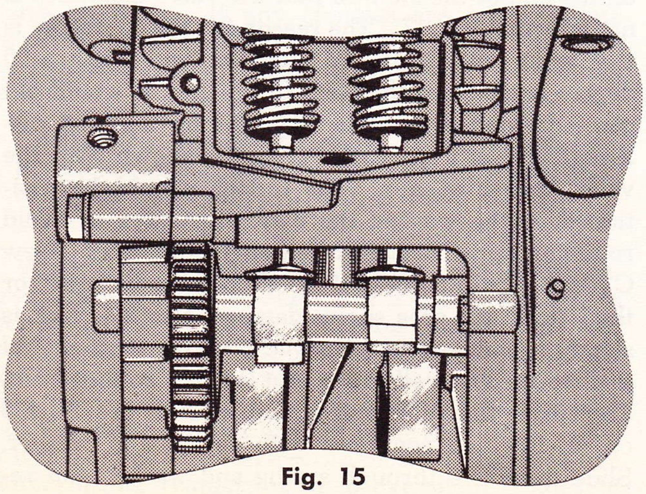

Fig. 15

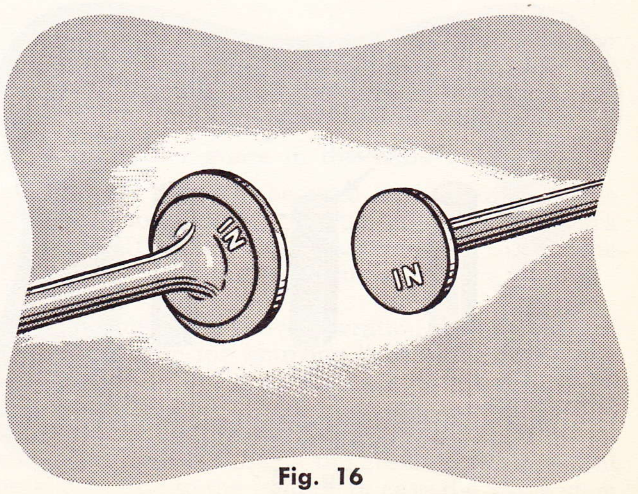


Fig. 16

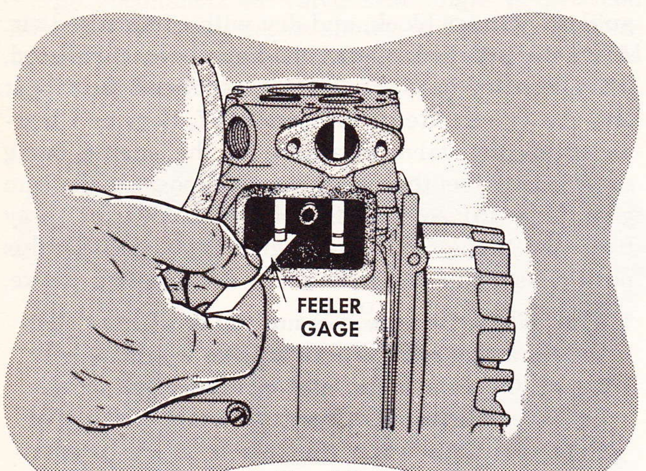


Fig. 17

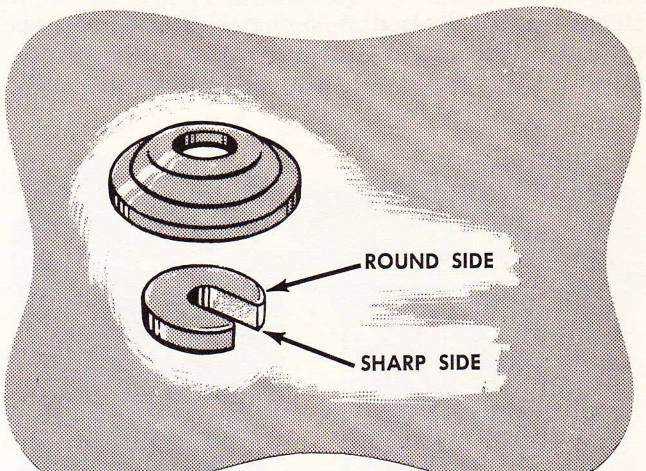


Fig. 19

end of the valve stem at 90 degrees to the valve stem (Fig. 18A) until the .009 gauge passes between tappet and valve. Care should be taken in grinding not to take too much metal off the end of the stem, and this should be checked by using the .011 gauge after the .009 gauge passes between tappet and valve to determine that the .011 gauge does not. Maintain pressure on valve head when checking clearance. Using a "GO .009" and a "NO GO .011" is more accurate and much quicker in adjusting clearance. The clearance on various engines does vary. The clearance given is a cold setting.

Refer to Section VI, Service Clearances for respective engine. If the valve tappet to valve stem is excessive, do not cut the seat down to reduce it, but replace the valve and set clearance. It is possible to secure some idea of the condition of the cam by rotating crankshaft ¼ revolution from each side of top dead center of compression stroke. The clearance on the valve should not vary over .002 when this is done. If crankshaft turns further

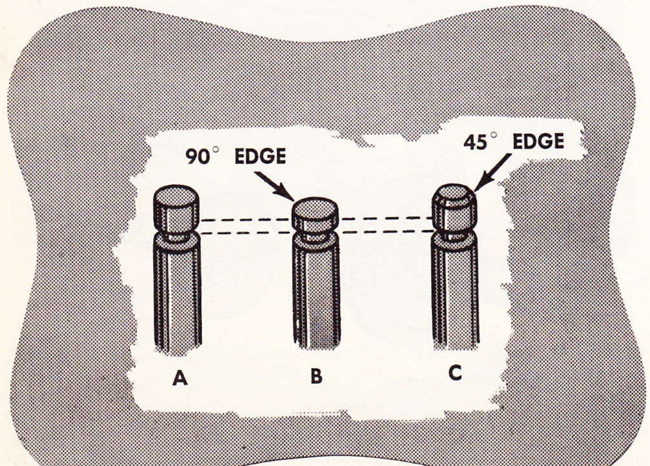


Fig. 18

than this either way, one lobe of the cam or the other lobe depending on direction of rotation will start to close this clearance, which is normal. As clearance is being ground on the end of the valve stem, compare the distance between the C lock groove and end of valve stem against the new valve, and if much more than ½ of the metal has been ground away from the groove to the end of the valve stem, the valve should be replaced with a new valve (Fig. 18B). If a new valve is being used and the valve seat has been cut quite low, consideration should be given to installation of an insert in the block so that the stem does not have to be ground off nearly as much. Valve seats exceptionally low will require such grinding of valve stem and make the valve stem weak in the C lock area. Also these low valve seats reduce the valve spring tension. As the valve is refaced, it produces less valve spring tension as well. After the clearance has been set, check the end of the stem and be sure that it is a 45 degree bevel (Fig. 18C). If there is not a bevel, grind it on the end of the stem, then remove the burr on the end of the stem so that the valve clearance is not affected, Fig. 17. The reason for the 45 degree is that wear tends to turn a burr out, and if it is a 90 degree angle from the stem to the end, it would become difficult to remove the valve on the next disassembly. In Fig. 19, the C lock is shown with the valve spring washer. The C lock should be positioned to the washer the way illustrated to avoid roughing up valve stem when engine operates. New C locks should be used if the C locks show wear, or the C lock slot area shows damage, also if C lock is sloppy to valve stem. Groove of valve stem should be inspected as well to see that it is not rounded out. To replace the valve spring and washer, use TL 925 or TL 974 and compress both spring and washer. Slide the valve through spring and washer and re-

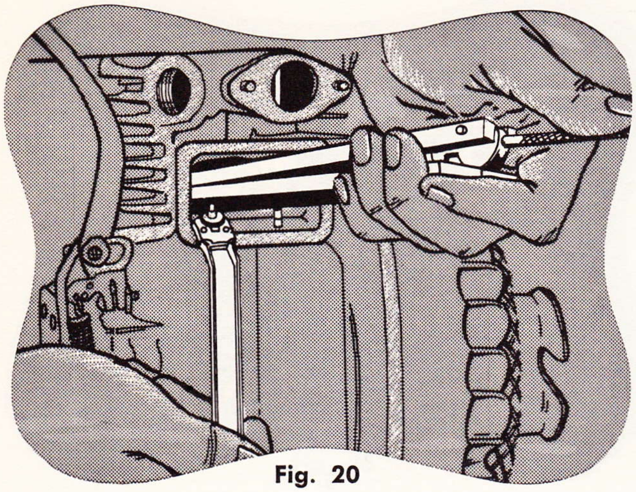

Fig. 20

place the C lock (Fig. 20). Illustrated is a magnetic tool. However, a pair of long nose or needle nose pliers can be used as well. After C lock is in place, release pressure from compressor and remove compressor, and visually inspect to be sure the C lock is completely in place. If there is any question concerning the condition of the valve spring, compare it to a new spring. If the old spring is weaker, it will be shorter and will usually lean to one side. If definitely shorter or not straight, replace with a new spring. Some of the cast iron engines were built with a stronger spring on the exhaust side. Be sure that spring goes in the exhaust side, or when springs are replaced, two exhaust springs can be used in the engine. As previously mentioned in some cases where valve seats are very low and the valve face has been ground away as much as allowable, the spring tension will be reduced due to the valve stem extending further into the valve chamber. This can be noted by the amount that has to be ground from the end of the valve stem (Fig. 18B). This reduction of spring tension may cause valve problems at high speed. A valve seat insert and/or new valve will minimize this condition. Also a thin washer may be placed in top of valve chamber around the metal extrusion to compensate for the additional distance between the C lock groove on valve stem and top of valve chamber. If any changes are made, rotate camshaft to check spring compression. This will restore the spring tension comparable to original tension.

**CAUTION: Never substitute valve spring or double springs as damage can occur to camshaft, camshaft axle, tappets, and possibly to tappet guides.**

When it is necessary to oversize valve guide, extreme care should be taken as it is possible to ruin a block in this oversizing operation due to oversized guide being larger than desired or due to the guide not being true to the valve seat resulting in a wider seat on one side than on the other. In doing any service operation that has not been previously done, it is wise to practice on a scrap block. There are two different size reamers used in oversizing guides in Clinton engines. The one for the Gem or the Clintalloy series engine is TL 939 and enlarges the guide approximately .010 oversize which brings it to .260. The reamer for the Long Life series is TL 915-1 which enlarges the guide to approximately .282. Be sure to use the proper reamer for the particular engine being worked on. On the Gem series engine, it is recommended that a T handle be used on the reamer and the reaming be done by hand as it is relatively easy to ream these guides. The guides on Gem and Clintalloy are not parallel to cylinder, therefore, it would be difficult to set these blocks up in proper alignment and use a drill press. When oversizing the valve guides on the Long Life series engines, the following procedure should be followed:

1. Clean the table of a drill press so that the bottom surface of the cylinder block will be flat against the metal table.
2. Install the valve guide reamer in the chuck of the drill press and check for wobble in the spindle and/or reamer. Any tendency of the spindle and reamer to not run true will cause the guide to be above tolerance. Also check reamer to the top of the block as it must be at a right angle. Operate the spindle approximately

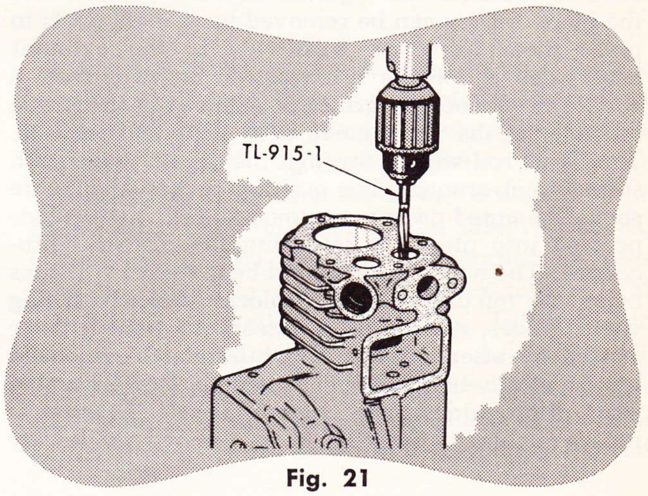


Fig. 21

   600 revolutions per minute and feed the reamer aggressively through the valve guide (Fig. 21). Make only one pass through the guide with the reamer.
3. Ream other guide in the same manner.
4. If block is not to be used immediately, oil the guide to prevent rusting. **Caution:** Rework seats after the guides are oversized so that the seat is true to the valve guide.

In addition to the above operation, a knurling tool is now available for knurling both valve guide and tappet guide to bring guides back to a smaller size than the original. They then can be reamed to standard size. If this tool is used, the seats should be reworked after knurling of the guides to be sure that the seat is true to the guide. In case the valve stem

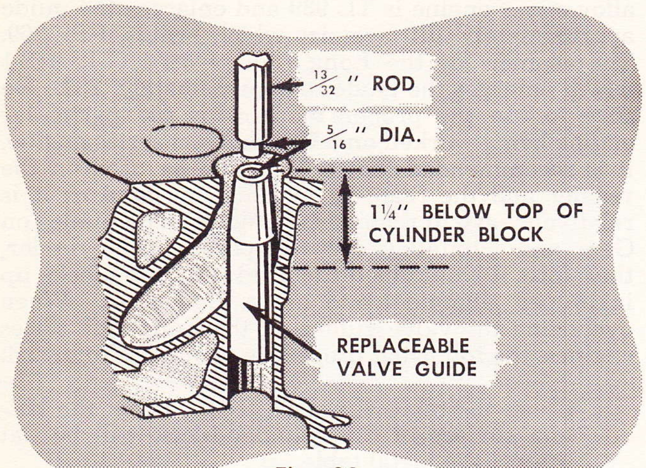

Fig. 22

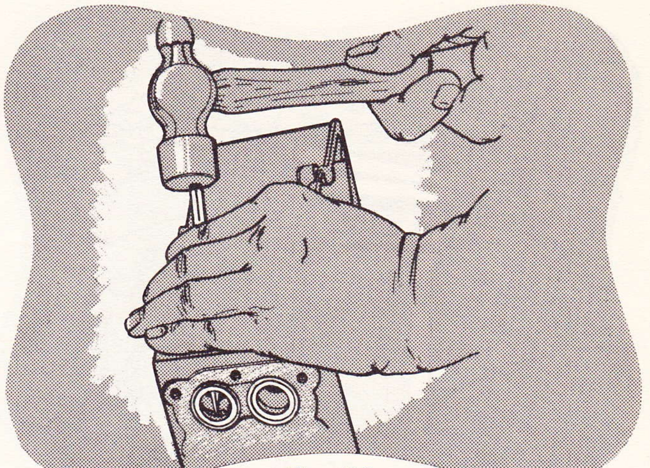
Fig. 24

to valve guide clearance is incorrect on the Red Horse series engine, the method of the correction is different than that previously listed as far as oversizing. (These guides could be knurled as well as the others). First, check the valve stem and then the valve guide. If the guide is worn, it can be replaced as the 1600, 2500, and 2790 series engines have replaceable valve guides that are pressed into the block. They can be removed by using a press to press them from the base side to the cylinder head side. A tool for removal can be made from a 13/32 round stock by grinding a step to fit the inside diameter of the valve guide (Fig. 22) which is 5/16. The 13/32 rod will fit through the tappet guide with sufficient clearance. The position of the valve guide should be noted prior to removal and the new guides pressed into place by reversing the previous procedure. The new guides should be at least 1¼ inches below the top of the cylinder block. After replacing valve guides, it may be necessary to remove burr caused by insertion, and this burr can be removed by use of a 5/16 (.312) inch reamer. Rework valve seats after guides have been replaced. If press is not available, it is possible to remove guides by

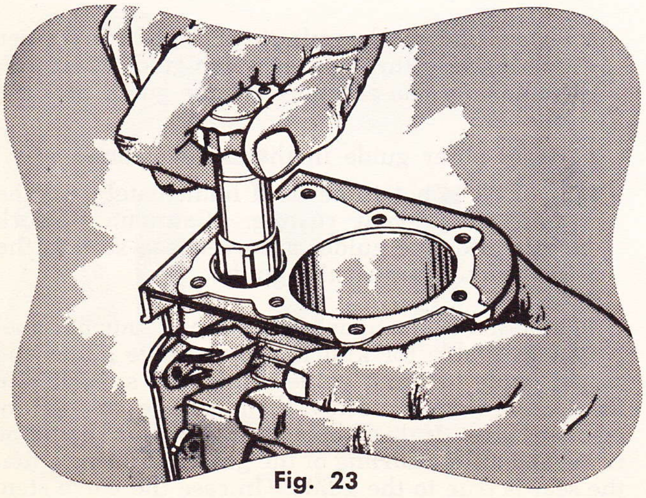
Fig. 23

driving on a tool such as that previously illustrated (Fig. 22).

When the valve seat (standard 10379 or 31379) is to be removed and replaced on a Gem series engine, the first step is to remove the metal that has been rolled over the upper, outer circumference of the insert by using a TL 936 cutter and TL 957A pilot assembly. See Fig. 23. If the seat is loose, obviously this is not necessary, or if it is an installation in a Long Life series engine block, it will not be necessary. The actual dimension of the Gem series insert is .040 oversize. The oversize insert number is 15119. The cutter used is approximately .038 oversize so there is a definite press fit when installing this insert. After the metal lip has been removed from over the Gem series insert, the insert can be removed by using a long punch to drive the insert out as shown in Fig. 24. This is the intake seat, and the exhaust seat can be removed in a similar manner if a curved tool is used. Care should be exercised to keep from damaging the cylinder block. After the seat has been removed, or if the seat was loose, then use the cutter TL 936 for the Gem series engines (15119 insert) or TL 961 for the Long Life series engines, (3156 standard or 3994 Stellite insert), and cut the block to the proper depth of 3/16 inch to 7/32 of an inch. See Fig. 25. This is the depth of the insert plus 1/32 of an inch which is used to hold the inserts in place. There is a depth gauge on the Long Life series cutter to control depth of cut. The pilot **must be tight** in the valve guide or the cutter will cut oversize. Take periodic measurements so that cutter does not go too deep, Fig. 25. In using TL 936, operate it by use of a hand tool and do not press down with much pressure as the single edge cutter will gouge and damage the pilot. When using the TL 961, it can be used in conjunction with a half inch electric drill and pressure should be applied to keep the speed of the drill low and to maintain steady feed and a steady cut. A drill press can be used, but it must be in a very good condition as any tendency for the spindle or cutter to wobble in the spindle of the press would result in oversizing of

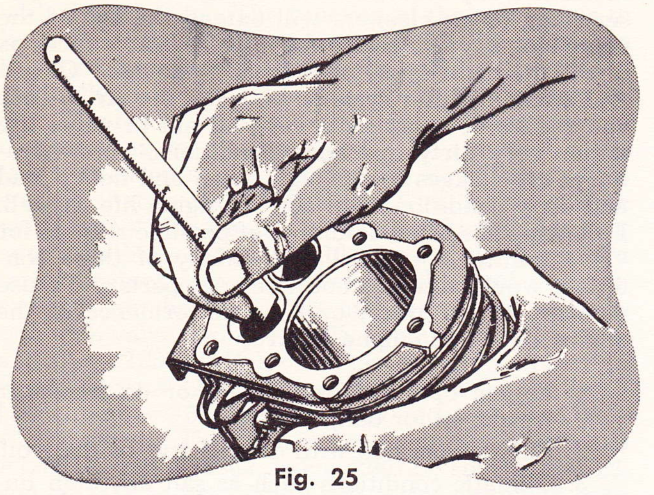

Fig. 25

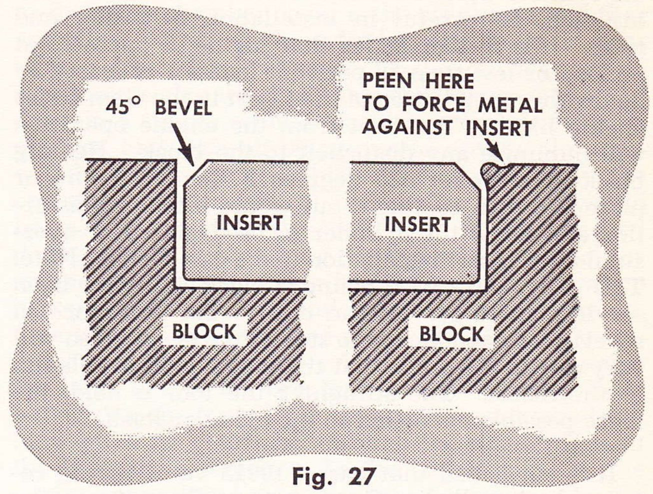


Fig. 27

the bore and the insert would be loose. Drill press should be operated as slow as possible, and if possible at 300 RPM for proper cutting. It is very essential that the pilot used in conjunction with the TL 961 be very tight in the guide and that the top of the pilot be lubricated so that the cutter will not overheat the pilot and pick it up which would cause oversizing. Check cutter to pilot prior to insertion of pilot to assure that they operate freely. It is recommended that the TL 961 be used on a scrap block first to learn the usage of the tool. After the block has been prepared for the insert by the use of the respective cutter, clean up this bore by use of compressed air so that there are no metal chips. Clean the chips out of the engine carefully. If cleaning is done before the pilot is removed, the chips would not be in the valve guide or valve chamber. In installation of an insert, it is recommended that insert be chilled to aid in the insertion. The insert can be placed in the block by the use of the driver TL 951. Refer to Fig. 26. Install the insert so that the 45 degree bevel is up toward the driver as this will aid in moving metal over the insert for holding it in place. Refer to Fig. 27. Do not drive on a solid object when driving the insert in place as it will tend to distort the block. The insert can be installed by holding the block against the body which will minimize block distortion.

**CAUTION: Be sure the driver does not contact the tappet as damage can result to cam and/or cam axle.**

After the insert is in place, the metal should be peened to roll over the top edge of the insert using the tool TL 952. The peening is very necessary on die cast material. Tip the tool aid in moving metal toward insert. Be sure the insert is staked firmly in place all the way around the insert (Fig. 28). Criss-cross to start the staking operation or insert may be moved or driven off center to the guide resulting in a variation of seat width. If the cylinder is to be deglazed or oversized on the Gem series engines, this deglazing or cylinder rework should be done prior to installation and staking in of the insert as installation of the insert can temporarily distort

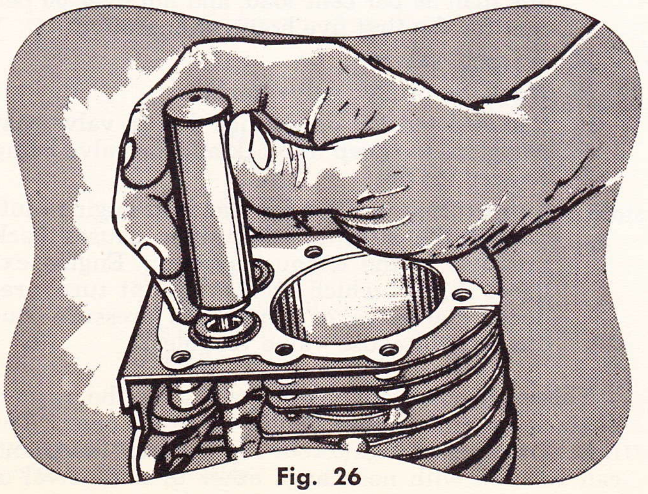

Fig. 26

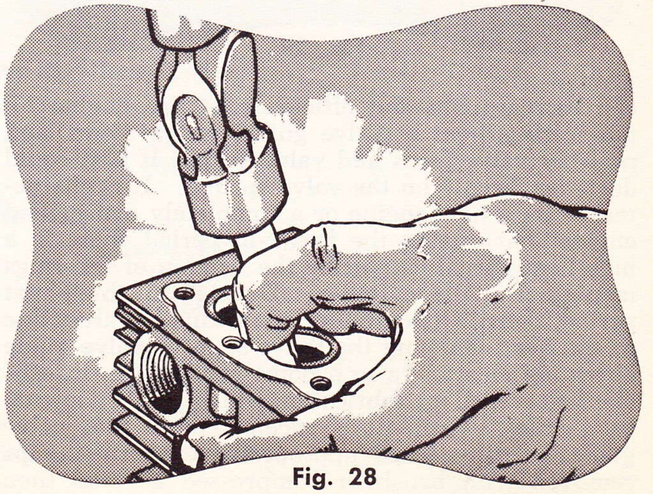

Fig. 28

the cylinder bore at the top. After inserts have been installed, be careful in installation of piston and rings. It is recommended that engine be operated at no load or less than 50 per cent load for at least two hours after installation of the insert in the Gem series engine block. The heat from the engine operation will minimize any distortion to the block. Heating block at not over 425 degrees F. for 2½ hours or more and then cooling it out would minimize distortion and allow the cylinder to be deglazed or oversized after insert installation in die cast blocks. Note: This distortion to the cylinder block will vary from serviceman to serviceman due to the difference in severity of impact used to stake inserts, and also will vary due to the angle that the tool is held in relation to the insert. The straighter the tool is held, the more possible distortion to the cylinder itself.

It is suggested that part #10013 valve spring retainer be installed in Gem series or Clintalloy series engines when valve work is performed. (Fig. 29). Retainer is inserted into the upper portion of the valve chamber with the flared edge down so the valve springs are positioned over these flared ends aiding the valve springs to retain alignment to the valve guide. This retainer was added to the Gem series and Clintalloy series engines to maintain a positive location for the valve springs in relation to the intake and exhaust valve stem and guides which

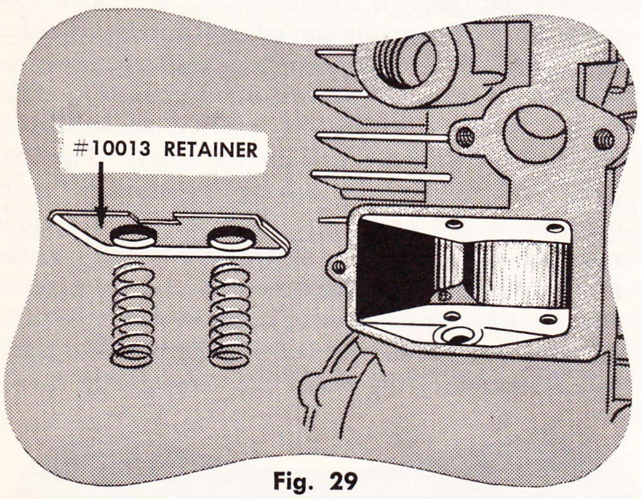


Fig. 29

can increase life and efficiency of the engine by minimizing wear of valve guides, valve stems, and possibly valve faces and valve seats. It also could decrease fatigue on the valve springs. It is characteristic of a new engine or a completely overhauled engine that during the break-in period there is a high-heat period caused by the friction of the rings lapping into the cylinder. During this high-heat period, there is a possibility of sticking of valves due to the heat changing the valve stem to valve guide operating clearances to a point resulting in insufficient clearance for lubrication which would show up as a stuck valve. It is recommended that valve guides be cleaned with appropriate reamer and chips removed with brush or compressed air and then lubricated any time valves are being serviced. Proper servicing of air cleaners will extend the life of the valve stems, valve seats, valve guide, valve faces as dirt is the main cause of wear and damage. Closed crankcase breather systems between the air cleaner and the valve chamber cover will aid in valve life under very dirty operating conditions. More frequent oil changes under high speed and heavy load and dirty conditions will add to engine life as well. Following are listed a number of possible reasons for valve failure or stuck valve. Many of these conditions would also affect other engine parts and cause damage, excess wear, or poor performance of the engine or actual engine failure.

1. Engine operated low on oil or on improper weight oil for temperature.
2. Engine operated with diluted and/or dirty oil.
3. Climatic conditions such as salt air, high humidity, etc.
4. Improper storage of engine and dirt and/or moisture cause damage or rust.
5. Improper cooling, air intake plugged, cooling fins plugged with dirt or grease, air shrouds removed, engine boxed in not allowing proper cooling.
6. Improper fuel. For example, ethyl or premium fuels, low octane fuels, or two cycle mix.
7. Distortion due to improper torque. This also would affect the ability to hold an insert in place.
8. Improper air cleaner service resulting in dirt entering air intake system.
9. Excessive carbon caused by filling oil bath oil cleaner too full, two cycle mix, etc.
10. Rust due to hosing off engine with water.
11. Lean mixture of gas and air in combustion chamber due to lean carburetor adjustment or a leak between carburetor and combustion chamber.
12. Overheating due to overspeed or overload.
13. Improper break-in, overheating due to heavy load being applied before engine is broken in. Should run without load at half speed for a minimum of 20 to 30 minutes and preferably less than 50 per cent load, and not over 66 per cent for the first five hours of operation.
14. Warped valves.
15. Weak or broken valve springs.
16. Reduced tension on springs due to valve seat being cut too deep in block and/or valve being refaced too far.
17. Substituting muffler for standard engine muffler; if the substituted muffler causes back pressure to the exhaust system. Engine exhaust system which creates abrupt turns, reduced diameters, or other back pressure conditions will cause valve troubles.

There are some options on valves for the various engines such as stellite valves and roto caps. The Red Horse series engine roto cap is part #90441 and can be used with no change other than removal of the valve spring washer and replacement of washer with the roto cap. The function of the roto cap is to keep the valve rotating slowly, and if the valve has carefully been replaced and the seat is true to the guide, this will give additional life to a valve service job. For heavy loads and long continuous operation, the roto cap is recommended. Also available for this type of an application for the Red Horse series engine, that is the 1600, 2500, 2790, is the stellite valve part #16386, and it is to be used in conjunction with a stellite insert part #16385. For the Long Life series engines roto caps are available and the roto cap part number is 12363A and is used in conjunction with valve spring #12405, exhaust valve #12364, and pin #12362. If block does not have insert in it, use insert #3994. The stellite valve for the Long Life engine is #3031-3 to be used in conjunction with #3994 insert. The Gem series engines use roto cap #12363A, pin #12362, valve #90723, spring #90722, and #31512 insert. The Gem series equipped with stellite valves use #31512 insert and #21301 stellite valves. In the usage of stellite valves especially, it is normal to use the exhaust valve in the intake side with the stellite valve and stellite seat in the exhaust side. This also could be followed when roto caps are used, but the special valving is normally applied to the exhaust side due to the heat applied to this valve in an open position. Those engines equipped with LPG normally are built to operate with a stellite valve and the stellite seat in the block exhaust side. It is not recommended that these engines be operated otherwise.

In reassembling an engine that has had careful valve guide, valve face, and valve seat work done to it or had inserts installed in it, it is recommended that the torque information in Section VI be followed in reassembly so that the guides, seats, and/or inserts are not distorted due to improper torques. Any time an engine is serviced, the cooling fins should be cleaned as a hot spot due to a plugged fin or general dirtiness over the cylinder fins decrease cooling, cause valve guide distortions, cylinder distortion, possible stuck valves, and inefficient operation of the engine. Overheating an engine due to the previous conditions or due to air being blocked from moving into the flywheel can loosen an insert in a die cast block.

An important assembly used in the valve chamber or the valve chamber cover is the crankcase breather assembly. The single cylinder engine, if it was vented from the crankcase to the outside, would expel much air each time the piston comes down and draw in a similar amount each time the piston traveled up, and with oil being moved around throughout the crankcase and this oil being thin from the operating temperature of the engine, the oil would be moved out with the air as the piston traveled down, and in a short time there would be no oil for engine lubrication. This breather assembly, when it is properly installed and functioning as it should, maintains a vacuum in the crankcase of a single cylinder four-stroke engine. As the piston comes down the large disc of the breather assembly moves to let out any air that may be in the engine crankcase from blow-by or air returning through the smaller hole in the breather assembly. As the piston goes up, the engine is operating on a crankcase vacuum. As the piston goes over top dead center and comes down, the engine is operating on a crankcase vacuum. But due to blow-by and the slight relief in each of these breather assemblies for air, it will expel air through the breather assembly each time the crankshaft approaches bottom dead center. Following are some variations in breather assemblies and the figures illustrate them. In each case it is necessary for the oil to have some means of moving from the valve chamber back to the crankcase.

The Gem series engine originally used the 6330 breather assembly which is a breather assembly with a solid body and a disc on top of the body which moves open as the piston goes over bottom dead center. The oil return on the Gem series engine is through a drilling in the bottom of the valve chamber back to the crankcase (Fig. 30). In the case of the horizontal shaft Gem series engine, the oil is returned by way of a drilling next to the breather assembly (Fig. 31). The vertical shaft Long Life engines have the breather assembly similar to the vertical Gem with the oil return through a drilling from the valve chamber to the crankcase so that the oil does return to the crankcase. The exceptions to this on the vertical shaft engines would be the vertical Long Life engines, the VS-700, VS-800, and the VS-750 number 7150-A2. These engines have a

**Stellite Exhaust Valve and Seat Use**

| | Red Horse | Long Life | Gem. |
|---|---|---|---|
| Valve, Stellite | 16386 | 3031-3 | 21301 |
| Insert, Stellite | 16385 | 3994 | 31512 |

**For Roto Cap Assy.**

| | Red Horse | Long Life | Gem. |
|---|---|---|---|
| Roto Cap Assy. | 90441 | 12363A | 12363A |
| Valve, Exhaust | Std | 12364 | 90723 |
| Insert, Valve | Std* | 3994 | 31512 |
| Spring, Valve | Std | 12405 | 90722 |
| Retainer, Valve | Std | 12362 | 12362 |
| Washer, Valve | remove | remove | remove |

*Valve insert standard on A-1600, B-2500, and 2790 series. Use 16385 insert on 1600 and 2500 when block does not have an exhaust insert installed.

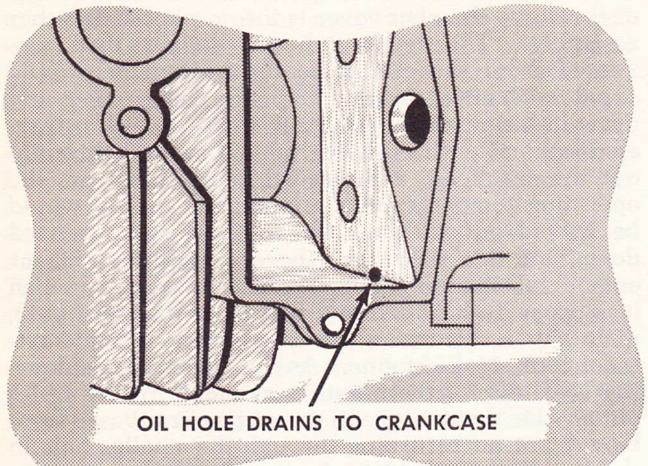


Fig. 30

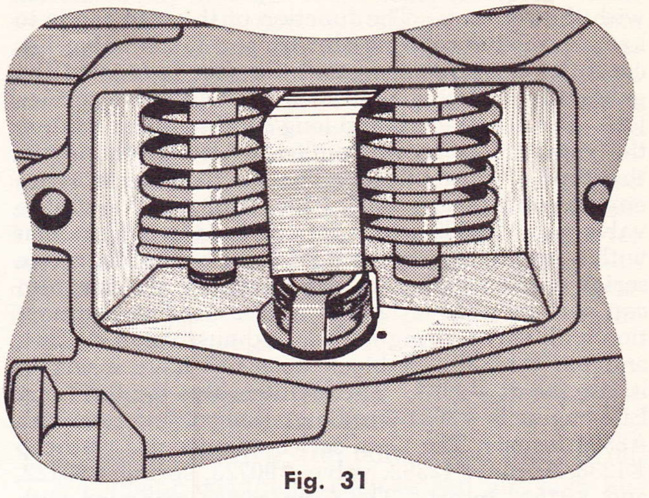

Fig. 31

breather body which has a long tube. This tube points towards the low portion of the valve chamber and as the piston travels up, any oil around the end of this tube will be pulled or lifted into the crankcase. If this tube is turned up, obviously the oil level would raise in the valve chamber until it ran out the valve chamber cover. Fig. 32 illustrates installation of this breather assembly. The horizontal shaft cast iron engines use a breather assembly with a hole through the body of the breather assembly for the oil to return to the crankcase. This breather assembly is illustrated in Fig. 33 and is part #7150-A. The 300 series, A-300, and 350 series engines vary from this in that they use the #7150-A1, which is a similar type breather but a metal clip holds it in rather than a spring. The VS-300 and 350 are the same as the horizontal 300. Turn oil hole toward crankcase on VS-300 and VS-350. Late production Gem, Clintalloy, and Long Life engines have been using a 6354 breather assembly in conjunction with 90610 elbow breather. This elbow holds the breather assembly in the valve chamber cover. In the case of the vertical shaft Long Life and Gem series engines as well as Clintalloy, it is necessary that the oil returns through a drilling from the bottom of the valve chamber cover to the crankcase. Fig. 34 illustrates this latest breather system. This breather system may be used on most previous production engines. See chart—for usage.

Under extreme dust conditions a closed breather system from the valve chamber to the air horn will aid in minimizing the dirt going into the engine, the engine life can then be increased. Closed breather systems may be added as necessary on those applications that have a dirt problem (Fig. 35). The air horn or air cleaner mounting bracket to carburetor can be drilled through with a 7/16 drill to give a hole to take the breather line. The breather line can be fastened in the air cleaner mounting bracket or air horn by use of a 10353 sleeve. The 12308 breather line is 7¼ inches long and may be stocked and shortened as necessary for those applications that do not require this length. The breather line may be held in the valve chamber cover by use of the 10353

| ENGINE SERIES | BREATHER ASSEMBLIES | | BREATHER TUBE ASSEMBLY | | |
|---|---|---|---|---|---|
| | Breather Assembly Standard | Breather Assembly Replacement | Breather Tube | Air Horn or Air Cleaner Support Ass'y Sleeve | Valve Chamber Support Sleeve |
| Long Life Hor. & Vert., except for below | 7150-A | 6354* | 12308 | 10353 Note 4 | Note 1 |
| VS-700, VS-750, VS-800 | 7150-A-2 | *** | 12308 | 10353 Note 4 | 10353 |
| VS-900, VS-1100 | 7150-A-3 | 6354* | 12308 | 10353 Note 4 | Note 1 |
| 300 Series, Horizontal & Vertical | | | | | 10353 |
| | 7150-A-1 | None | 12308 | 10353 Note 4 | Note 3 |
| D-1100, 1200, 1200-1000, 1200-2000 | 7150-A-2 | 6354** | 12308 | 10353 Note 4 | Notes 1 & 2 |
| Gem—Vertical & Horizontal | 6330 | 6354* | 12308 | 10353 Note 4 | Note 1 |
| Clintalloy | 6354 | 6354* | 12308 | 10353 Note 4 | Note 1 |

Note 1—The 6354 Breather Assembly will fasten the Breather Tube or 10353 Sleeve can be used.
Note 2—Change to 7938 Valve Chamber Cover.
Note 3—Drill Valve Chamber Cover Hole to 7/16".
Note 4—If Air Horn or Air Cleaner Support Assembly not drilled for Breather Tube, drill 7/16" hole.
* Use 90610 Elbow with 6354 Breather Assembly when converting.
** Use 7938 Valve Chamber Cover and 90610 Elbow.
*** Change not recommended. It is necessary to drill a 3/32" hole from Valve Chamber to Crankcase for oil return as used in vertical Gem or vertical Long Life.

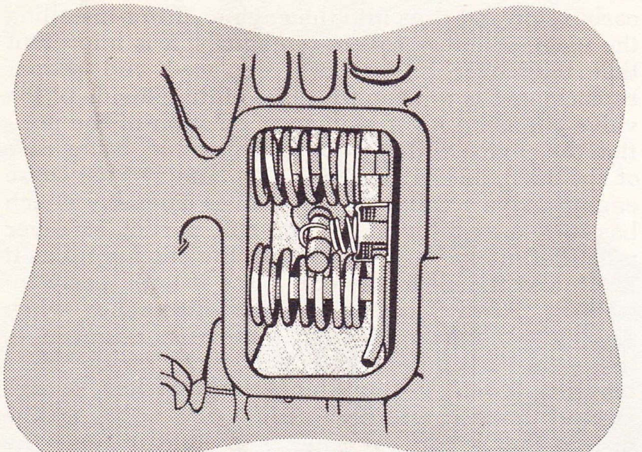

Fig. 32

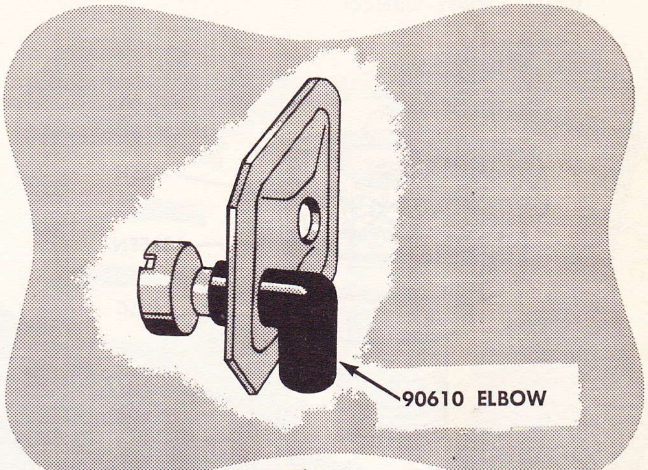


Fig. 34

sleeve or by use of the 6354 breather assembly (Fig. 36). If the 6354 breather assembly is used, the older assembly should be removed from the engine. Remember on the VS-700, VS-750, and VS-800 that there is not a hole drilled for the oil to return from the bottom of the valve chamber back to the crankcase and the substitution of the 6354 breather assembly for the breather assembly that was in these engines will give an oil problem in the valve chamber. In the case of this engine, it would be easiest to use a 10353 sleeve to secure breather tube to valve chamber cover. In most cases the valve chamber cover already installed in the engine will work with the breather tube, the 6354 breather assembly, or the breather tube and the 10353 sleeve. The exception to this would be the 1200, 1200-1000, 1200-2000, and D-1100 engines. On these engines it will be necessary to change the valve chamber cover to the 7938 valve chamber cover, or if this is not in stock, the 3035 valve chamber cover to complete the breather assembly on the engine. The average engine on the average application does not need this closed breather tube assembly, but in certain areas and especially on certain types of applications the oil will remain cleaner and the wear characteristics of the engine reduced.

Fig. 36 illustrates the breather assembly on the Red Horse series, that is the 1600, 2500, and 2790 series engines. This breather assembly functions in the same way as previously discussed, but is screwed to the block on the outside underneath the fuel tank. This breather assembly is made up of a disc that moves to allow air to be expelled from the crankcase and seals off air return except for one small notch in the seat which is for oil to return back to the crankcase. This breather assembly has a metallic mesh in it that requires service periodically. If this breather assembly is not serviced as far as the metallic mesh filter is concerned, it is possible under severe conditions that it could affect engine operation due to the plugged condition of the filter. Breather assemblies of all types are important in the engine operation.

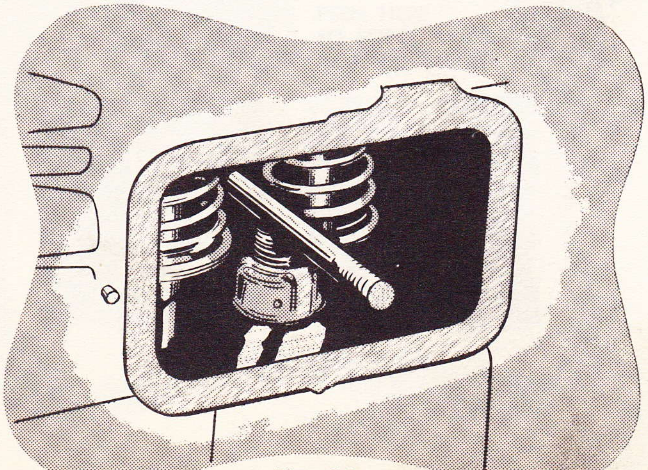

Fig. 33

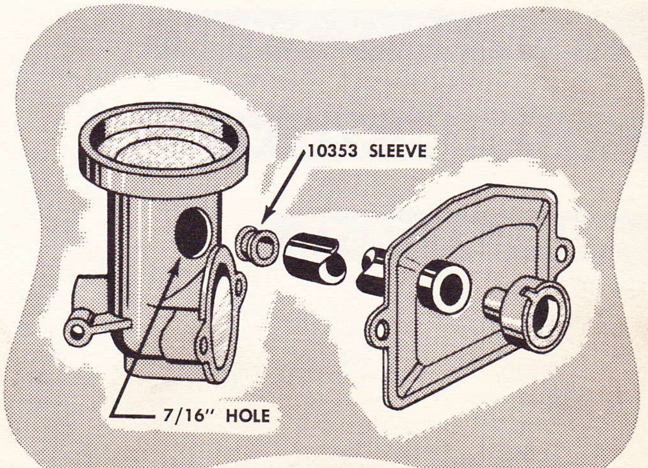


Fig. 35

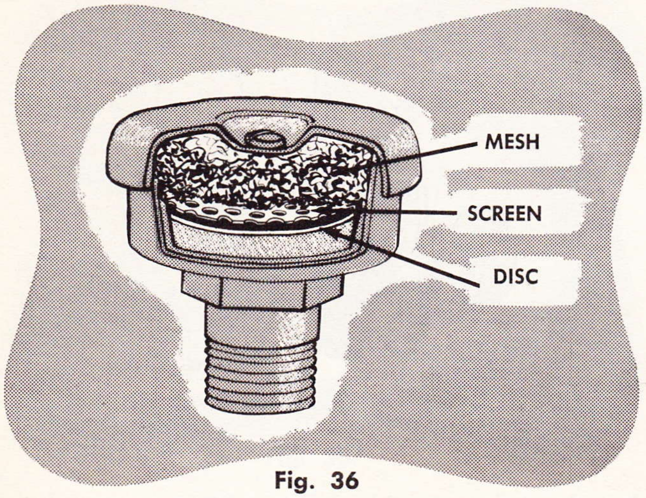


Fig. 36

When the breather assembly is not functioning, the crankcase will move from a crankcase vacuum over to a crankcase pressure. This will give a horsepower loss, it can give seal troubles, it can increase oil consumption, and under those conditions where pressure occurs in the crankcase, oil will be forced past the rings and through valve guides, and in those engines equipped with a closed breather system, the closed breather system will move oil to the carburetor or air cleaner. When a closed breather system is used from the valve chamber cover to the air horn or air cleaner mounting support, care should be taken not to tip the engines as oil will run in the breather tube from the crankcase and then into the air cleaner or carburetor and thus into the engine. In re-installing the valve chamber covers to engines, it is important that the cover be properly replaced and proper replacement is to keep the hole on the outside of the valve chamber cover as high in relation to the position the engine will operate in as possible. In the case of the 1200, 1200-1000, 1200-2000, and D-1100 these engines have a valve chamber cover assembly which has in it a metallic mesh, and this particular cover must definitely have the hole to the outside up as it can lower the oil in the crankcase if improperly installed. Always check breather assemblies when servicing engines and when there is question as to the part functioning, replace with new. Most breather assemblies in the past have had a cage around the disc, and if this cage should lock up the disc so that it could not move, or hold it open, the previously mentioned problems could occur. The condition of the valve chamber gasket and tight valve chamber cover is important with the newer breather assemblies. *Note: On early production engines the vent hole between crankcase to valve chamber was 3/16 inch. This can be drilled to 3/8 inch and breather assembly installed.*

**CAUTION: An engine overfilled with oil will give crankcase breather problems as the excess oil will be expelled through the breather assembly, valve guides, past rings, and can cause oil seal leaks. Oil that is too thin or diluted from usage can cause what apparently is crankcase breather problems, but a change of oil may be the only cure.**

## SERVICE NOTES