Although the horizontal type of engine has always been favoured for stationary work, the alternative direct-acting form of engine having the cylinder located vertically above the crankshaft has some advantages where floor space is limited, and is generally considered more suitable for running at high speed than the former type.

It is, of course, more common in marine practice than stationary work, but both on land and sea it has been extensively used for auxiliary purposes such as driving electrical generators, ventilating and forced draught fans, and centrifugal pumps for circulating water in condensing plant, or dock drainage.

One of the earliest engines in this general class was introduced a few years after the Nasmyth hammer made its appearance. and because of its structural similarity to the latter machine it was customary to refer to it as the "steam-hammer" type.

The salient features of such engines, an example of which is illustrated in Fig. 26, include a relatively small bedplate on which is mounted a symmetrical pair of cast columns, usually of channel or hollow-box section, and these in turn support the cylinder assembly. In outline, the structure bears a resemblance to that of a lighthouse, tapering more or less gracefully from the cylinder head to the base, to give maximum rigidity against both dead load and working stresses.

The inside faces of both the columns are flat near the top end, and have machined surfaces which serve as crosshead guides. The working parts are generally similar to those of horizontal engines, except in certain points of detail which may be influenced by their disposition and order of motion.

In one respect, this particular engine may be regarded as an anachronism, in that while its main structure follows the "steam-hammer" tradition, it is fitted with a piston valve, a feature which did not become popular until later developments, and particularly higher steam pressures, made it desirable. However, Muncaster knew steam-engine practice better than I ever shall and I would never dispute his authority over such details.

A piston valve is nothing more than a slide-valve having a circular instead of a flat face, but this alteration in shape involves characteristics which may have advantages or limitations according to circumstances. First of all, it is capable of controlling ports all round its circumference instead of over a limited width of face, and thus it can give much more rapid and efficient valve events than a normal flat valve, though this feature is not always used to full advantage.

Secondly, it is not pressed hard against the portface by the steam pressure, and therefore works with much less friction, especially where high working pressure is employed; this is perhaps its most important practical advantage.

But because of being pressure-balanced it is not self-seating, and unless it is very carefully fitted to the bore of the steam-chest or liner, it is liable to leakage, much more so than the flat valve. Many small piston-valve engines have been found less efficient than those with flat valves for this reason, especially when wear has taken place; large engines have piston rings fitted to the valve to avoid leakage, but this is hardly practicable in a model.

Thirdly, piston valves may be adapted to control steam admission either on their outer end faces (as in the case of the flat valve), or the inner faces, which would normally control exhaust events. The latter arrangement, known as "inside admission," is generally preferred as it enables the steam-chest and passage design to be simplified, though it makes no difference to efficiency so long as design is adapted to suit.

It will, of course, be clear that in this case steam lap must be provided by reducing the width of the clearance portion of the valve, corresponding with the cavity of the flat valve, and the total length of the valve must be such that it exactly covers the ports in the steam-chest, unless exhaust lap is specified-in other words, normal "line for line" exhaust timing.

Piston valves generally allow the cylinder steam passages to be made shorter and more direct, thus improving thermal efficiency by reducing the dead volume at the ends of the stroke and also the conducting surface area of the passages. They do not, however, provide the same facility for visual valve timing as the flat valve, and it is necessary to adjust their position by exact measurement in most cases.

The piston valve of the engine shown in Fig. 26 is of the inside admission type, the main steam inlet being in the centre of the steam-chest and the exhaust being taken from two ports at the extreme ends to a passage shown in the plan section BB. It is driven by a rod which passes up through a clearance hole in the centre for most of the length of the valve, thus giving a small amount of side freedom for self-centring in the gland, but the upper end is screwed into a short tapped hole and a locknut, is provided so that lateral position adjustment can be obtained.

It should be noted that for an inside admission valve the eccentric timing must be adjusted so that it trails behind the crank instead of leading it. The angle of advance, however, is still in the same direction, so that for a valve with fairly orthodox lap and lead, calling for 30 deg. angle
of advance, the setting will be $90 - 30 = 60$ deg. behind the crank in the direction of engine rotation.

Details of the piston valve and the two short half-liners, which are pressed into opposite ends of the steam-chest, are shown in Fig. 27. Three ports are shown in each of the half-liners, giving a large total area, and the sides of the ports are cut obliquely to minimise ridge formation on the valve as a result of wear. Alternatively, a greater number of round holes may be used, and personally I should favour this method.

A groove is turned in the outside of the liner to form an annular passage when it is inserted in the steam-chest. The liners must be accurately located to give the designed port timing in conjunction with the valve dimensions. A stainless steel valve with bronze liners is recommended.

**MAIN COLUMNS**

In order to ensure accuracy in cylinder location and guide alignment, I recommend that the columns should first be machined on the guide faces and then clamped together for facing the top and bottom surfaces. When erecting the columns, they should first be bolted to the bedplate with a gauge block between the guides to locate them the correct distance apart. To locate the cylinder, the machined crosshead, or a dummy made to the same dimensions, may be fitted to the piston-rod to ensure correct alignment.

If straightforward machining methods are used accuracy should be positive, but it is not advisable to take anything for granted and routine checks should be made at all stages of assembly!

**SINGLE-COLUMN VERTICAL ENGINE**

The "steam-hammer" type of engine is suited equally well for running in either direction, as the crosshead guides are symmetrical and of equal bearing area each side; but this is but rarely called for in stationary work. Even marine engines do not often run for very long periods in the reverse direction. In such cases, a lighter but quite adequate form of structure can be adopted in which only one cast column is employed, and the crosshead is of the slipper type, having its major bearing surface on the soleplate, which slides on the face of the column.

An engine of this type is illustrated in Fig. 28. It is intended to run in a clockwise direction, looking at the end of the shaft as seen in the right-hand elevation. Note that when the piston is on the up-stroke, the thrust, which is tending to straighten out the piston rod and connecting rod linkage, presses the crosshead against the column; but on the down-stroke, the tendency is to increase the angularity of the linkage and thus the crosshead is still pressed against the column.

If the engine rotation is reversed, the side thrust on both strokes is in the opposite direction so that the crosshead will pull away from the column and bear against the keep plates, which are of much smaller surface area than the column face, besides having to rely on their retaining studs for security.
As the offset support of the cylinder by a single cast column leaves the structure somewhat weak to resist alternate upward and downward stresses, the opposite side is stayed by means of a single machined steel column (sometimes more than one is used) which, though light in section, has greater inherent strength than cast iron. As this is usually somewhat out of the vertical plane, both its length and the angle of its seating at both ends must be carefully adjusted to hold the cylinder assembly exactly perpendicular.

This drawing does not show the interior details of the cylinder, but these may be similar to the previous design, using either a flat slide or a piston valve. It is fitted with a governor, mounted directly on the shaft and acting on the engine throttle valve. The rather unusual position of the eccentric, immediately adjacent to the flywheel, avoids excessive projection of the shaft at the governor end. Engines similar to this have been used extensively for driving dynamos, though they were superseded by enclosed engines in later years.

**Brickbat department**

To those readers who, despite my explanations in the March 7 issue, have chastised me for not giving complete details with full dimensions of all these engine designs, I would like to point out that the drawings are copied as exactly as possible from Muncaster's original published designs, and this is what has been asked for by many readers over a period of several years.

The descriptive matter is my own, but if I attempt to amplify the drawings in any way their individuality will be lost; in any case, the amount of work involved and the space occupied would be out of proportion to the popular appeal, which is bound to be specialised to some extent.

The value of Muncaster's designs lies in his genius for adapting typical examples of all kinds of full-size engines to reproduction in miniature while retaining true prototype character; exact details are of lesser importance, but my previous articles on steam-engine construction should make up any deficiencies in this respect.

To be continued

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**GUIDE FOR MAKING SMALL WIRE SPRINGS**

The simple arrangement shown below enables a short run of wire springs to be made without having recourse to normal spring-making machinery.

A wooden block, A, has a handle and several holes of different diameter, C, drilled through into the V-shaped opening. The wire, Br is then threaded through the appropriate hole, passed under a core rod, E, and secured in a chuck carrying the rod. The diameter of the rod is chosen to suit the internal diameter of spring required.

After making the wire taut and completing a few turns by manipulating the wooden tool, the core rod is rotated mechanically until the correct length of spring is reached. The spring is of the closed variety, but by driving a pin or nail through one of the holes, D, open springs can be made with spacing as desired.

The holes, C, will probably wear out quickly so that the wooden tool may need frequent replacement.

Digested from "A Device for Forming Small Lots of Wire Springs," in "Wire Industry," 1956 (October) page 921. The illustration is reproduced by courtesy of the publishers.