To propel a steamboat which carries its own skipper, an engine of at least a half horsepower is essential. This power must not be nominal; it must be capable of development with a full head of steam, continuously, but without draining the boiler.

It is surprising how small a cylinder is really necessary, so long as it is built in a truly scientific manner. Over-cylindering must, at all times, be avoided as the real source of power is the boiler. The engine is only the medium by which the heat energy is converted into mechanical energy. (It would be no good to put a 10 HP electric motor onto a wireless battery and expect it to go.) Also, so long as the bearings are of ample area and the framing of sufficient stiffness, the lightest construction may be adopted.

The revolutions should be high enough to make the engine more or less efficient as a heat engine. All small engines have only a minute amount of calories in the cylinder at each stroke and to keep the walls at the proper steam temperature, the number of strokes per minute should be as high as the components of the machinery will stand. By this means, the cylinder walls will be maintained at proper temperature and condensation losses will be reduced to the minimum. For the present purpose, I am recommending 300 to 400 RPM as the normal rate and a pressure of at least 60 psi at the boiler stop-valve. Allowing this, we can reckon on an average or mean pressure in the cylinder of 35 psi. The Indicated Horsepower should be:

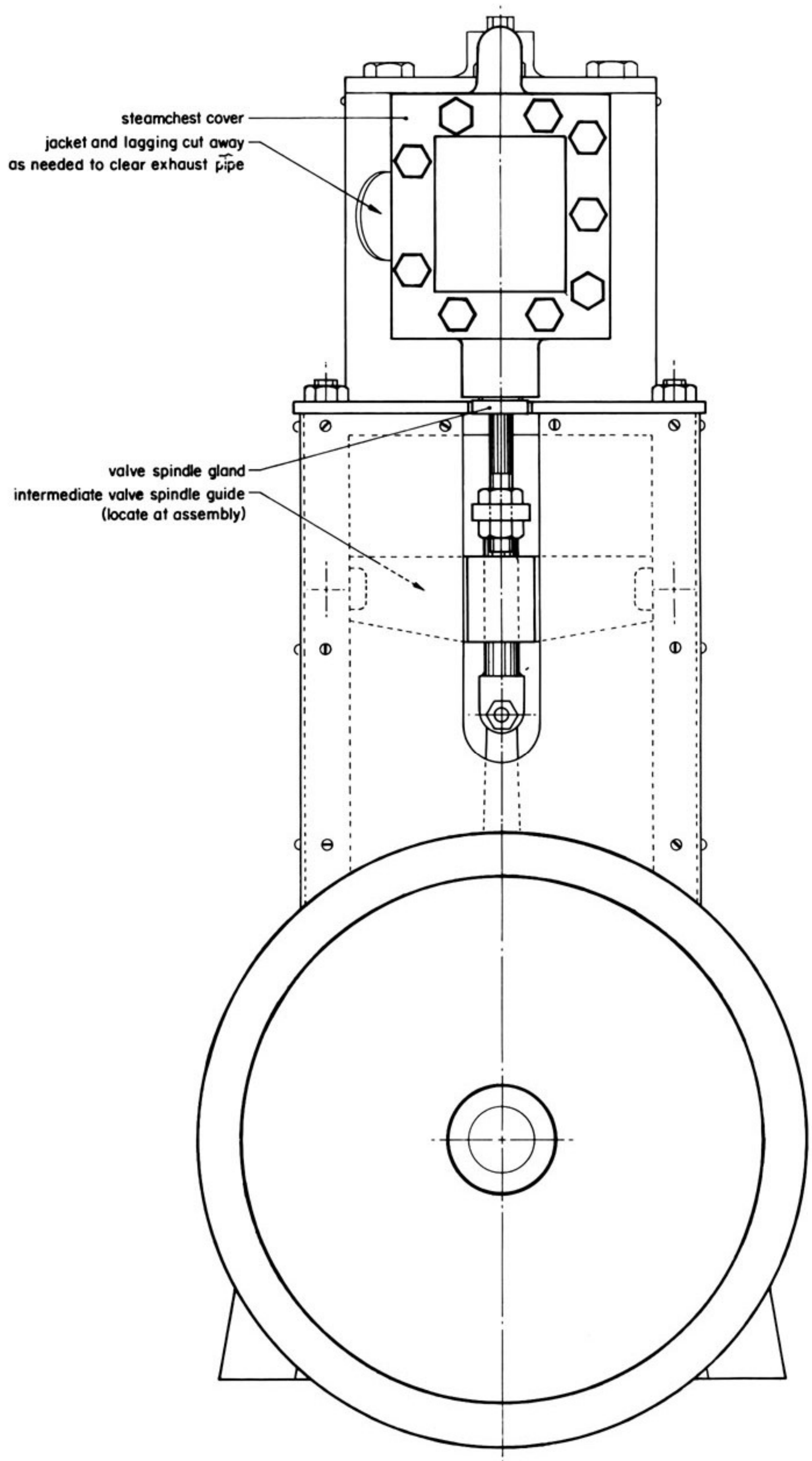
$$\frac{\text{pressure x area x length x number of strokes}}{33{,}000}$$

or, in the case of this particular engine,

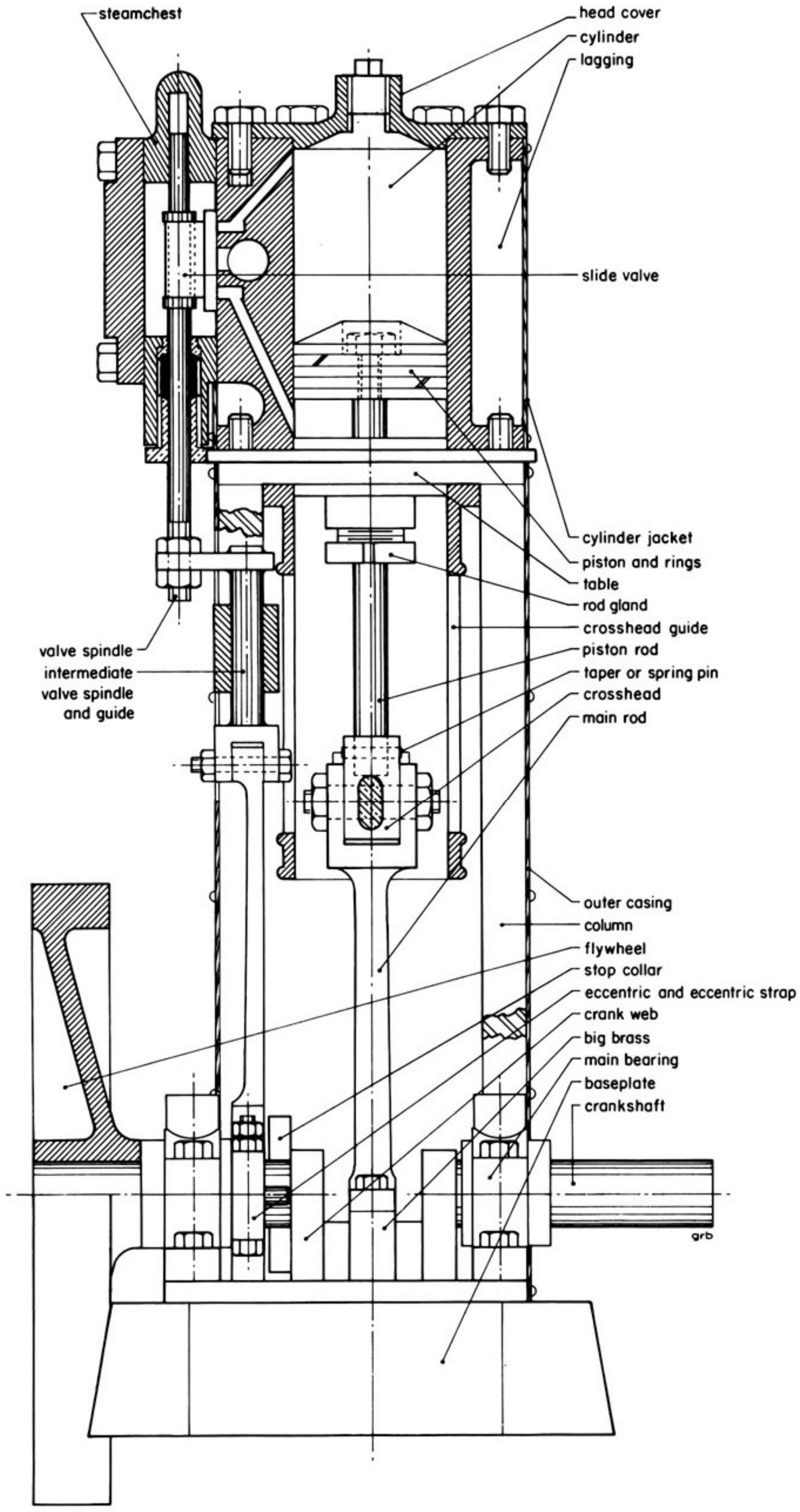
$$\frac{35 \times 2.4 \times 2.5 \times 400 \times 2}{12 \times 33{,}000} = 0.424 \text{ IHP.}$$

If the pressure can be pushed up a little, the half horsepower designed as a maximum can be obtained easily, as the speed will go up quite a lot with a small increase in mean pressure.

Another point about the job is that the engine should be simple to make. There must be no castings bigger than can be machined in the lathes usually found in the average Amateur Machinist's home work-



FLYWHEEL END



SIDE SECTION

shop. The crankcase should be enclosed so that oil may be confined to the bed of the engine and not splash about all over your boots, but at the same time, it is highly desirable that the casing be removable readily in case any adjustments to the normally-hidden machinery are necessary.

Further, it is essential that the reversing gear be as simple as possible. Nothing is as likely to go wrong or to wear so quickly that it is in danger of falling to pieces as a finnicky link motion, full of small pins and innumerable highly-stressed joints. Therefore, I have proposed for this small engine a robust slip eccentric reverse gear, the sort that will outlast all others and at the same time, give a perfect steam distribution in both directions of rotation. To reverse the engine, all that is necessary for the engineer to do is to shut off the main stop-valve and on the engine coming to rest, grab the flywheel and spin it in the opposite direction of rotation. Turning on the steam again will make the engine continue to operate in the reversed way, until the reversing process is repeated.

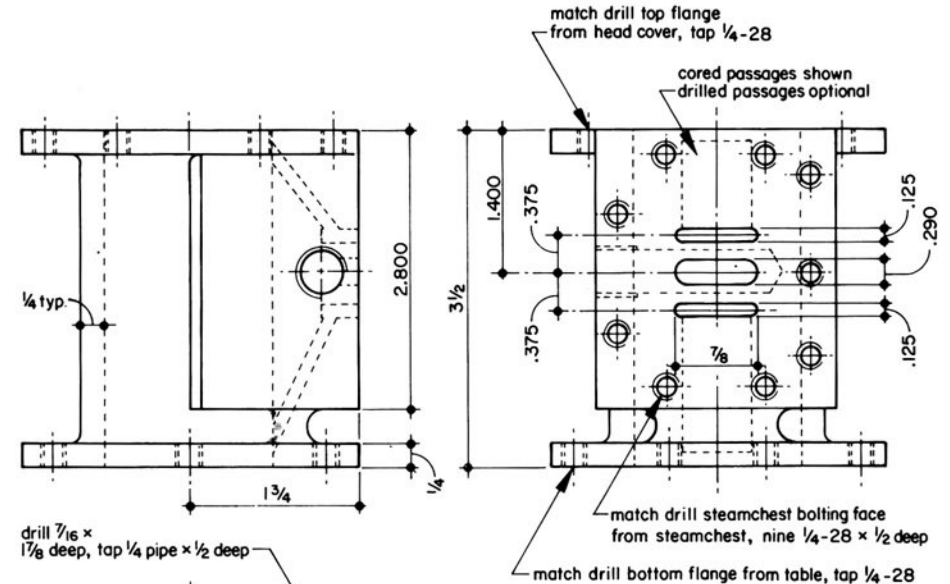
The following is a brief set of specifications and an outline which will assist you in construction of your engine.

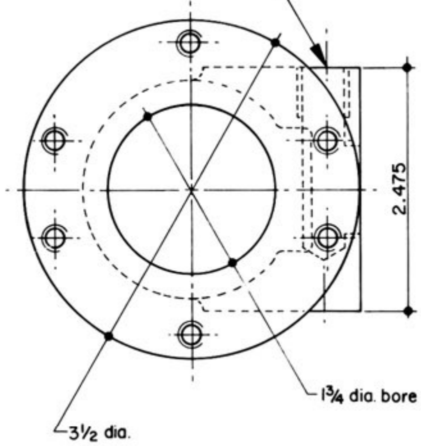
The **CYLINDER** is of cast iron, 1¾″ bore x 2½″ stroke. When finished, it is complete in itself with the added steam chests and bored crosshead guide standing on the four columns.

The **STEAMCHEST** is a separate casting (or fabrication) studded onto the cylinder, the studs being extended to attach the steamchest cover. This makes the valve facing and ports in the cylinder plain, straightforward jobs. There is no endmilling into recesses. Castings or component parts are relatively small. Thus, if you should happen to "muck up" any drilling, surfacing or boring operation with this cylinder and steamchest, there is not much work scrapped.

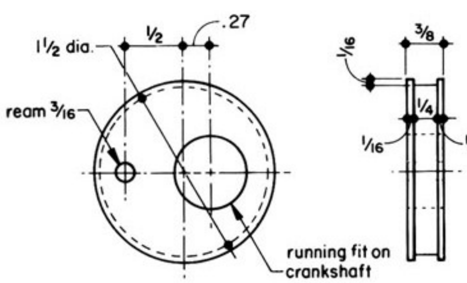
All passages are drilled in the cylinder casting and if an endmilling attachment to the lathe is not available, the ports may be formed by drilling and chipping.

The **SLIDE VALVE** and **VALVE SPINDLE** are simple jobs. A plain D-valve is used in gunmetal or hard bronze. It is slotted at the back and driven by the spindle, which has two collars turned on it out of the solid. To enable this spindle to be entered into the steam chest, the stuffing box is drilled and tapped with a ½″ dia-

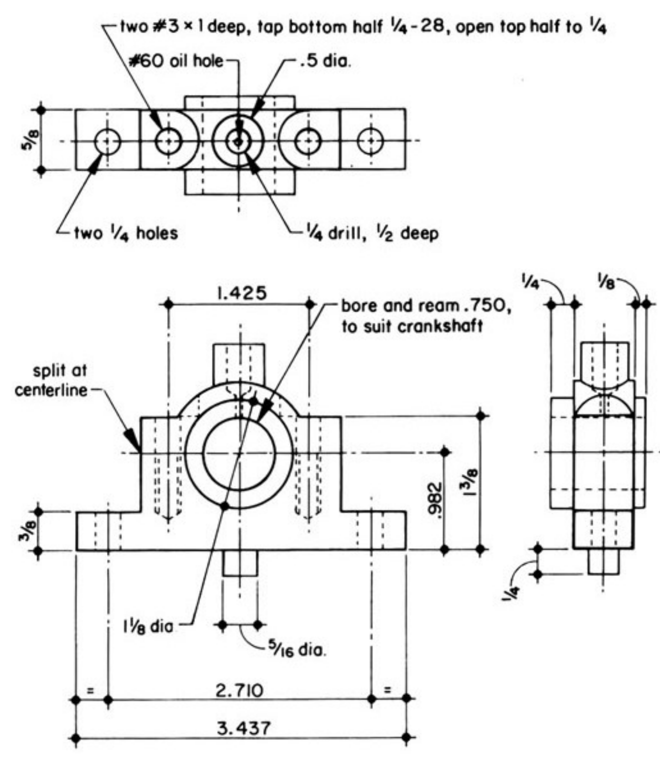




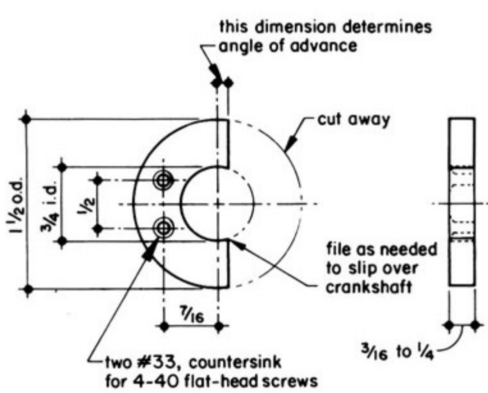
CYLINDER
Cast Iron, 1 required



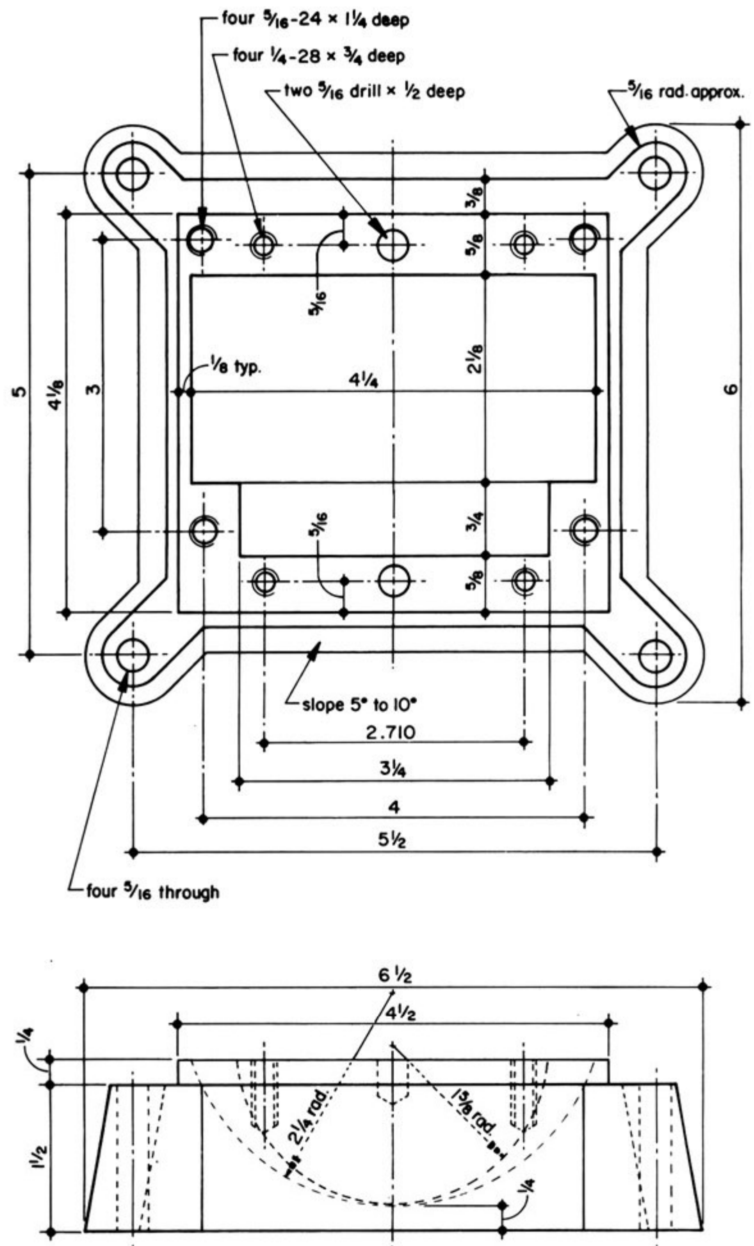
ECCENTRIC
Steel, 1 required



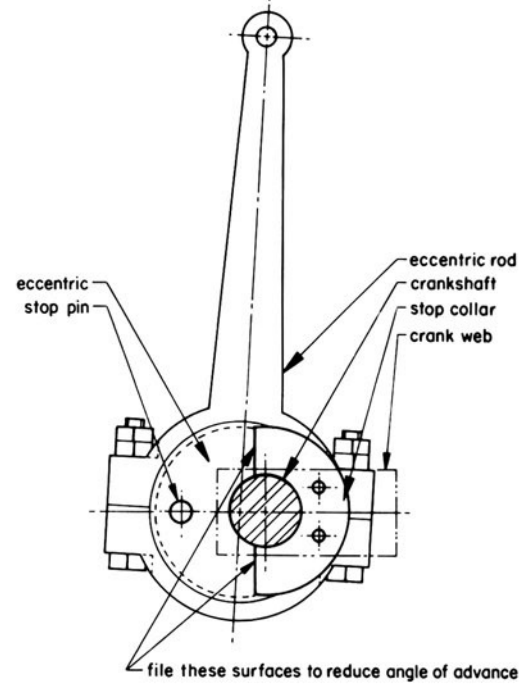
MAIN BEARING
Bronze, 2 required



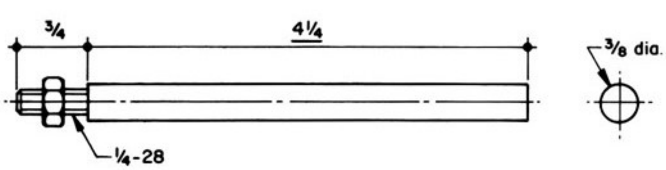
STOP COLLAR
Steel, 1 required



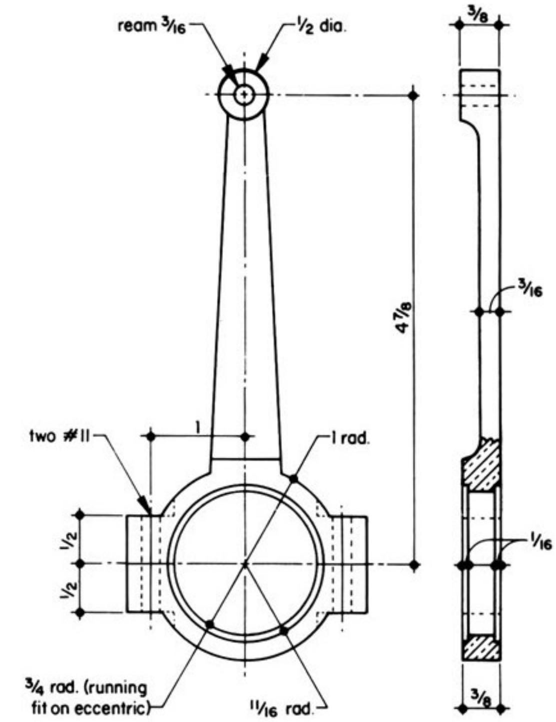
BASEPLATE
Cast Iron, 1 required



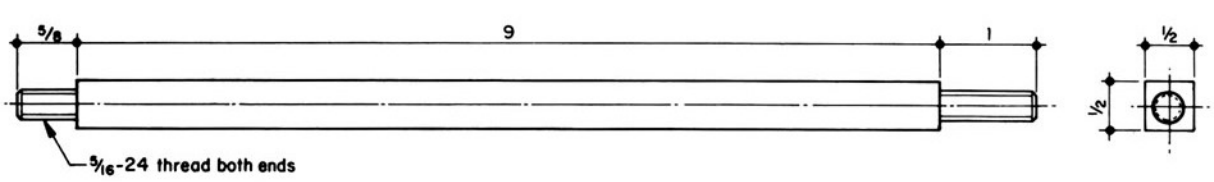
REVERSE GEAR ARRANGEMENT



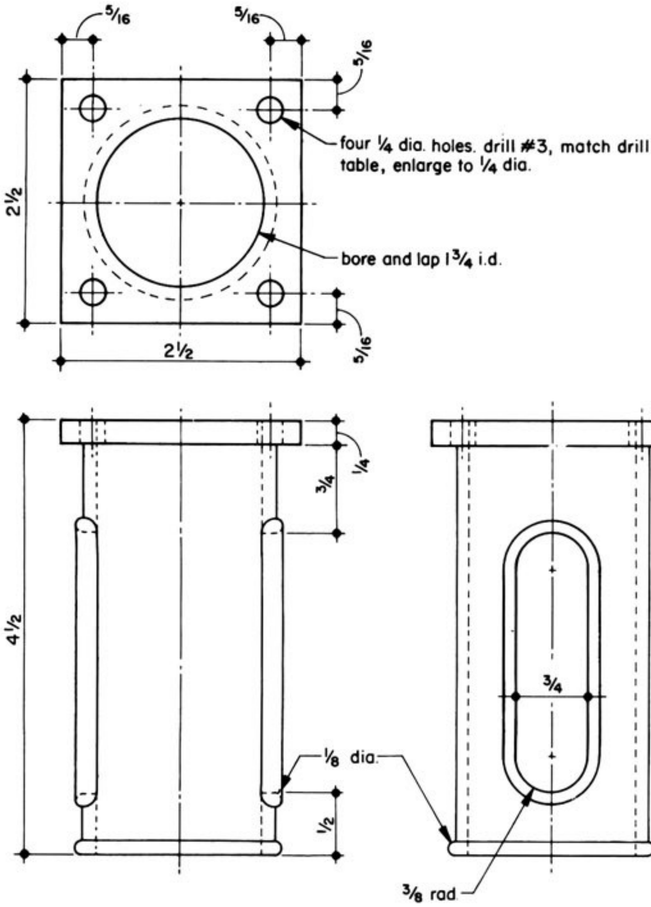
PISTON ROD
Drill Rod, 1 required



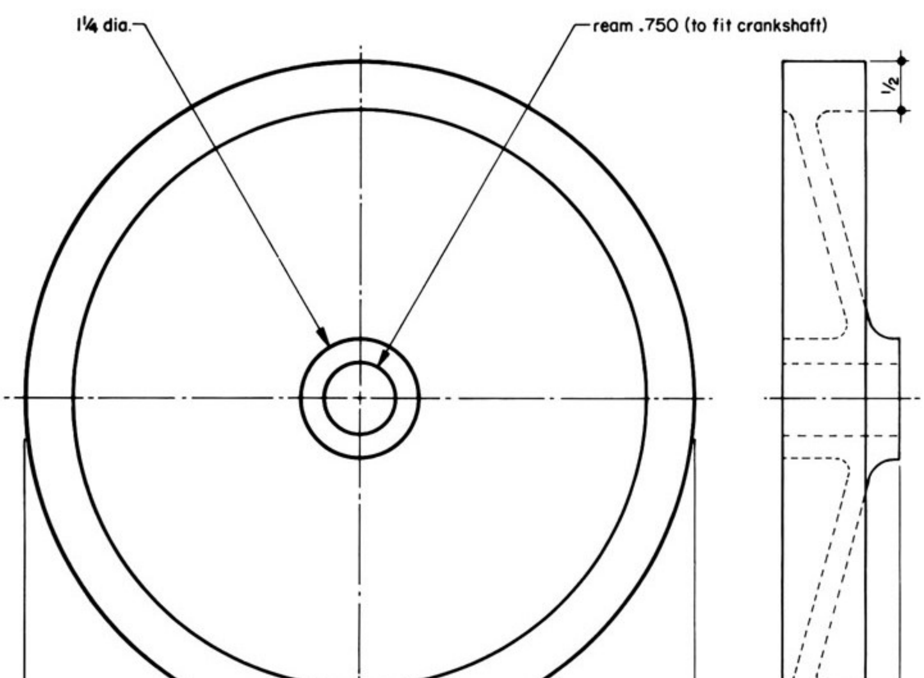
ECCENTRIC STRAP AND ROD
Bronze, 1 required



COLUMN
Steel, 4 required



CROSSHEAD GUIDE
Cast Iron, 1 required



FLYWHEEL
Cast Iron, 1 required

meter fine thread and a brass gland plug small enough to clear the threads is driven into the bottom of the box after the spindle has been entered. The gland plug seats in a 3/8″ diameter hole.

The **PISTON** is lightened out as much as possible to reduce out-of-balance effects at high speed. The rings should be obtainable from commercial suppliers or any dealer handling small internal combustion engine rings.

The **PISTON ROD** should be marked off to the correct length on the job, after preliminary erecting.

Threaded **GLANDS** are recommended for the valve spindle and piston rod, but they must be machined and screw-cut true to their respective bores.

The **CROSSHEAD GUIDE** is circular and bored for the crosshead. It fits on a spigot formed on the underside of the lower cylinder cover, or table.

The **TABLE** is a square casting or fabrication, spigoted on the top for the cylinder bore and on the bottom for the crosshead bore. It should be noted that the bottom cylinder flange will have to be drilled differently from the top, in order to take the countersunk screws which attach the cover to the cylinder. Holes are also required in the corners of the table for the columns.

These four **COLUMNS** are 1/2″ square steel rods, turned down at each end. There is no real objection to round rods, except that square rods make the sheet steel outer casing easier to fit up.

The **BASEPLATE** looks like an intricate casting from the drawing, but once the pattern is made, it is an easy job to face and drill for the columns and main bearings. The facing can be done in the lathe. A fabricated baseplate would also be practical.

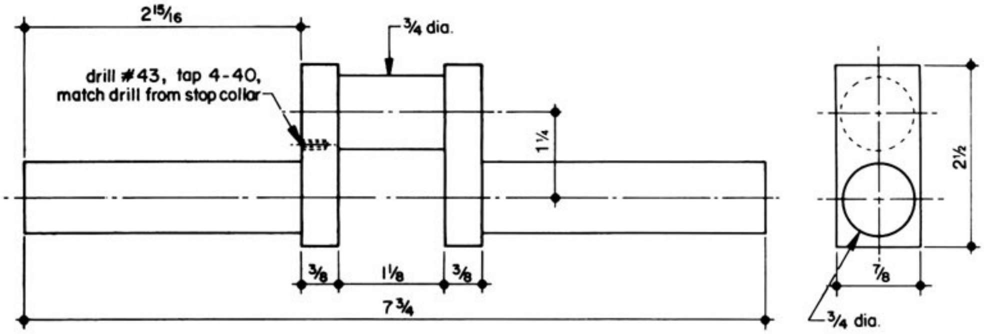
Cast gunmetal is used for the **MAIN BEARINGS**, which can be machined all over in the lathe. There is a little locating spigot on the bottom which is formed during the facing operation and fits into a drilled hole in the base casting.

Turn the **CRANKSHAFT** from 2¼″ x 1″ bar steel. Machine it all over after first removing the superfluous material by drilling and a hacksaw. Be sure to leave some lugs in the end of the crankshaft, so you will have a place to drill center holes for turning the crankpin. These will be removed when the shaft itself is turned.

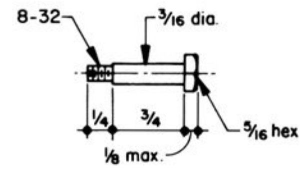
The eccentric has a short, carbon-steel pin fixed in one side. This will be driven by a washer-like **STOP COLLAR** which is fixed to the outside of the crank web by one or two small countersunk screws. This washer should be completely circular at the outset and have nearly half sawn off. The fixing of the collar should be such that the eccentric moves equally on each side of the crankpin centerline. This accuracy can be insured by leaving plenty of metal on the flatted edge of the washer and removing this contact face by filing or scraping when making the final adjustments to the valve gear.

The **MAIN ROD** is made in two pieces, a steel rod and a split gunmetal **BIG BRASS**. The bearing bolts, being necessarily small, should be of good stuff. They are kept small to reduce out-of-balance effects and to clear the crankcase.

The **CROSSHEAD** may be made of cast gunmetal and if more than one engine is being made, they can be cast and machined in pairs.



CRANKSHAFT
Steel, 1 required



ECCENTRIC ROD PIN
Steel, 1 required

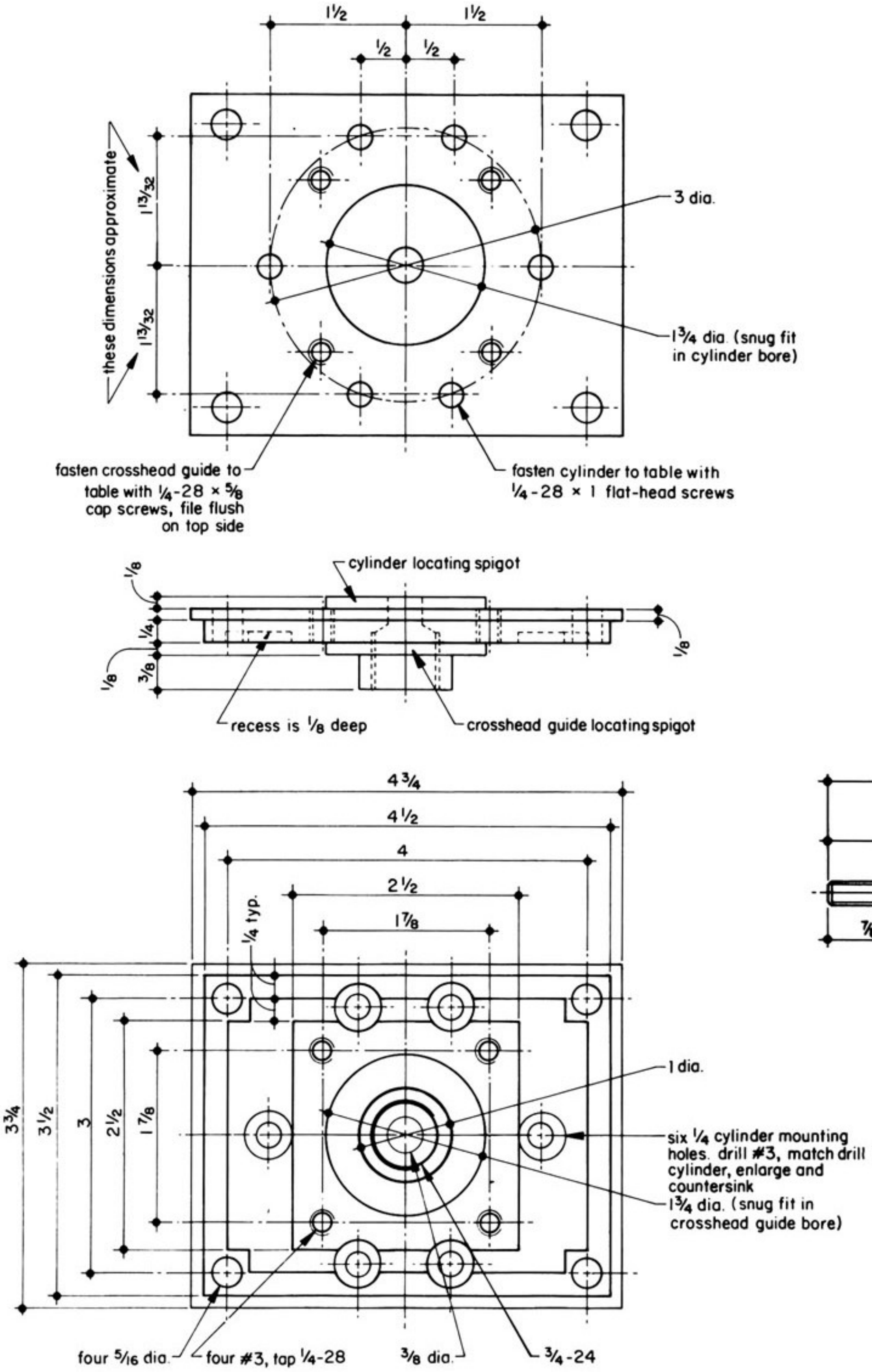
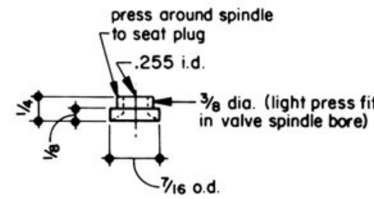
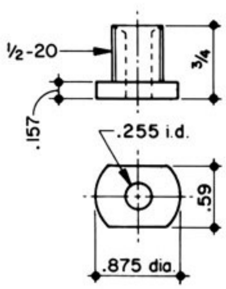


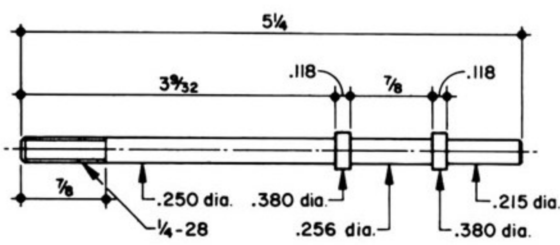
TABLE
Cast Iron, 1 required



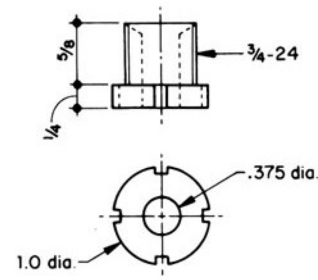
GLAND PLUG
Bronze, 1 required



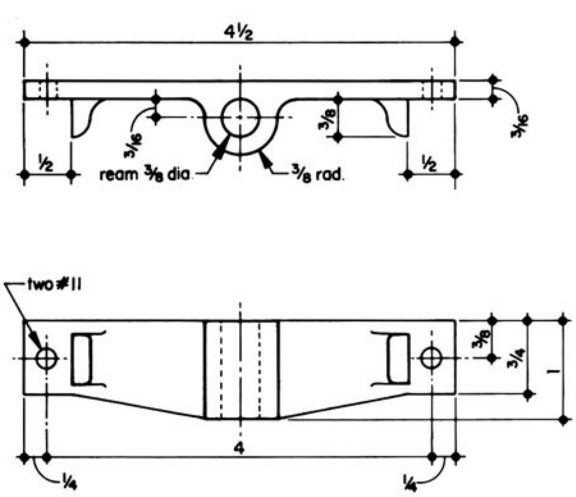
VALVE GLAND
Bronze, 1 required



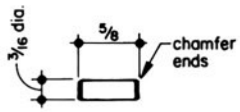
VALVE SPINDLE
Steel, 1 required



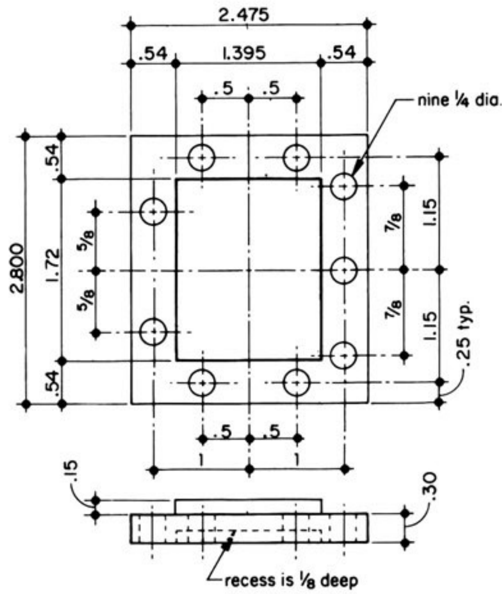
ROD GLAND
Bronze, 1 required



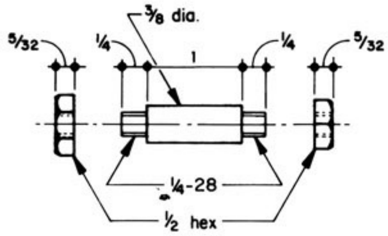
INTERMEDIATE VALVE SPINDLE GUIDE
Cast Iron or Bronze, 1 required



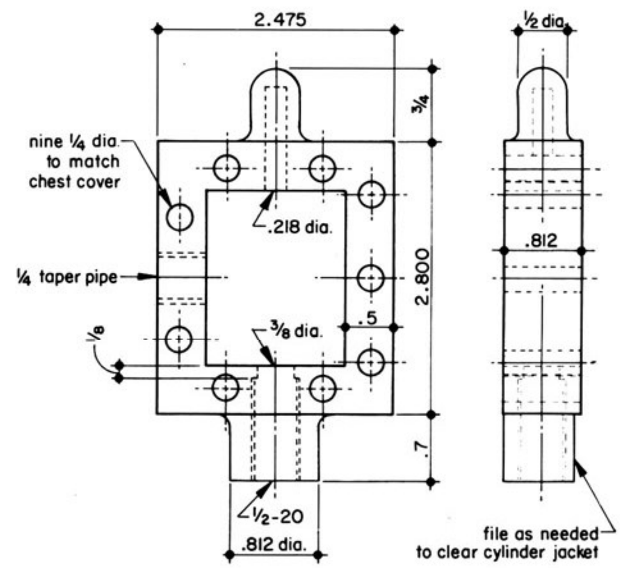
STOP PIN
Steel, 1 required



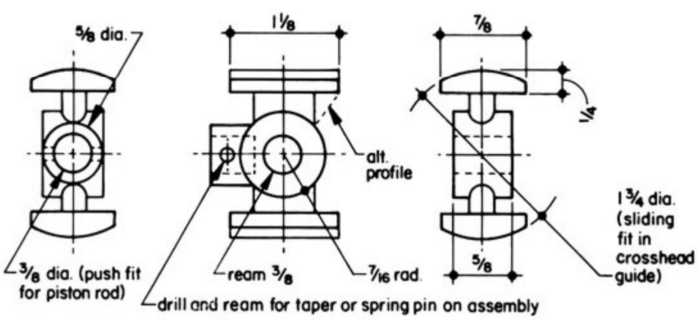
STEAMCHEST COVER
Cast Iron, 1 required



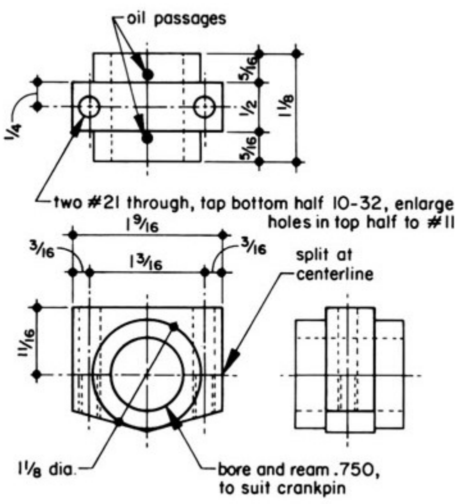
CROSSHEAD PIN AND NUTS
Steel, 1 Pin and 2 Nuts required



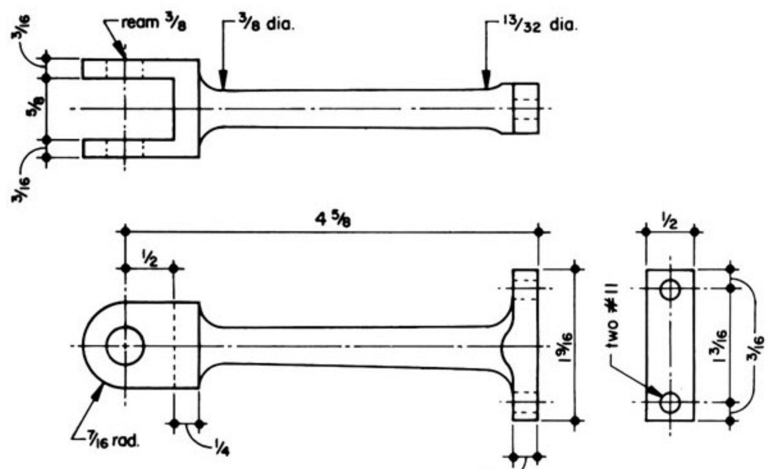
STEAMCHEST
Cast Iron, 1 required



CROSSHEAD
Bronze, 1 required



BIG BRASS
Bronze, 1 required



MAIN ROD
Steel, 1 required

The **ECCENTRIC** is of steel, loose on the shaft, and the **ECCENTRIC STRAP** is cast or fabricated integral with the eccentric rod. The sheaves themselves are split and jointed up again during the machining operations. Gunmetal or a hard bronze would be suitable.

The top end of the eccentric rod engages the forked **INTERMEDIATE VALVE SPINDLE**, which has a lug riveted or brazed on it to bracket the motion out to the valve spindle. This intermediate valve spindle is carried by the cast **INTERMEDIATE VALVE SPINDLE GUIDE**, which is attached to the columns by small screws.

The **FLYWHEEL** is of cast iron and should be turned up quite true to 7″ diameter. To balance the piston, several blind holes may be drilled in the rim. The exact number is a matter of experiment.

If the drive is taken off at the back of the engine, the flywheel need not be drilled and tapped for any coupling bolts. The shaft extends far enough at the back end to allow the fixing of a flexible coupling. This can be made from a pair of flanged fittings with a disk of ¼″ boot-sole leather between the lugs of the couplings, these being crossed on each other at a 90° angle to provide the necessary flexibility.

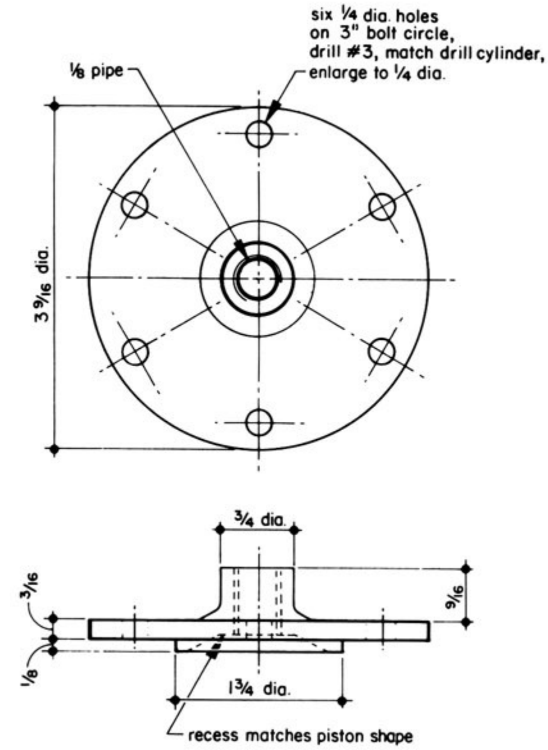
The outer casing enclosing the crank and machinery is not detailed as a separate drawing, since it must be fitted carefully to place. Make it from 16-gauge Brown and Sharpe or 18-gauge American Standard (.05″) sheet steel, screwed onto the columns with round-headed screws. The casing must be cut away where necessary to allow the intermediate valve spindle and guide to poke through. On the eccentric end of the engine, the sides of the casing may be bent to enclose the bearings, if desired, and the back sheet bent to conform with the outline of the sides. The casing sheets also can carry oil boxes for the main bearings, big brasses, crosshead guides and crosshead. As many as the engineer finds convenient may be added.

The cylinder should be lagged with asbestos yarn and jacketed with sheet steel.

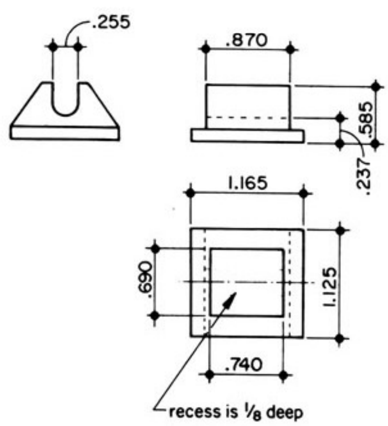
A Roscoe lubricator is advised on the main steam pipe, but give the engine a gulp of cylinder oil at the start. The top cover can be bored for an easily removable plug. In a Roscoe displacement lubricator, the oil outlet to the steam pipe is at the top of the chamber and should be a quite small hole, about 1/32″ maximum. Right on top of the oiler is a large filling plug and at the bottom, a drain cock is required. The steam condenses in the lubricator and displaces an atom of oil until it becomes full of water. This can be drained off and the lubricator replenished with oil. (Steam must be off for this operation.) A suitable lubricator for this engine is one that can hold about 3 cubic inches of oil. Thick cylinder oil should be used for this accessory, not the engine oil used for the running bearings.

Cylinder drains should be provided on the front or side of the cylinder, as desired. In the best-made engines, the outlets from the cocks are generally led down the sides to the bilges.

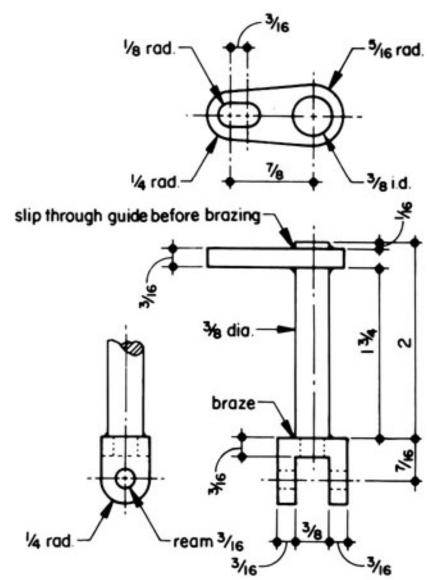
One final comment, for pipes and glands, where 26 threads per inch is specified, 28, 32 or 40 threads may be used, depending on which is the most convenient to thread or tap with the tools available in the Amateur Machinist's workshop.



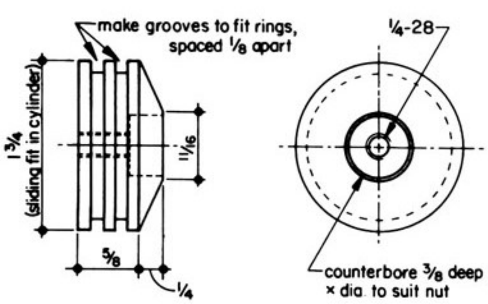
HEAD COVER
Cast Iron, 1 required



SLIDE VALVE
Bronze, 1 required



INTERMEDIATE
VALVE SPINDLE
Steel, 1 required



PISTON
Cast Iron, 1 required