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Patented Oct. 17, 1899.

R. M. SCOTT & A. GOODSIR.  
APPARATUS FOR DRILLING ROCK.

(Application filed Dec. 17, 1897.)

(No Model.)

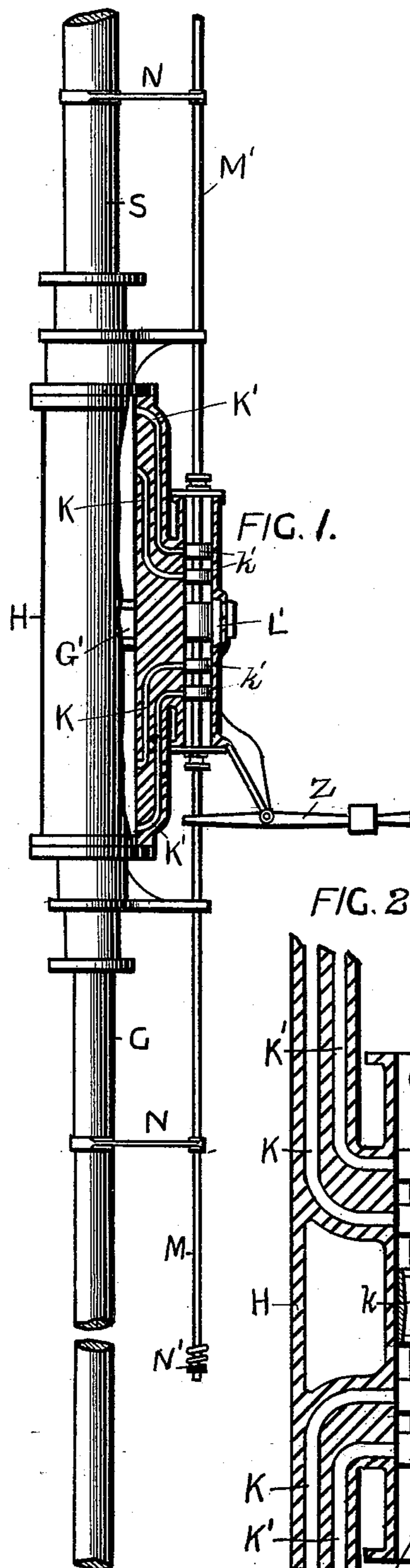
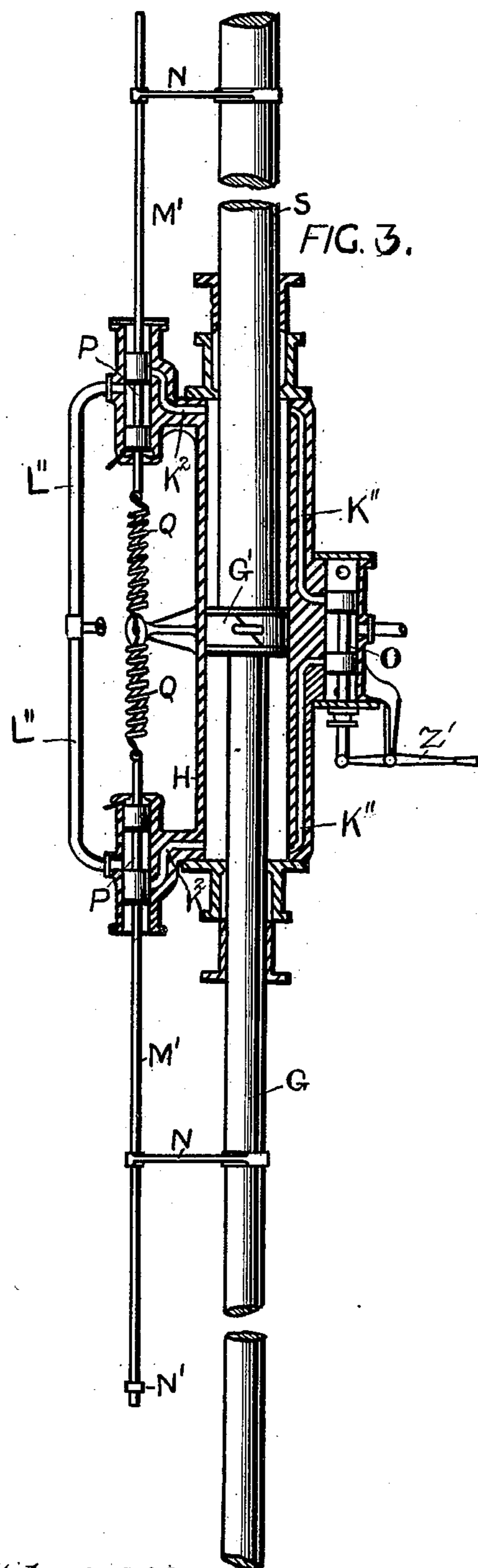
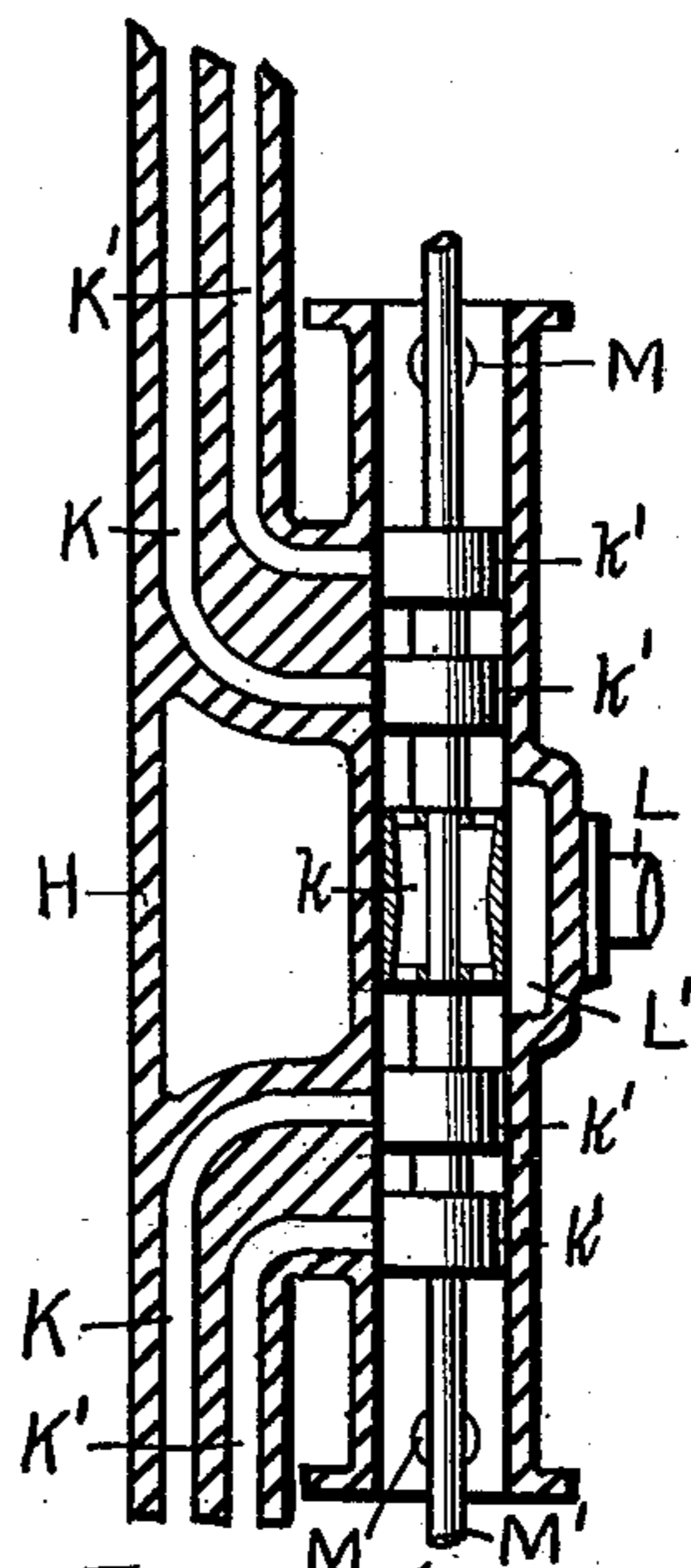


FIG. 1.

FIG. 2.



Witnesses

S. C. Edmonston.  
Chas. E. Rindon

Inventors  
R. M. Scott and A. Goodsir.  
By Julian C. Dwyer  
Att'y

# UNITED STATES PATENT OFFICE.

ROBERT M. SCOTT, OF STRATHFIELD, AND ALEXANDER GOODSIR, OF  
BALMAIN, NEW SOUTH WALES.

## APPARATUS FOR DRILLING ROCK.

SPECIFICATION forming part of Letters Patent No. 635,271, dated October 17, 1899.

Application filed December 17, 1897. Serial No. 662,350. (No model.)

*To all whom it may concern:*

Be it known that we, ROBERT MELVILLE SCOTT, contractor, residing at Strathfield, near Sydney, and ALEXANDER GOODSIR, contractor, residing at Balmain, near Sydney, New South Wales, subjects of the Queen of Great Britain and Ireland, have invented new and useful Improvements in Steam-Engines for Submarine Rock-Drilling, of which the following is a specification.

This invention relates to apparatus for excavating and breaking up submerged rock, and usable also as a drill, and comprising a tool connected directly to a piston acted on by steam or air pressure, reciprocating in a cylinder of considerable length which may be carried on a vertical slide on a tower on a scow or other floating structure, whereon it may be varied in vertical position to start and follow up the work. The sliding carrier on the tower may be made capable of being set at an angle to facilitate operations on inclined faces of rock which might glance off vertical blows of the tool. When the situation and nature of the work make it desirable or convenient, as in the case of a reef under rough water, a scow with lifting spuds or a decked structure built on the rock may be used to carry the tower.

It would not be possible to use a steam-cylinder with simple valves or with jump-drill or steam-hammer valves to operate tools used in the manner hereinafter described for reasons which will be evident to any experienced engineer. By reciprocating a rod of some tons weight through a stroke of several feet at considerable velocity by the positive action of a piston acted on by steam or air pressure the work of speedily breaking up large bodies of submerged rock is very greatly facilitated. We are aware that "jump" and "percussion" drills operated by fluid-pressure have been used in submarine drilling-work. The blow struck by these apparatus is, however, only a miniature of the blow struck by our apparatus, which latter is designed to mechanically break, split, excavate, and disintegrate the rock, and not merely to prepare it for blasting out. We are also aware that apparatus mounted on a punt has been used in which a number of long rods terminating

in chisel-points are operated by cams in the same manner as ore-stamps and that a series of ordinary percussion-drills have been used on a scow for drilling a line of holes in submerged rock. The expression "a heavy rod," occurring hereinafter, is to be taken to mean a rod of, say, half a ton or more in weight, as distinguished from reciprocating drill-rods of the kind now in use, the weight of which does not usually exceed one hundred pounds, and the expression a "long stroke" to indicate a stroke of, say, three feet or more. We would have it understood, however, that an apparatus would be within the principle of our invention if the remaining features were substantially retained but the length of stroke materially shortened. We find in practice that an apparatus constructed according to the present invention is capable of completing an excavation in a fraction of the time which is necessary when drilling and blasting are resorted to; not only so, but clean and regular work may be done and the excavation finished to a flat or inclined bed, as may be necessary. When the moving parts weigh about two tons and the stroke is about sixty-five inches, we have found that we are able to remove over thirty cubic yards of average sandstone per day. In many cases it is found convenient to pulverize the debris *in situ* by means of a hammer-head substituted for the chisel or cutter and to raise the reduced stuff by means of a sand-pump.

The invention consists in certain novel features of construction and combinations of parts for manually controlling reciprocations of the piston, while at the same time providing for automatic cushioning action and also automatic reversals of movement of the piston, the essential elements of the invention being recited in the appended claims.

The drawings which accompany and form part of this specification illustrate a number of forms in which the invention may be embodied.

Figure 1 represents one form of apparatus or engine in sectionalized side elevation. Fig. 2 is a fragmentary view, on a large scale, of the sectionalized portion of Fig. 1. Fig. 3 represents a different form of apparatus in sectionalized side elevation.

Referring to Figs. 1 and 2, K K K' K' are respectively main and auxiliary ports leading from the valve-chamber to the ends of the cylinder II. L is the steam-pipe, L' the steam-chest, and M M exhaust-ports. The valve consists of five heads, of which the central one, *k*, is cored out in order to allow steam to pass from end to end of it. The two heads *k' k'* at each end of the valve form practically only one head with a ring turned out of it, so that in effect the valve consists of three heads or pistons, whereof the middle one is a ring through which steam may pass from end to end. The valve is operated through a rod M', extending from each end of it and actuated by a hand-lever Z and by tappets on the piston-rod G or connected parts, as herein-after explained. The end valve-pistons are made longer than the port-faces in order to lap the ports. In the middle position of the valve, as shown, the ports from the valve-chamber into the cylinder are all closed. Upon moving the valve upward the upper port K is opened to admit pressure to the top end of the cylinder, whereupon the piston commences to descend. When sufficient steam to effect the stroke has been admitted, the valve is moved downward, all the ports closing at the same moment, so that the last portion of the stroke is cushioned. When a sufficient stroke has been made, the valve is again lowered to admit steam to the lower port K, whereupon the piston is raised by the pressure which enters below it. If, however, the piston should overrun, the tappet N on the piston-rod G will strike the nut N' on the valve-stem and cause the valve to move farther. When the outer head of the valve is brought beyond the port K, which will occur shortly before the piston G passes that port, pressure will be admitted. If such pressure be insufficient to check the movement of the piston, the valve will still continue to be moved and the port K will again be closed by the middle head of the valve lapping it, dead-cushioning being thus obtained. Finally, when the piston is approaching the cylinder-cover, which it is prevented from touching by the dead-cushioning, the port K' becomes open to pressure, and the movement of the piston is reversed. By means of the hand-lever the valve may be moved at will into any desired position to admit pressure or provide cushioning; but in all cases the tappet device operates the valve to prevent over-running of the piston and consequent accident.

In the arrangement shown in Fig. 3 the hand-valve O and the automatic valves P are separate. The former is a simple two-head piston-valve operated by hand-lever Z' and controlling two passages K'', leading from the steam-chest to the opposite ends of the cylinder. The latter are balanced pistons maintained in normal closed position by springs Q and moved by tappets on the piston-rod and tail-rod, passages K<sup>2</sup> extending between

the chambers of these piston-valves and the ends of the cylinder and steam being supplied to the said valve-chambers through branch pipes L. If the operator should not reverse the hand-valve in sufficient time to check the piston before it touches the cylinder-cover, one of the automatic valves will be opened by its tappet and admit pressure at the proper moment; but the pressure thus admitted will be cut off by the return of the valve by the action of the spring after the piston has reversed slightly. Pressure to make the stroke must then be admitted by the hand-valve.

In further explanation of the operation of the two forms of apparatus the following may be stated: In the form of embodiment of the invention shown in Fig. 3 the port which admits for cushioning is limited to this function; but in the form of embodiment shown in Figs. 1 and 2 this port, which admits cushioning-pressure, also admits pressure for the stroke under manipulations of the hand-lever. Of course in the form of construction in Fig. 3 the admission and exhaust of pressure to produce reciprocations of the piston take place only through the ports controlled by the hand-operated valve, the tappet mechanism only performing the function of admitting cushioning-pressure in front of the piston and trapping such pressure. It must be assumed in this connection that the hand-valve is restored to its middle position after being manipulated to admit pressure for the stroke; otherwise the cushioning charge could exhaust through the hand-valve chest. It follows that reciprocations of the piston do not continue automatically with the form of construction shown in Fig. 3. However, the construction shown in Figs. 1 and 2 provides not only for an automatic admission and trapping of a cushioning charge, but also for a return stroke of the piston by reason of the operation of the tappet devices. In the operation of the construction last referred to upward movement of the valve structure produced by manipulation of the hand-lever and sufficient to uncover the upper port K will admit steam above the piston and open the lower port K' for exhaust of steam on the lower side of the piston. As hereinbefore stated, when sufficient steam is admitted to effect this down-stroke the valve structure is moved downwardly far enough to close all the ports. If the cushioning thus provided for is insufficient to check the movement of the piston, the tappets come into play, with the result of moving the valve structure downwardly, uncovering the lower port K, through which steam may enter in front of the piston, and then covering said port with the central valve-section. If the cushioning thus provided for checks the downward movement of the piston, the parts naturally remain in the relative positions assumed, to change which manipulations of the hand-lever are neces-

sary. Thus far, then, the operation corresponds with that of the arrangement shown in Fig. 3. However, should the piston continue to move downward even after the admission of steam in front of it and the trapping of such steam then the further action of the tappets moves the valve structure still farther down, and the lower port K' is uncovered, and steam is admitted to effect an upward stroke of the piston. It is to be assumed, of course, that traverse of the piston between the ports K provides the necessary movement of the tool, and the ports K' and tappet devices are to prevent pounding when conditions arise which would otherwise give an opportunity for the piston to strike the heads of the cylinder.

The piston is provided with a tail-rod S, solid or hollow, of very large diameter, to reduce the effective area of its top side. The action of the apparatus is automatic. The piston cannot bump on the cylinder-heads, as it becomes reversed by the valve motion before it overruns. The sound and vibration will indicate whether or not an effective blow has been struck, and the workmen must use their judgment in fixing the vertical position of the cylinder in order that effective strokes may be made.

The general mode of operation is as follows: The scow or carriage is moved up until the tool is above the place at which the work is to be commenced. If it is required to drill a hole or well in the rock, the apparatus is manipulated in such a way that the tool may suitably approach its work. When excavating, the scow or carriage is traversed across the line of the excavation and the rock stoped out, the lower tables being advanced in turn by breaking down the tables above them in order. It is clear, however, that the most advantageous method of working in any particular case will depend upon its circumstances. We usually form the tables a little less in depth than the piston stroke in order that the full available length of stroke may be taken advantage of and a long line of cuts made without altering the position of the cylinder-carriage in the slide. In working ordinary sandstone we find that we are able to advance about one foot at every cut, a cut requiring from two to six blows to complete it to its full depth of, say, five feet.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, we declare that what we claim is—

1. In an apparatus of the character described, the combination of a piston and its rod, a cylinder having a pair of ports at each end, one port of each pair for both admitting and exhausting pressure and the other also for admitting pressure, valves controlling said ports with provisions for opening communication between the first-mentioned one of either pair of ports and the supply and exhaust alternately, and for trapping charges

of pressure admitted through the other port of each pair, together with piston-actuated tappet mechanism for effecting such trapping action of the valve.

2. In an apparatus of the character described, the combination of a piston and its rod, a cylinder having a pair of ports at each end, one port of each pair for both admitting and exhausting pressure and the other also for admitting pressure, valves controlling said ports with provisions for opening communication between the first-mentioned one of either pair of ports and the supply and exhaust alternately, and for trapping charges of pressure admitted through the other port of each pair, together with piston-actuated tappet mechanism associated with said valves for effecting such trapping action thereof and also admission of pressure for the return stroke, substantially as described.

3. In an apparatus of the character described, the combination of a piston and its rod, a cylinder having a pair of ports at each end and separate passages leading therefrom to the steam-chest, the latter having suitable exhaust and inlet ports, a valve device comprising sections controlling communication between the latter ports and said passages and a middle section for trapping cushioning charges of fluid-pressure admitted in front of the piston through one of the ports of each pair, and valve-operating means.

4. In an apparatus of the character described, the combination of a piston and its rod, a cylinder having a pair of ports at each end and separate passages leading therefrom to the steam-chest, the latter having suitable exhaust and inlet ports, piston-valves controlling communication between the latter ports and said passages, a middle valve for trapping cushioning charges of fluid-pressure admitted in front of the piston through one of the ports of each pair, and means for simultaneously operating said valves to successively trap pressure in front of the piston and admit pressure for the return stroke.

5. In an apparatus of the character described, the combination of a piston and its rod, a cylinder having a pair of ports at each end and separate passages leading therefrom to the steam-chest, the latter having suitable exhaust and inlet ports, a valve device comprising sections controlling communication between the latter ports and said passages and a middle section for trapping cushioning charges of fluid-pressure in the ends of the cylinder, and piston-actuated tappet mechanism for shifting said valve device to successively trap pressure in front of the piston and admit pressure for the return stroke, for the purpose described.

6. In an apparatus of the character described, the combination of a piston and piston-rod, a cylinder having a pair of ports at each end spaced apart longitudinally, a steam-chest with which said ports separately communicate, said steam-chest having an ex-

haust-port at each end and a centrally-located  
steam-inlet port, a piston-valve device com-  
prising a central hollow section and solid  
outer sections suitably spaced from the cen-  
5 tral section to permit the uncovering of the  
ports leading to the cylinder, and emergency  
tappet mechanism associated with said pis-  
ton-rod and said valve device for effecting  
trapping of pressure admitted through one of

the ports of each pair and thereafter effect- 10  
ing admission of pressure through the port  
beyond to produce the return stroke of the  
piston, substantially as described.

ROBERT M. SCOTT.

ALEXANDER GOODSIR.

Witnesses:

C. M. HEPBURN,

W. J. DAVIS.