

In this arrangement, to a crank 1 (or its equivalent) on a driving-shaft 2 is attached a connecting-rod 3, jointed by a vertically-guided rod 3a to a cylinder 4, so that when the crank revolves the cylinder will be moved up and down in a straight line. Within the cylinder is a piston 5, the rod 6 of which passes through the cylinder-bottom and a stuffing-box 7, and constitutes the stem to which the stamp-head 8 is attached. At a distance above the bottom of the cylinder 4 there is a port 9, which communicates with a chamber 10 that is also in communication with the cylinder above the piston through a port 11. The cylinder below the lower port 9 is filled with liquid 12—for example, water—and the chamber 10 also contains liquid 12a, above which is an air-space 13. With this arrangement, when the bottom of the piston 5 closes the lower port 9, and the cylinder moves upwards, the piston 5 and stamp-head 8 will be supported by the cushion or buffer of the liquid 12, and if none of this escapes, and the strokes of the cylinder 4 per minute do not exceed the maximum number which the stamp-head 8 could make under the action of gravity *minus* the loss through friction, then, if the stroke of the stamp-head is equal to the stroke of the cylinder, the position of the piston 5 within the cylinder 4 will remain constant, and the liquid 12 will be practically undisturbed.

If, however, the strokes of the cylinder 4 are increased in number in a given time beyond the number of possible strokes of the stamp-head 8 due to gravity alone *minus* friction, and if the lengths of the strokes of the stamp-head and the cylinder are equal, then, the velocity of the cylinder in the early part of its stroke being, in consequence of the cylinder being driven from a crank-pin, in excess of the velocity of the falling weight due to gravity *minus* friction, it follows that the friction between the piston 5 and the wall of the cylinder 4, as well as between the packing in the stuffing-box 7 and the piston-rod 6, will increase the velocity of the falling stamp-head up to the point of synchronism—that is to say, up to the point where cylinder and stamp-head move at the same velocity; consequently, for all parts of the full stroke up to that point the velocity acquired by the stamp-head will be increased.

By increasing the length of the stroke of the cylinder beyond the length of the full stroke of the stamp-head the increased velocity imparted to the stamp-head will be still further increased. In the case of an 8 in. stroke of cylinder and a 7 in. stroke of piston and stamp-head, at the end of the down-stroke of each the position of the bottom of the piston would be higher in the cylinder than the point of cut-off, thus establishing communication between the cylinder 4 and the chamber 10 through the port 9, and allowing any deficiency of liquid through leakage or otherwise to be made up, and at the same time compensating automatically for the wearing of the shoe and die. When the stamp-head is prevented from making its full stroke by the ore in the crushing-box 14, then the piston will be still higher within the cylinder at the end of the stroke of the latter by a proportionate distance, and the volume of liquid below the piston in the cylinder will be increased. On the upstroke of the cylinder the surplus liquid will flow back into the chamber until the cut-off position is reached—that is to say, until the lower edge of the port passes the lower edge of the piston, and so closes the port, thereby reducing the shock at the point from which the piston and stamp-head are raised. To further aid in reducing the shock, the port 9 may advantageously be made of V-shape, the smallest end of the port being at the bottom.

It will be seen, therefore, that the differential motions of the cylinder and of the piston, particularly when the stroke of the cylinder is greater than the stroke of the piston, is such that a considerable increase in the number of strokes per minute can be obtained beyond those which are obtainable with the ordinary cam construction, by reason not only of the reduced friction of mechanism, but also by the assisting effect of the friction between the wall of the cylinder 4 and the piston 5, and between the packing in the stuffing-box 7 and the rod 6. It will be obvious that to obtain the greatest number of blows in a given time with this arrangement the rate of rotation of the driving-shaft 2 must be such that the velocity of the cylinder 4 in the down-stroke shall not be less than the possible velocity of the piston due to gravity *minus* friction. The retarding effect of friction to the downward movement of the stamp-head may be eliminated altogether by surrounding the piston-rod 6 with a sleeve 15 connected to the cylinder, and arranged to work in the fixed transverse guide 16, through which the said rod ordinarily works. By this means the friction of the guide will be transferred from the falling rod to the positively-driven sleeve.

The cylinder 4 may be guided vertically in its movements by providing it with extensions 17 arranged to work on a guide-rod 18 fixed to the upper and lower transverse guides 16a, 16 that form part of the framing of the apparatus.

In order to minimise the leakage of liquid from the cylinder 4 through the stuffing-box 7, the latter may be fitted with a gland 19, formed with an annular recess 20 into which any liquid passing down the rod will flow, and whence it can pass back into the chamber 10 by a passage 21 and pipe 22. The tightness of the gland 19 may in this case be insured by a supplementary gland 23, which may conveniently be formed in one with the sleeve 15.

The chamber 10 may be arranged behind the cylinder 4, and, as will be seen from the drawings, can be made of a capacity which will admit of the apparatus being applied in connection with the stamp-heads of existing stamp-batteries, and which are usually pitched at a distance apart of about 10 in. from centre to centre. Figure 3 shows the apparatus applied in connection with a stamp-battery containing ten stamp-heads. The applicability of the apparatus to existing stamp-batteries is a feature of considerable practical importance.

Any suitable means may be employed for imparting an intermittent rotary movement to the stamp-head when desired. Figure 4 is an elevation, and Figure 5 a plan in section, showing an arrangement for this purpose, in which there is provided in connection with a toothed wheel 24 fixed on the rod 6 a pawl 25, carried by a bracket 26, the arrangement being such that the wheel 24 will engage the pawl 25 on the upstroke, and the pawl, turning upon the centre 25*, will revolve the piston-rod by means of the attached wheel 24 through a small portion of a revolution.