

#### **XIV. A SIMPLE RECIPROCATING ENGINE.**

Figs. 51 and 52 illustrate a very simple form of fixed-cylinder engine controlled by a slide valve.

An open-ended "trunk" piston, similar in principle to that used in gas engines, is employed; and the valve is of the piston type, which is less complicated than the box form of valve, though less easily made steam-tight in small sizes. The engine is single-acting, making only one power stroke per revolution.

The cylinder is a piece of brass tubing; the piston another piece of tubing, fitting the first telescopically. Provided that the fit is true enough to prevent the escape of steam, while not so close as to set up excessive friction, a packing behind the piston is not needed; but should serious leakage be anticipated, a packing of thick felt or cloth, held up by a washer and nuts on the gudgeon G, will make things secure. Similarly for the built-up piston valve P may be substituted a piece of close-fitting brass rod with diameter reduced, except at the ends, by filing or turning, to allow the passage of steam.

**CONSTRUCTION.**

The *bed* is made of wood, preferably oak, into the parts of which linseed oil is well rubbed before they

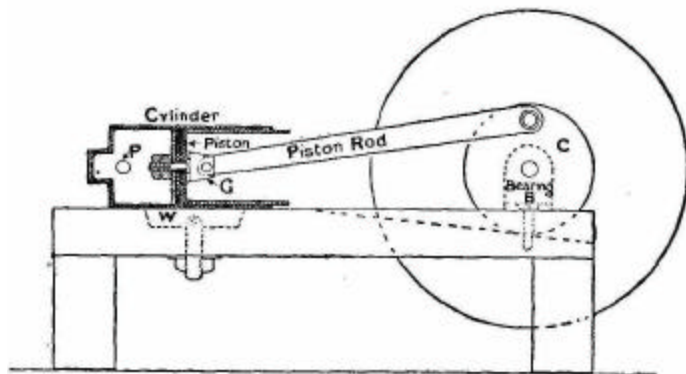


FIG. 51.—Elevation of simple reciprocating steam engine.

FIG. 51. -- Elevation of simple reciprocating steam engine.

are screwed together, to prevent the entry of water. A longitudinal groove is sawn in the top of the bed, as indicated by the dotted line in Fig. 51, to give room for the connecting rod in its lowest position, and a cross groove is scooped in line with the crank shaft to accommodate the lower part of the crank disc and the big end of the rod. (If the wing W under the

cylinder is screwed to the side of the bed, instead of passing through it, as shown, a slight cutting away of the edge will give the necessary clearance in both cases. )

The *cylinder* and *valve tube* A should be flattened by filing and rubbing on emery cloth, so that they may bed snugly against one another and give a good holding surface for the solder. A steam port, S P, should

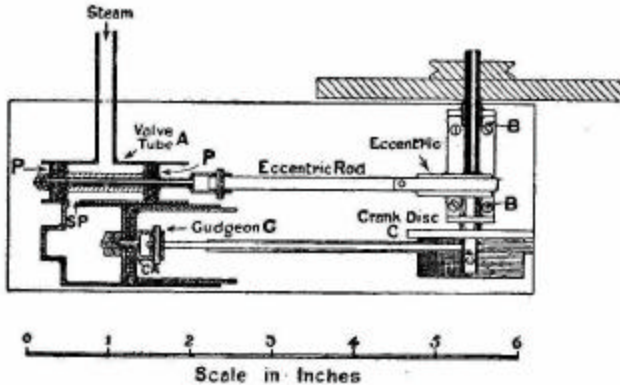


FIG. 52.—Plan of simple reciprocating steam engine.

FIG. 52. -- Plan of simple reciprocating steam engine.

next be bored in each, and the "burr" of the edges cleaned off carefully so as not to obstruct valve or piston in the slightest degree. "Tin" the contact surfaces thinly, and after laying valve tube and cylinder in line, with the portholes corresponding exactly, bind them tightly together with a turn or two of wire, or

hold them lightly in a vice, while the solder is made to run again with the aid of a spirit lamp. If it seems necessary, run a little extra solder along the joint, both sides, and at the ends.

The *valve*, if built up, consists of a central rod, threaded at the rear end, four washers which fit the tube, and a central spacing-piece. The forward washer is soldered to the rod. Behind this is placed a felt packing. Then come in order the central spacing-piece, with a washer soldered to each end, a second packing, and a fourth washer. The series is completed by an adjusting nut to squeeze the packings, and a lock nut to prevent slipping. The back end of the valve must be wide enough to just more than cover the steam port. If the felt proves difficult to procure or fit, one may use a ring or two of brass tubing, with an external packing of asbestos cord.

The cylinder *wing* W should have the top edge turned over for an eighth of an inch or so to give a good bearing against the cylinder, and be held in position by a wire while the soldering is done. It is important that the line of the wing should be at right angles to a line passing through the centres of the valve tube and cylinder.

**Shaft Bearings.** -- Take a piece of strip brass half an

inch or so wide and 3-1/2 inches long. Bore four holes for screws, and scratch cross lines an inch from each extremity. Turn up the ends at these lines at right angles to the central part, stand the piece on some flat surface, and on the outer faces of the uprights scratch two cross lines at the height of the centre of the cylinder above the bed. Mark the central points of these lines.

Next select a piece of brass tubing which fits the rod chosen for the crank shaft, and bore in the bearing standards two holes to fit this tubing. Slip the tubing through the standards and solder it to them. The ends and central parts of the tubing must now be so cut away as to leave two bearings, BB -- that at the fly-wheel end projecting far enough to allow the fly wheel, when brought up against it, to just clear the bed; that at the crank end being of the proper length to allow the eccentric to be in line with the valve rod, and the crank disc to occupy its proper position relatively to the central line of the cylinder. Finish off the standards by filing the tops concentrically with the bearings.

The eccentric may be built up from a metal disc about 3/4 inch diameter and two slightly larger discs soldered concentrically to the sides. The width of

the middle disc should be the same as that of the eccentric rod. A careful filer could make a passable eccentric by sinking a square or semicircular groove in the edge of a wide disc. The centre of the eccentric must be found carefully, and a point marked at a distance from it equal to half the travel of the valve. To ascertain this, pull the valve forward until the steam port is fully exposed, insert a bar at the rear end of the valve tube, and mark it. Then push the valve back until a wire pushed through the port from the cylinder side shows that the port is again fully exposed. Insert and mark the bar again. The distance between the marks gives you the "travel" required.

**Order of Assembly.** -- The following list of operations in their order may assist the beginner:

Make the bed.

Cut out cylinder barrel, piston, and valve tube.

Bevel off the ends of the last inside to allow the valve to enter easily.

Make the valve.

Bore the steam ports, and solder valve tube and cylinder together.

Solder holding-down wing, W, to cylinder.

Finish off the piston.

Solder the bearings in their standards.

Prepare shaft, crank disc, crank pin, and piston rod.

Fix the cylinder to the bed, in which a slot must be cut for the wing and holding-down bolt.

Attach the piston rod to the piston, and insert piston in cylinder.

Bore hole for shaft in centre of crank disc, and another, 9/16 inch away (centre to centre), for crank pin.

Solder in crank pin squarely to disc.

Pass shaft through bearings and slip on the crank disc.

Pass front end of piston rod over the crank pin.

Lay bearing standard on bed squarely to the centre line of the cylinder, turn crank fully back, and move the standard about till the back end of the piston clears the back end of the cylinder by about 1/32 inch.

Get standard quite square, and adjust sideways till connecting rod is in line with axis of cylinder.

Mark off and screw down the standard.

Make the eccentric, eccentric rod, and strap. Slip eccentric on shaft.

Put valve in position and draw it forward till the port is exposed.

Turn the eccentric forward, and mark the rod opposite centre of valve pin.

Bore hole for pin, and insert pin.

Hold the crank shaft firmly, and revolve eccentric till the port just begins to open on its forward stroke. Rotate crank disc on shaft till the crank pin is full forward.

Solder eccentric and disc to shaft.

Solder steam pipe to cylinder, and a brass disc to the rear end of the cylinder.

Fit a fly wheel of metal or wood. This must be fairly heavy, as it has to overcome all friction during the return or exhaust stroke.

**Action of Engine.** -- During the forward motion of the piston the valve is pushed back by the eccentric until the steam port is fully opened, and is then drawn forward, covering the port. At the end of the power stroke the port has begun to open to the air, to allow the steam to escape throughout the exhaust stroke, in the course of which the valve is pushed back until, just at the end of the stroke, the steam port begins to open again.



*Notes.* --

(1.) The connecting rod may be made shorter than shown in Figs. 51 and 52; but in that case the piston also must be shortened to allow for the greater obliquity of the rod at half-stroke.

(2.) If two opposed cylinders are made to operate the one crank, a double-acting engine is obtained. Both valves may be operated by a single eccentric, the connecting rod of one being pivoted to a small lug projecting from the eccentric strap. If *three* cylinders are set 120 degrees apart round the crank shaft, a continuous turning effect is given. This type will be found useful for running small dynamos.

(3.) If it is desired to use the exhaust steam to promote a draught in the boiler furnace, it should be led away by a small pipe from the rear end of the valve tube.