(No Model.)

3 Sheets—Sheet 1.

G. A. BARTH.

DIRECT ACTING ENGINE.

No. 397,166. Patented Feb. 5, 1889.

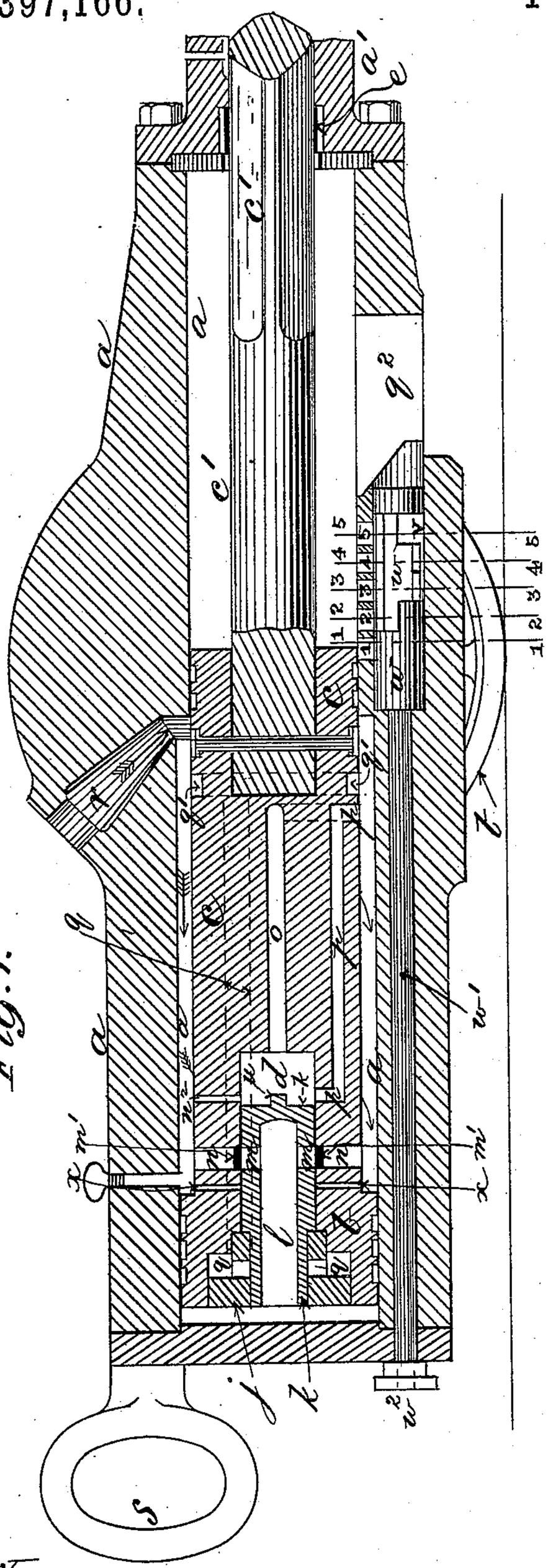

Fig. 1.

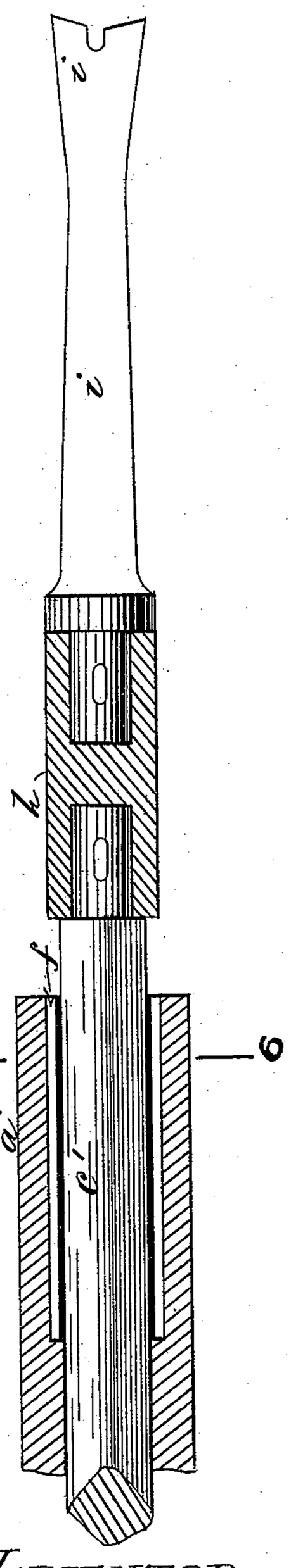

Fig. 1a

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(No Model.) 3 Sheets—Sheet 2.

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DIRECT ACTING ENGINE.

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Fig. 2.

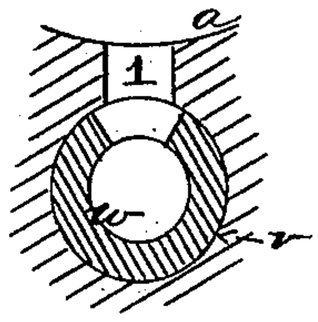


Fig. 3.

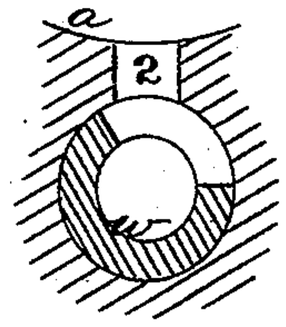


Fig. 4.

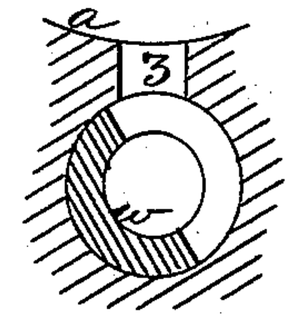


Fig. 5.

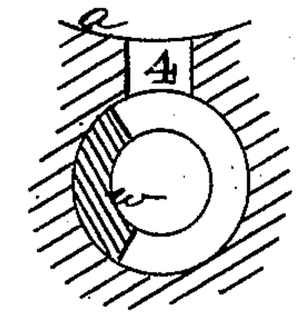


Fig. 6.

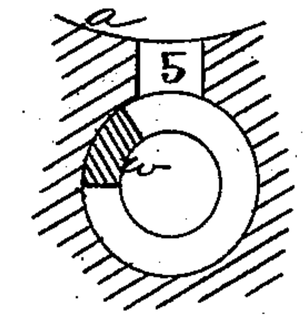


Fig. 7.

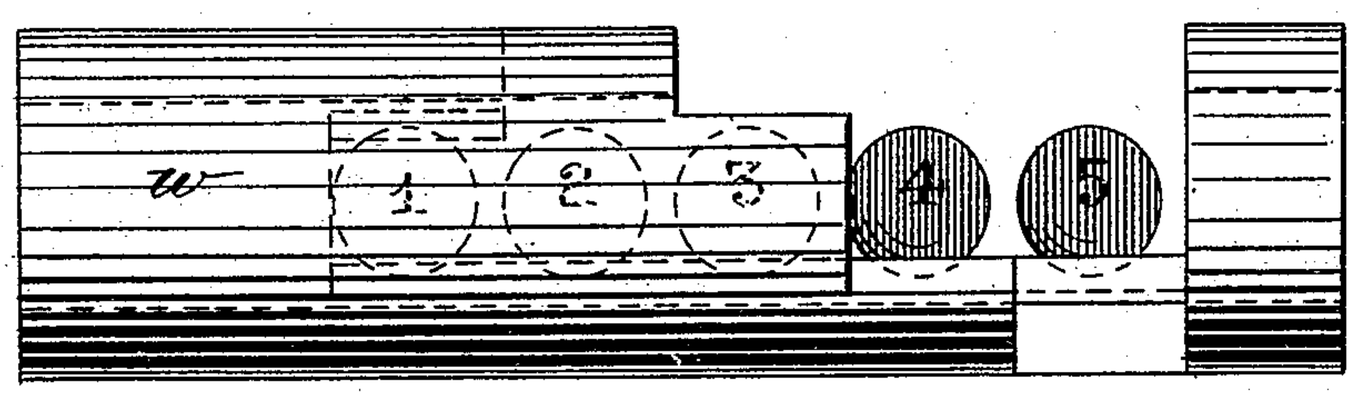


Fig. 9.

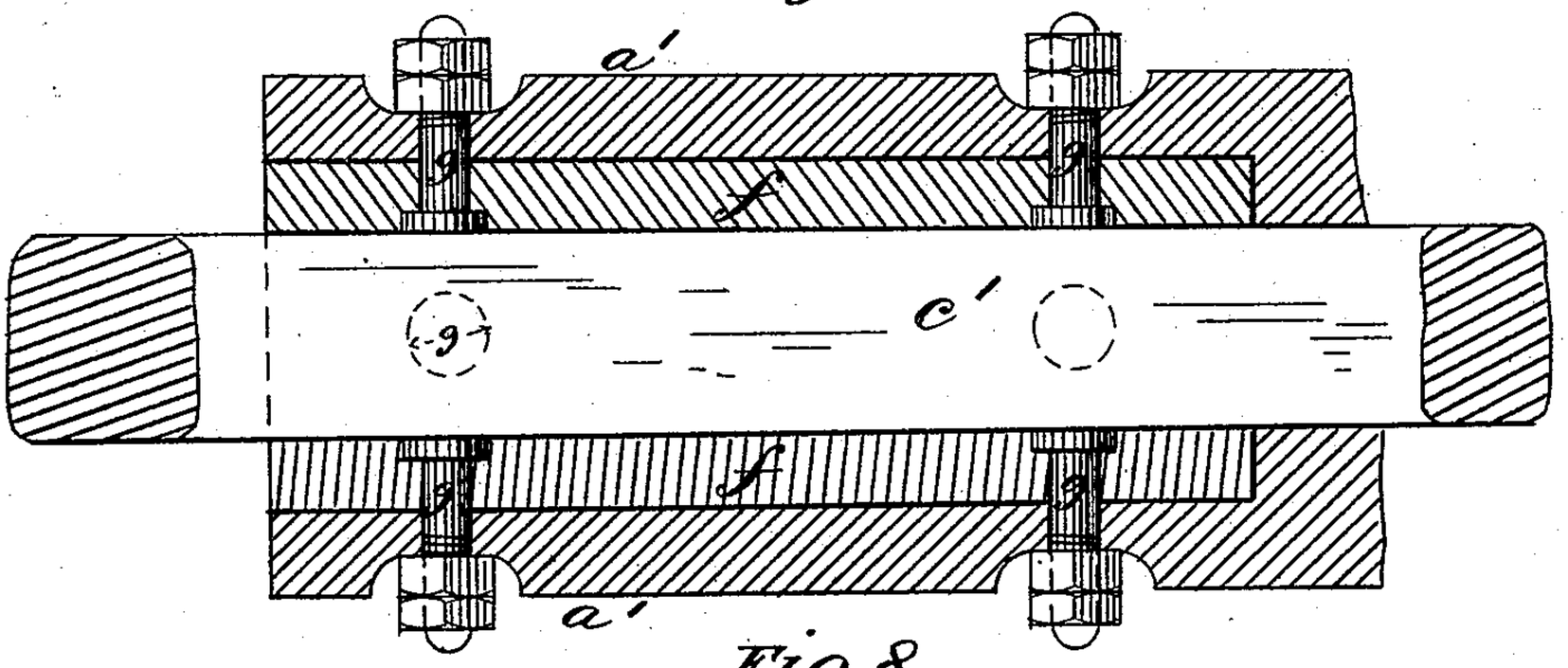
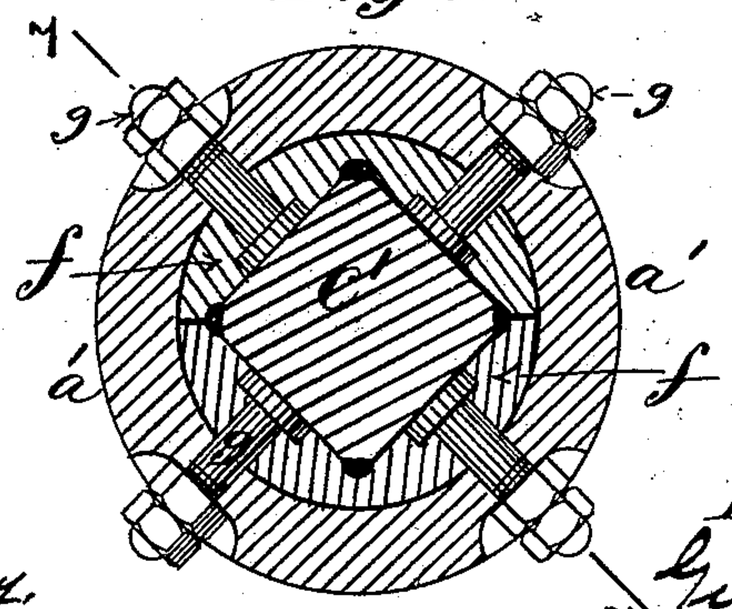


Fig. 8.



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(No Model.) 3 Sheets—Sheet 3.

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DIRECT ACTING ENGINE.

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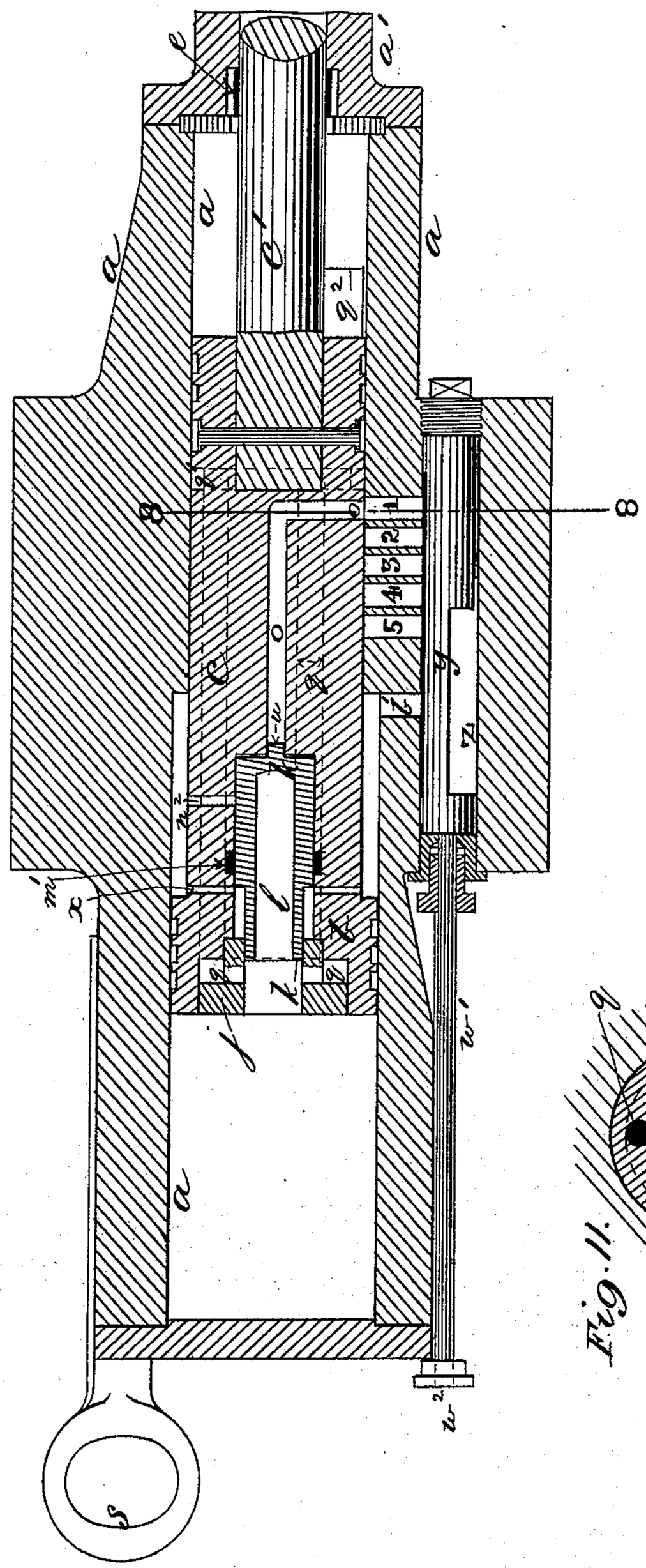

Fig. 10.

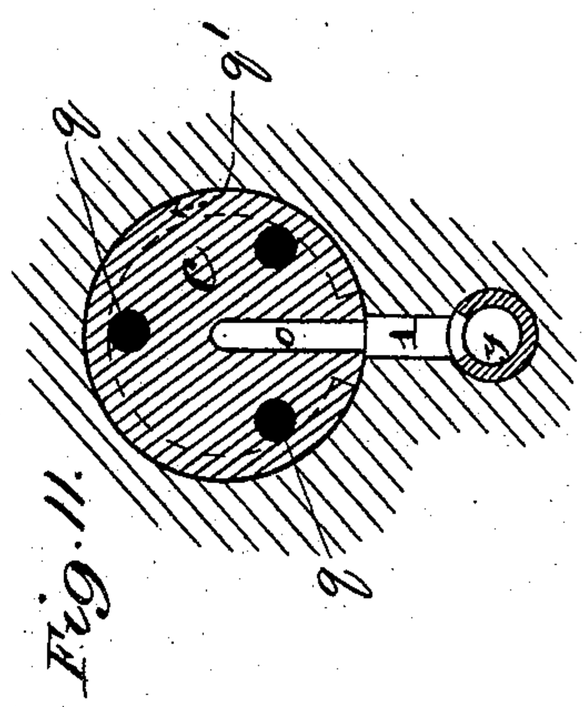

Fig. 11.

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UNITED STATES PATENT OFFICE.

GUSTAV A. BARTH, OF ST. LOUIS, MISSOURI, ASSIGNOR TO PIERRE CHOUTEAU, OF SAME PLACE.

DIRECT-ACTING ENGINE.

SPECIFICATION forming part of Letters Patent No. 397,166, dated February 5, 1889.

Application filed August 20, 1888. Serial No. 283,220. (No model.)

To all whom it may concern:

Be it known that I, GUSTAV A. BARTH, a citizen of the United States, residing at the city of St. Louis, State of Missouri, have invented certain new and useful Improvements in Direct-Acting Steam or Pneumatic Engines, of which the following is a full, clear, and exact description.

My invention relates to improvements in direct-acting steam or pneumatic engines wherein the piston is reciprocated in the cylinder by the action of its valve without the intervention of valve-operating mechanism; and my present invention has for its object to check the momentum and jar on the piston and its valve when at the termination of their inner stroke, to insure a more positive guide to the piston-rod, and to regulate the stroke of the piston from either end of the cylinder while handling the machine when used for calking, riveting, mining, and other purposes. It comprises a cylinder bored out concentrically to two different diameters for different portions of its length and a piston working therein, a tubular piston-rod provided with an improved arrangement of inlet and discharge passages, a distribution-valve adapted to reciprocate within said piston-rod, a rod attached to the tubular piston-rod and extending through a cylindrical tube or casing projecting from and closing the inner end of the cylinder and provided with a specially-constructed packing device, a stock or holder secured to the outer end of the extension piston-rod and carrying a chisel or other appliance, and a supplemental arrangement of ports or passages controlled by a specially-devised valve for regulating the length of stroke of the piston when starting from either end of the cylinder, the whole being mounted on wheels for facilitating the transport and application of the machine.

On the accompanying drawings, Figures 1 and 1ª represent a central longitudinal section of my improved direct-acting engine adapted for use as a chipping device in mining operations, the piston being shown at the outer termination of its stroke; Figs. 2, 3, 4, 5, and 6, transverse sections on lines 1 1, 2 2, 3 3, 4 4, and 5 5, respectively, taken through the ports and valve, (shown at the lower part of Fig. 1 to an enlarged scale;) and Fig. 7, a full-size longitudinal view detached of the valve as seen with relation to the ports from beneath or at right angles to its position in Fig. 1; Fig. 8, a transverse section on line 6 6 in Fig. 1ª, and Fig. 9 a longitudinal section on line 7 7 in Fig. 8; Fig. 10, a similar view to Fig. 1, taken diagonally thereto, showing a modification of part of my invention, the piston being part-way along the cylinder toward the outer end of its stroke; and Fig. 11, a transverse section thereof on line 8 8 in Fig. 10.

Like letters of reference denote like parts in the respective figures.

a represents the cylinder, which is bored out concentrically to two different diameters extending in opposite directions from a plane at or near the middle of its length and corresponding, respectively, with the diameters of its piston *b*, and of a tubular piston-rod, *c*, which is formed in one piece with or secured to the piston *b*. The piston *b* and tubular piston-rod *c* are bored out centrally to provide a cylindrical chamber or cavity, *d*, which extends from its open end, where it is flush with the outer side of the piston *b*, to a suitable depth within the tubular piston-rod *c*, the inner end of which is extended by means of a rod, *c'*, passing through the inner end of the cylinder *a* and through a cylindrical tube or casing, *a'*, which projects therefrom, and may either be cast in one piece therewith or flanged at one end and secured thereat by studs or bolts to the flanged inner end of the cylinder *a*, as shown, or in any other suitable manner. The tube or casing *a'* closes the inner end of the cylinder *a* and forms a guide for the extension piston-rod *c'*, which is preferably of a circular section for a certain distance from the tubular piston-rod *c*, but square with convex corners, or otherwise suitably shaped, where it reciprocates through the outer portion of the casing *a'*, so as to prevent the rotation of the piston-rods *c c'* and piston *b* during the operation of the machine, as hereinafter more particularly referred to.

In the inner end of the tube or casing *a'*, adjacent to the cylinder *a*, is fitted around the extension-rod *c'* a suitable packing, *e*, which insures a tight joint with the circular part of the extension-rod *c'*, and at the same

time permits the square part of the rod c' to reciprocate through it without disturbance to the packing, as would occur with an ordinary gasket-gland.

Longitudinally into the outer end portion of the tube or casing a', which is bored from its outer face for the purpose, are inserted, as seen more particularly in Figs. 8 and 9, two or more packing-strips, f, which are grooved or shaped, respectively, along one side to the sectional shape of the extension piston-rod c', and are turned on the outside so that when placed together they will exactly fit within the bored end portion of the casing a' and closely fit around the rod c'. The packing-strips f are secured within the bored portion of the casing a' by bolts g, which pass through the strips f and wall of the casing a', to which they are fastened by lock-nuts or other device, and thereby prevent the rotation of the rod c' during its reciprocation through the casing a'.

To the end of the extension piston-rod c', external to the outer end of the casing a', is fixed a stock or holder, h, for receiving and holding the chipping-tool i, or other appliance, as the case may be.

In the outer open end of the cylindrical chamber or cavity d in the piston b and rod c is fitted and fixed a cylindrical flanged tube or sleeve, j, which is flush at its outer end with the outer side of the piston b, and extends a certain distance within the chamber d.

Into the inner end portion of the tube or sleeve j projects the outer diametrically-reduced end portion of a cylindrical distribution-valve, k, which, to the extent of that portion of its length beyond the shoulder of its reduced end, is fitted to and capable of reciprocation within the chamber d, and is formed with a longitudinal central supply-passage, l, extending from its outer open end, inclosed by the tube or sleeve j to a suitable distance therefrom, one or more inlet-passages, m, being formed near the inner closed end of the supply-passage l through the wall of the distribution-valve k, and communicating with an annular space, m', formed by a circumferential recess in the interior surface of the chamber d in conjunction with the circumferential surface of the distribution-valve k.

n n^2 are inlet-passages leading to the chamber d, through the wall of the latter, from the outside of the tubular piston-rod c.

o is an inlet-passage extending from the outside of the tubular piston-rod c beyond the inlet-passages n^2, through the wall of the tubular piston-rod c, and through the inner end of the chamber d, with which it communicates behind the distribution-valve k; and p is an outlet-passage extending from the side of the chamber d, at a suitable distance from the inner end of the latter, through the tubular piston-rod c, to the outside of the latter toward its inner end.

q q are exhaust-passages extending from the interior of the tube or sleeve j through the wall of and surrounding the latter, and thence longitudinally through the inner portion of the piston b, as indicated by dotted lines in Figs. 1 and 10, and tubular piston-rod c, to a circumferential recess, q', formed on the outside of the rod c toward its inner end beyond the outlet-passage p, by which arrangement the inner end of the tubular piston-rod c is closed for the purpose of cushioning the piston b and rod c at the termination of their inner stroke, as hereinafter more particularly referred to.

q^2 is an exhaust-passage opening from the small portion of the cylinder a into the external atmosphere.

Steam or other motive fluid is admitted to the engine through the inlet-passage r, which opens into the cylinder a at the inner end of its larger portion, and is provided at its mouth with a suitable valve (not shown) for controlling the pressure.

In operation, the parts being in the position seen in Fig. 1, the operator locates the machine by means of its handle s and wheels t into the desired position for the work, and admits steam or other motive fluid through the inlet-passage r into the cylinder a on the inner side of the piston b, as indicated by the arrows, where, circulating around the tubular piston-rod c, it passes through the inlet-passages n, annular space m', and inlet-passages m into the central supply-passage, l, of the distribution-valve k, and through the tube or sleeve j to the outer side of the piston b, which, with the tubular piston-rod c, is thereby forced toward the inner closed end of the cylinder a, and, carrying with them the extension piston-rod c' and stock or holder h, causes the chipping-chisel i to strike upon the material to be dislodged. Meanwhile the outlet-passage p, on reaching the exhaust-passage q^2 through the wall of the small portion of the cylinder a, and the inlet-passages n, n^2, and o entering the same part of the cylinder a, and being thereby closed to the ingress of steam, the steam which was behind and held the distribution-valve k in its outward position is exhausted through the passages p and q^2 and allows the distribution-valve k to be forced toward the inner end of its chamber d, so as to close the inlet-passages n n^2 and thereby prevent the subsequent entrance of live steam to the central supply-passage, l. As the distribution-valve k is approaching the end of its travel, it closes the mouth of the outlet-passage p, so that the steam then occupying the space between the distribution-valve k and the inner end of the chamber d, and that contained in the inlet-passage o, not being able to escape, is compressed and acts as a cushion to the distribution-valve k in terminating its stroke. To render this cushioning more positive, the inner end of the distribution-valve k may be formed with a projecting piece, u, which enters and closes the mouth of the passage o as the valve k is near the end of its stroke, and thereby con-

fines the cushioning to the layer of steam imprisoned at the inner end of the chamber *d*, which positively prevents the distribution-valve *k* from striking and jarring against the chamber *d* thereat. In a similar manner the inner end of the tubular piston-rod *c*, on approaching the corresponding end of its stroke in the cylinder *a*, closes the exhaust-passage q^2 through the side of the cylinder *a*, and the air thereafter confined in the latter between its inner closed end at the casing *a'* and the tubular piston-rod *c* is compressed and acts as a cushion to the piston *b* and rod *c* when terminating their stroke.

To prevent the accidental outward stroke of the distribution-valve *k* in the chamber *d* during the return-stroke of the piston *b*, a slight backward or inward pressure is imparted to the valve *k* by small inlet-passages *x*, which are located at or near to the inner side of the piston *b* and open from the outside of and through the wall of the tubular piston-rod *c* into the chamber *d* between the shoulder of the valve *k* and the inner end of the tube or sleeve *j*. Simultaneously by the inward movement of the distribution-valve *k* its outer reduced end uncovers the exhaust-passages *p*, through which and through the circumferential recess *q'* around the inner end portion of the tubular piston-rod *c* the steam from the outer side of the piston *b* is exhausted through the passage q^2 into the atmosphere, and the steam contained in the cylinder *a* on the inner side of the piston *b* presses upon the annular surface of the latter, and thereby forces the piston *b*, with the tubular piston-rod *c*, toward the outer end of the cylinder *a*, or so as to withdraw the chisel *i* from the material until the inlet-passage *o* passes just beyond the outer end of the small portion of the cylinder *a* into the larger portion of the latter, when the steam from the space on the inner side of the piston *b* enters the passage *o* and forces the distribution-valve *k* outward to its original position, or with the shoulder of its reduced end bearing against the inner end of the tube or sleeve *j*, thereby again opening communication between the inlet-passages *n m' m* for admitting the steam to the outer side of the piston *b* and to the passage n^2 for supporting the distribution-valve *k* in the outward position while the piston *b* is performing its return-stroke.

By the use of the extended piston-rod *c'*, guided at both ends of the long cylindrical casing *a'*, combined with the cushioning of the tubular piston-rod *c* and distribution-valve *k* at the termination of the percussive stroke, greater steadiness and precision of action are imparted to the piston *b* and its appendages, with less jar and liability to breakage of the parts hitherto produced by the blow of the chisel.

The above description applies to the normal operation of the machine with the piston and its appendages making a full stroke in the cylinder; but in practice it is found desirable to shorten the stroke of the piston for producing short and rapid blows of the chisel against the material to be dislodged.

To this end there are formed, through the wall of the cylinder *a*, at the lowest or other convenient part of its small portion between the inner end of the larger portion and the main exhaust-passage q^2, (see Fig. 1,) supplemental ports or passages 1 2 3 4 5, (more or less,) which are in line with each other at suitable distances apart and with the outlet-passage *p* from the chamber *d*, containing the distribution-valve *k*. These ports or passages 1 2 3 4 5 open from the cylinder *a* into a cylindrical chamber, *v*, formed longitudinally in the wall of the cylinder *a*, and within the chamber *v* is fitted a long cylindrical valve, *w*, to which is attached an operating-spindle, *w'*, extending to the outer end of the machine and provided thereat with a suitable handle, w^2. The wall of the valve *w* is cut away in a series of successive notches or spaces equal in number to the ports 1 2 3 4 5, and corresponding in length, respectively, with the arithmetical progressive additions of their diameters—that is to say, the circumferential length of the first notch around the valve *w* will be that due to the diameter and necessary cover of port 1, the second notch that due to port 1 plus port 2, the third notch to port 1 plus 2 plus 3, and so on throughout the entire series, so that during a complete revolution of the valve *w* the ports 1 2 3 4 5 may be successively or simultaneously opened or closed at pleasure from the cylinder *a* to the interior of the valve *w* and its chamber *v*, which communicates at one end with the external atmosphere.

As seen in Figs. 1, 2, and 7, the position of the valve *w* is so that its first notch or space is opposite to port 1 and its other spaces in the various relative positions to the ports 2, 3, 4, and 5, as seen, respectively, in Figs. 3, 4, 5, and 6—that is to say, the entire series of ports 1 2 3 4 5 are open, and establish communication from the cylinder *a*, through the valve *w* and its chamber *v*, to the external atmosphere. This being so, and the piston *b* performing its inner stroke, as soon as the mouth of the outlet-passage *p* in the tubular piston-rod *c* arrives opposite to port 1 the steam which was behind and held the distribution-valve *k* in its outward position is exhausted through port 1 and allows the distribution-valve *k* to be forced toward the inner end of its chamber *d*, which causes the steam previously pressing on the outer side of the piston *b* to be exhausted through port 2, and the movement of the piston *b* thereby reversed in precisely the same manner as if the passage *p* had been permitted to complete its full travel and exhaust through the ordinary passage, q^2. By this means the stroke of the piston *b* is shortened to the extent of the distance between port 1 and the passage q^2. In a similar manner by partially rotating the valve *w* by the spindle *w'* and handle w^2 to

the left hand the port 1 is closed by the wall of the valve *w*, the other ports, 2, 3, 4, and 5 remaining open, so that the passage *p* of the rod *c* does not exhaust until arriving opposite port 2, which shortens the stroke of the piston *b* to the extent of the distance between port 2 and the exhaust-passage q^2, and so on, by successive partial rotations the ports 3, 4, and 5 may be successively opened or closed to the passage *p*, the ports meanwhile between that exposed to the passage *p*, for shortening the piston-stroke, and port 1 remaining closed by the wall of the valve *w*, which on a complete revolution closes the entire series of ports 1 2 3 4 5.

In the modification of this part of my invention, as seen in Figs. 10 and 11, in lieu of exhausting the steam, as described, its pressure is utilized for shortening the stroke of the piston *b*. For this purpose the cylindrical valve *y* is fitted within the chamber *z* adjacent to the ports 1 2 3 4 5 and closed at both ends. Through the wall of and opening from the larger portion of the cylinder *a* at its inner end is a passage, *b'*, which communicates with the interior of the valve *y* and chamber *z*, the valve *y* being similar in construction to the valve *w* in Fig. 1, except that the ports 1 2 3 4 5 and the corresponding notches or spaces in the valve *y* are in reverse order, and that the ports 1, 2, 3, 4, and 5 are in line with the mouth of the inlet-passage *o*, which communicates with the chamber *d* behind the distribution-valve *k*, in lieu of with the passage *p*, as in Fig. 1.

The position of the valve *y* as seen in Figs. 10 and 11 is so that the ports 1 2 3 4 5 are open to the chamber *z*. As soon, therefore, as the mouth of the inlet-passage *o*, during the outer stroke of the piston *b*, arrives opposite to port 1, the steam coming from the larger portion of the cylinder *a* through the passage *b'* passes through port 1 and passage *o* and, forcing the distribution-valve *k* outward, reverses the movement of the piston *b* in the same manner as if the passage *o* had traveled to its full extent to the inner end of the larger portion of the cylinder *a*, for receiving the pressure in making a full stroke; or, in other words, the stroke of the piston *b* is thereby shortened to the extent of the distance between port 1 and the commencement or inner end of the larger portion of the cylinder *a*. By successive partial rotations of the valve *y* the ports 2 3 4 5 may be successively closed, or all closed simultaneously, as with the arrangement in Fig. 1.

I claim—

1. The combination of a cylinder, *a*, a piston, *b*, fitting therein, a tubular piston-rod, *c*, formed on or secured to said piston and provided with separate inlet and exhaust passages *n* and *q*, respectively, said passages *q* communicating with a circumferential recess or passage, *q'*, on the inner end portion of the piston-rod *c*, a distribution-valve, *k*, fitting within a chamber or cavity, *d*, in said piston-rod and having a central supply-passage, *l*, extending from its open end to lateral ports *m*, and annular passage *m'* adjacent to the inner end of the chamber *d*, the ports *m* and passages *l m'* being so arranged as to communicate alternately with the said inlet and exhaust passages *n* and *q q'*, inlet-passages n^2 in the tubular piston-rod *c* communicating with the chamber *d* between its inner end and the corresponding end of the distribution-valve *k*, an inlet-passage, *o*, in the piston-rod *c*, opening into the chamber *d* at its inner end behind the distribution-valve *k*, and an exhaust-passage *p*, leading from the side of the chamber *d* and through the piston-rod *c* to the outside of the latter, an exhaust-passage, q^2, in the cylinder *a*, and inlet-passages *x* in the piston-rod *c*, communicating with the chamber *d* above the upper shoulder of the distribution-valve *k* when in its extreme inner position, the whole operating to hold, reverse, and cushion the distribution-valve *k* at the proper times and so govern the supply and exhaust of motive fluid to and from the piston *b* and distribution-valve *k*, substantially as shown and described.

2. The combination of the distribution-valve *k*, having a projection, *u*, with the inlet-passage *o*, substantially as shown, and for the purpose described.

3. The combination of cylinder *a*, piston *b*, and tubular piston-rod *c*, closed at its inner end, and extension piston-rod *c'*, with cylindrical casing *a'* closing the inner end of cylinder *a*, for cushioning the tubular piston-rod *c*, substantially as shown and described.

4. The combination of tube or casing *a'* and extension piston-rod *c'* with packing-strips *f*, substantially as shown, and for the purpose described.

5. The combination of exhaust ports or passages and valve *w* with the outlet and exhaust passages from piston and piston-rod, substantially as shown, and for the purpose described.

6. The combination of exhaust ports or passages and valve *w* with the outlet-passage *p*, and exhaust-passages *q q'* from piston *b* and piston-rod *c*, substantially as shown, and for the purpose described.

7. The combination of inlet ports or passages and valve *y* with outlet-passage from cylinder and inlet-passage in piston-rod, substantially as shown, and for the purpose described.

In testimony whereof I have affixed my signature, in presence of two witnesses, this 16th day of August, 1888.

GUSTAV A. BARTH.

Witnesses:

PAUL BAKEWELL,

RENÉ BAKEWELL.