No. 684,325. Patented Oct. 8, 1901.

H. H. VAUGHAN & C. H. JOHNSON.

MOTIVE FLUID DRILL.

(Application filed July 30, 1900.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 2.

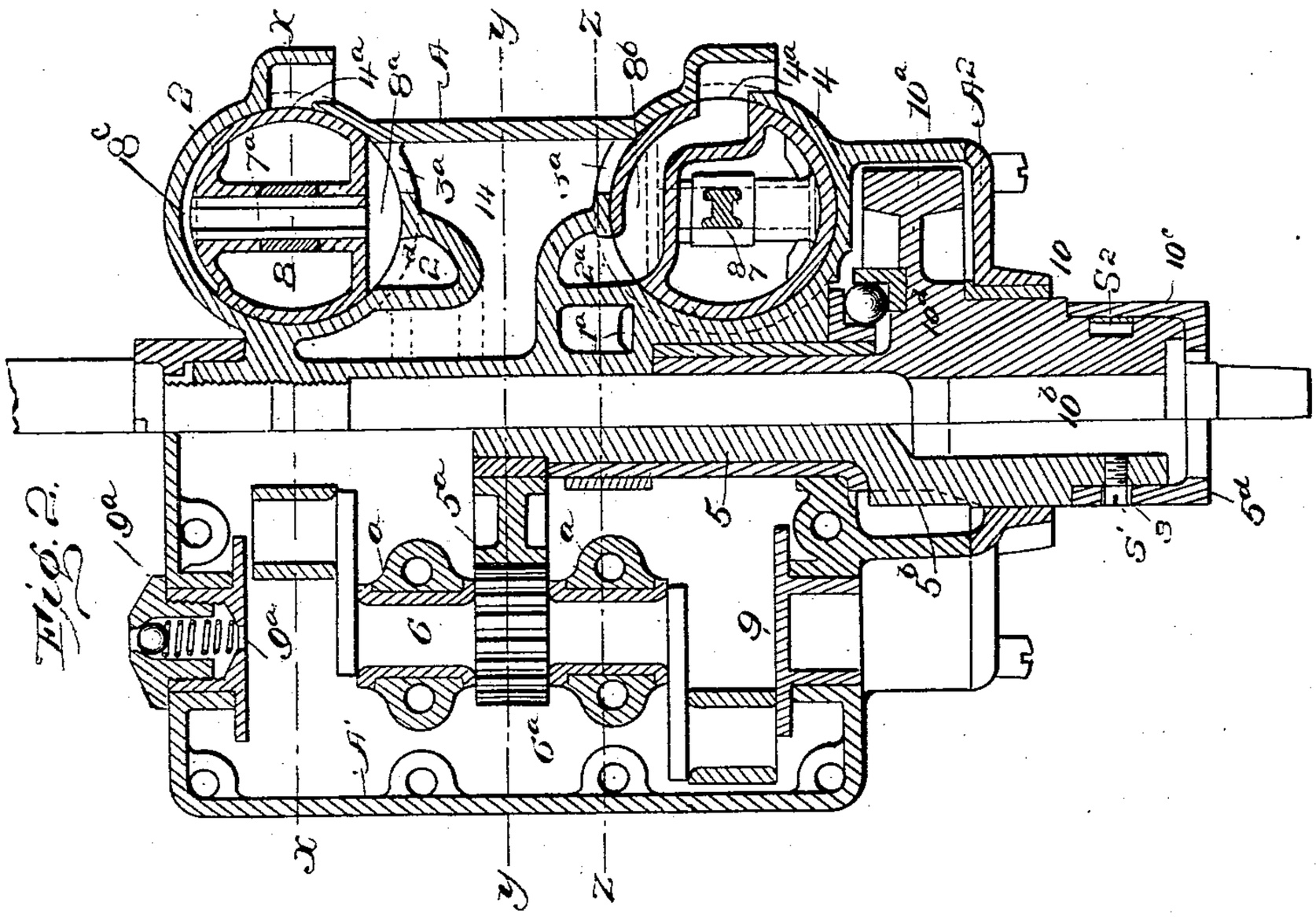
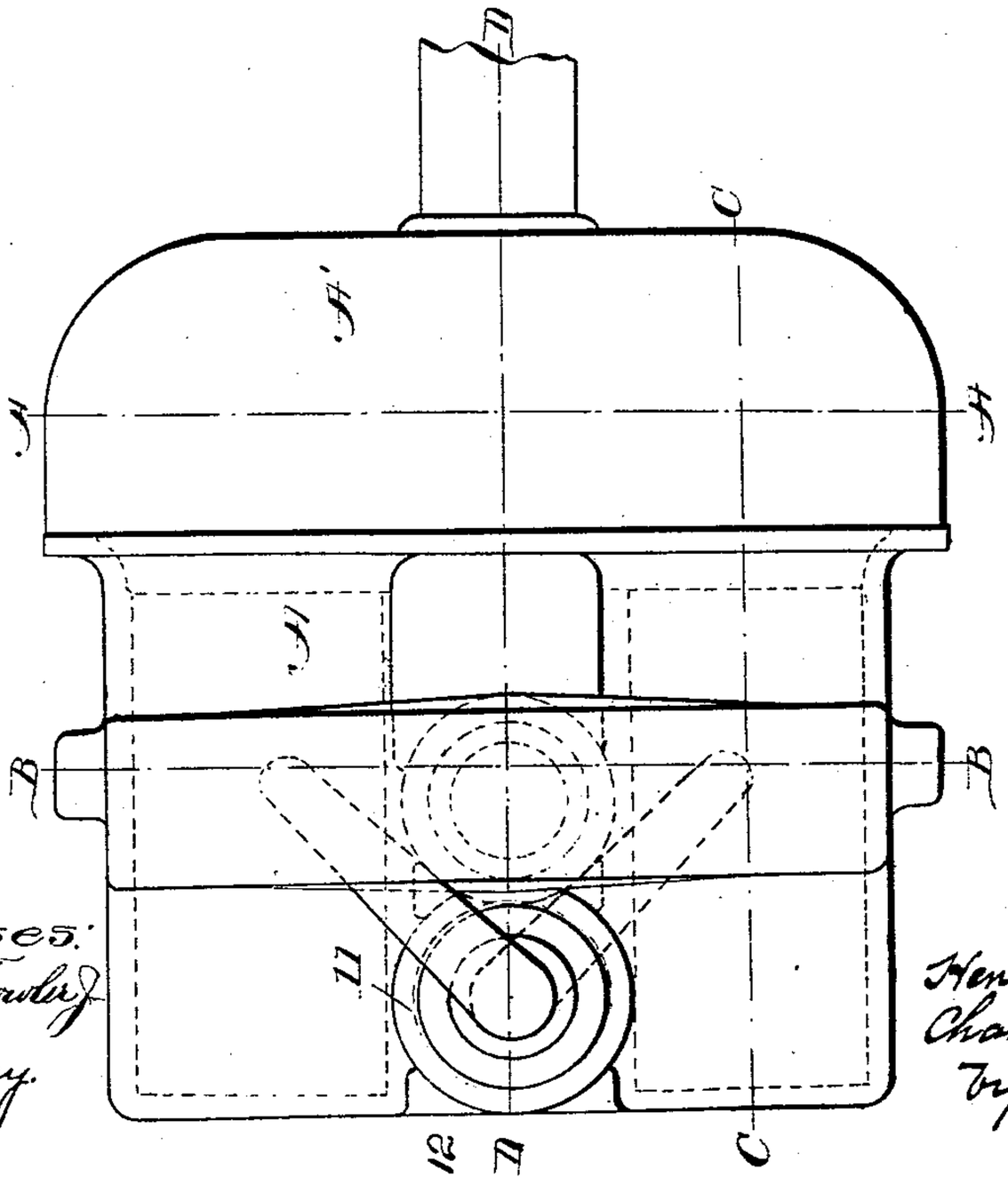


Fig. 1.



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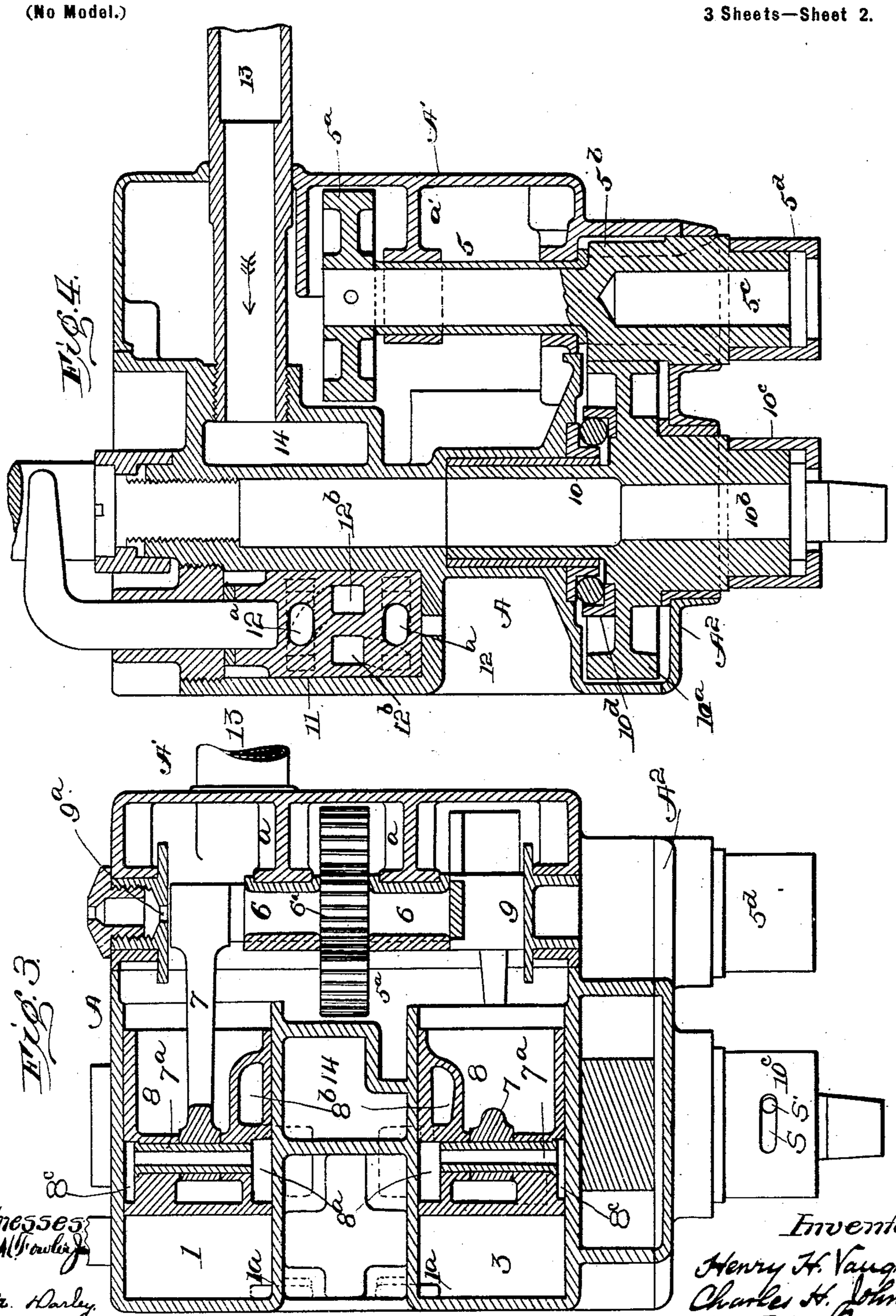
(No Model.) 3 Sheets—Sheet 2.



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(No Model.) 3 Sheets—Sheet 3.

Fig. 6.

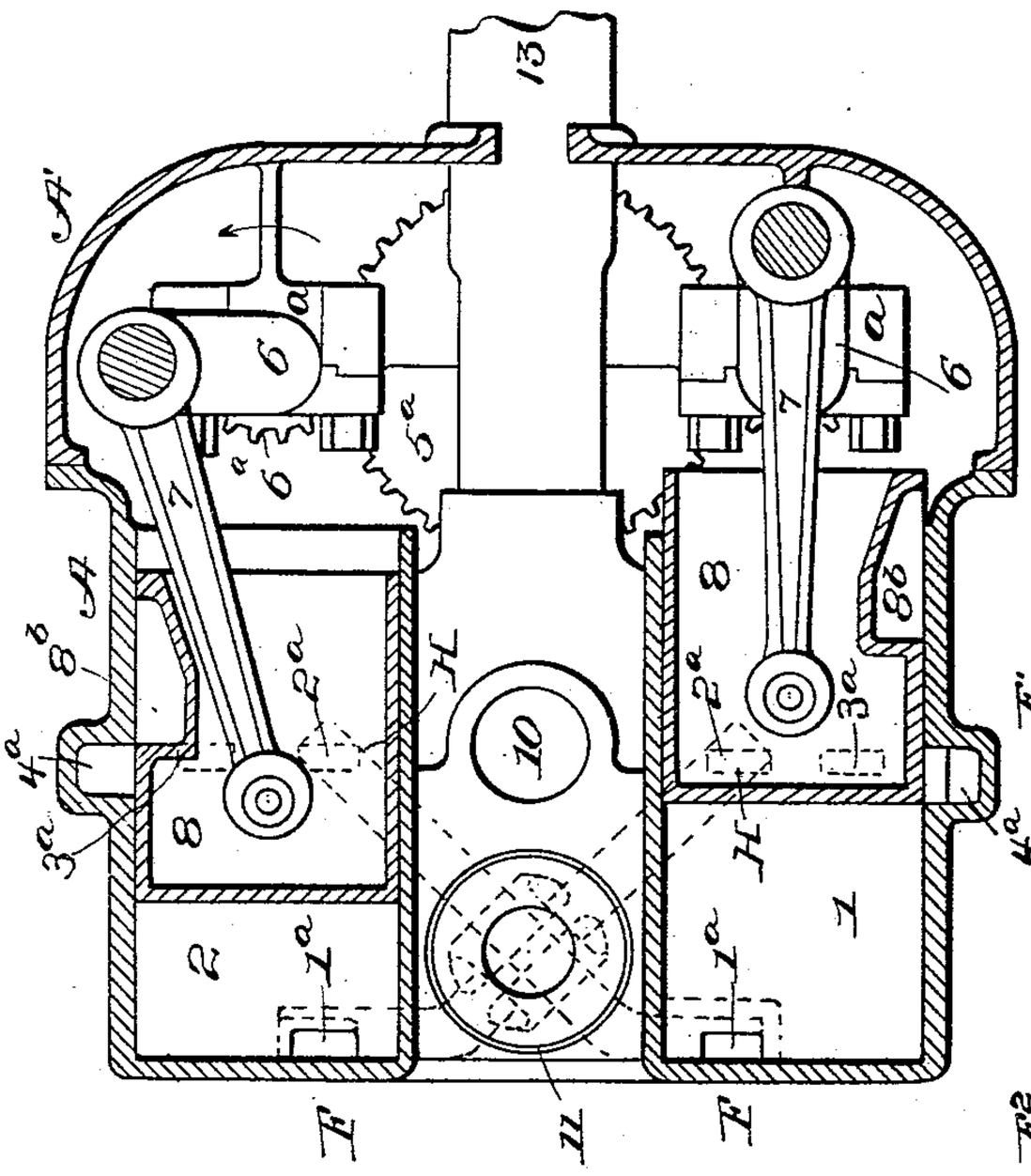


Fig. 8.

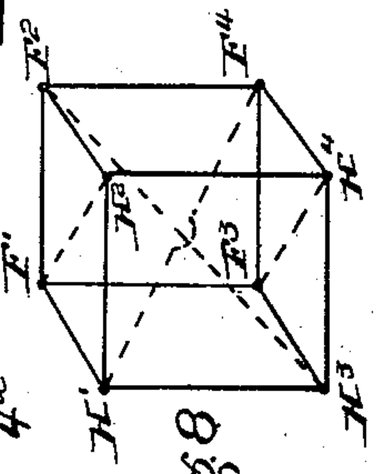


Fig. 9.

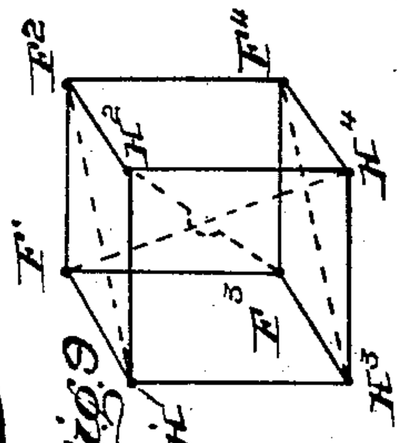


Fig. 7.

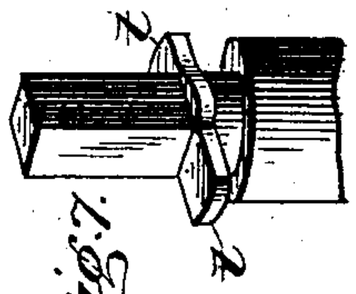
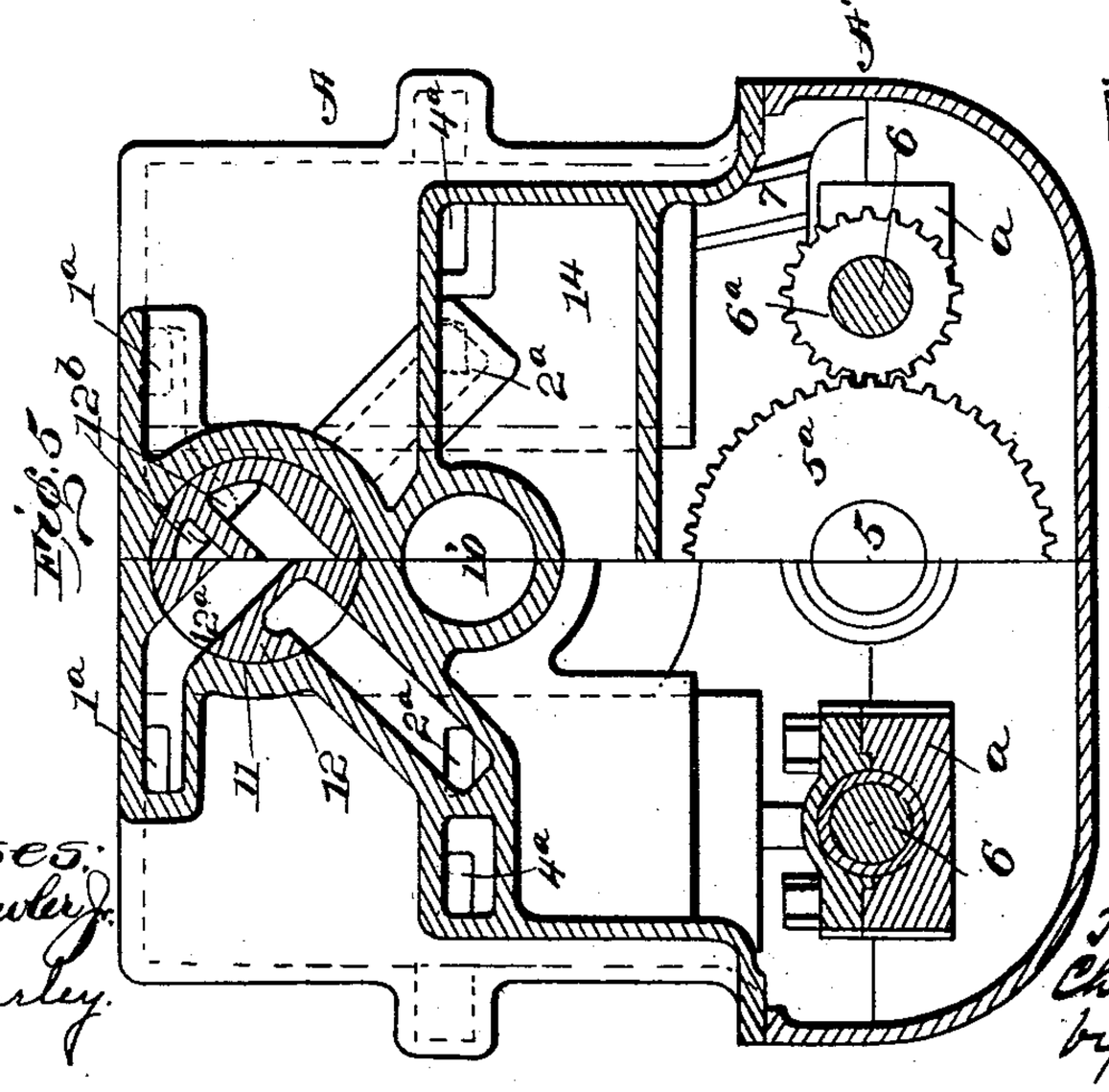


Fig. 5.



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UNITED STATES PATENT OFFICE.

HENRY H. VAUGHAN, OF CHICAGO, AND CHARLES HARRIS JOHNSON, OF CHICAGO HEIGHTS, ILLINOIS.

MOTIVE-FLUID DRILL.

SPECIFICATION forming part of Letters Patent No. 684,325, dated October 8, 1901.

Application filed July 30, 1900. Serial No. 25,272. (No model.)

To all whom it may concern:

Be it known that we, HENRY H. VAUGHAN, residing at Chicago, and CHARLES HARRIS JOHNSON, residing at Chicago Heights, in the county of Cook, State of Illinois, citizens of the United States, have invented certain new and useful Improvements in Motive-Fluid Drills; and we hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, in which—

Figure 1 is a plan view of a drill embodying our invention. Fig. 2 is a part cross-section on the line A A, Fig. 1, and a part cross-section on the line B B, Fig. 1, of the drill shown in plan view, Fig. 1. Fig. 3 is a cross-sectional view of the drill on the line C C, Fig. 1, parts omitted for sake of clearness. Fig. 4 is a cross-sectional view on the line D D, Fig. 1. Fig. 5 is a part cross-section on the line Y Y, Fig. 2, and a part cross-section on the line Z Z, Fig. 2, the main drill-spindle being omitted. Fig. 6 is a cross-sectional view on the line X X, Fig. 2, parts omitted and the ports leading to reversing-valve shown in dotted lines. Fig. 7 is a detached view of the socket end of the drill-tool. Figs. 8 and 9 are diagrams illustrating the relation of the ports or passages of the reversing-valve.

Like symbols refer to like parts wherever they occur.

Our invention relates to the construction of motive-fluid-operated drills, and has for its objects the dispensing with the usual valves for controlling the supply and exhaust of the cylinders, the increase of the driving power, and the multiplication of the drill-spindles operated thereby without materially enlarging the proportions of the drill, and, generally, the production of a compact and efficient motive-fluid drill adapted for use close to walls, in corners, and in like confined places.

We will first generally describe our preferred construction as illustrated in the accompanying drawings, and will thereafter particularly point out in the claims which follow the combinations and arrangements which embody our invention.

In the drawings, A indicates a suitable casing wherein are formed or assembled a plurality of cylinders in parallel relation, the number in the present instance being four, indicated, respectively, by the symbols 1 2 3 4. The case A is closed at one end by a detachable cap A′, having on its interior crank-shaft bearings *a a*, so that the cranks, pitmen, and cylinder-pistons are removable with the casing-cap A′ to facilitate assembling of the parts, dismantling of the drill, replacement, and repair. The crank-shaft bearings *a a* on the interior of the cap A′ will be positioned properly for the reception of the crank-shafts, which in the present instance are two in number, with each of which shafts two pitmen from the respective pistons of two cylinders are connected, the cranks on each shaft being opposite each other and at right angles to the cranks on the other shaft. In addition to the bearings *a a* for the crank-shafts (see Figs. 3 and 4) the cap A′ is also provided on its interior with a bearing *a′*, intermediate of the crank-shaft bearings, for the support of an intermediate driven shaft 5, which, as will hereinafter appear, also serves as a drill-spindle.

6 6 indicate the crank-shafts, journaled in the bearings *a a* of the casing-cap A′, and 7 7 the pitmen, which connect the pistons 8 of the respective cylinders therewith, each pitman being connected with its piston by a suitable wrist-pin 7^a and held in position on the crank-pins of crank-shaft 6 by means of disks 9, let into the walls of cap A′, the upper of which as to both cranks can be in the form of an oil-cup (see Figs. 3 to 9) to insure proper lubrication of the bearings.

On each of the crank-shafts 6, intermediate of the cranks and preferably formed integral with the shafts, is a pinion 6^a, which meshes with a pinion or gear-wheel 5^a on the intermediate driven shaft 5, and said intermediate shaft has a second gear-wheel or pinion 5^b, which in turn meshes with the master-gear 10^a of the main drill-spindle 10. The lower end of intermediate shaft 5 (see Fig. 4) is provided with a square or polygonal socket 5^c for the reception of a tool and with a chuck 5^d for holding the tool in position. By preference the chuck 5^d on intermediate shaft 5 (and also the chuck of the main drill-spindle 10) is in the form of a rotating collar, having an

elongated slot in its lower end for the passage of wings or flanges *t* on the upper end or stem of the tool (see Fig. 7) and an elongated slot *s* and set-screw *s'* (see Fig. 3) for securing the chuck and limiting the extent of its rotation and in addition thereto an included spring s^2 (see Fig. 2) to prevent the rotation of the chuck unless force is applied to turn it. In practice the tool, Fig. 7, is inserted in the socket until its wings *t* pass through the oblong slot in the end of the chuck, whereupon the chuck is turned slightly, and being fastened by means of the set-screw secures the tool in its spindle.

10 indicates the main drill-spindle, (see Figs. 2, 4, and 6,) located intermediate of the cylinders 1, 2, 3, and 4 and provided with the master-wheel 10^a, which meshes with the pinion 5^b on the intermediate shaft and spindle 5. The lower end of main spindle 10, which may be integral with the master-wheel 10^a, (see Fig. 4,) will have a tool-socket 10^b and chuck 10^c, which may be in all respects similar to that of the intermediate shaft 5, hereinbefore described, and the master-wheel 10^a will have a race 10^d on its upper face corresponding to a similar race on the bearing, between which will be antifriction-balls, constituting an antifriction-bearing on the casing A for the master-wheel and main spindle. The lower end of the casing A, constituting the master-wheel chamber, is closed by means of an end cap A^2, through which project the lower ends of main spindle 10 and intermediate shaft and spindle 5.

11 indicates the chamber of the reversing-valve, (see Figs. 4, 5, and 6,) also located intermediate of the cylinders and in line with the main drill-spindle 10 and the intermediate shaft and drill-spindle 5, with which chamber are connected a series of ports or passages leading from and to the respective cylinders, the connections between which ports or passages are established through and controlled by the reversing-valve 12.

13 indicates the motive-fluid-supply pipe, (see Fig. 4,) which will be provided with a suitable throttle-valve and which delivers into the motive-fluid-supply chamber 14, (see Figs. 2, 3, 4, and 5,) located within the casing A intermediate of the cylinders.

The general plan and arrangement of the cylinders 1 2 3 4 and their supply and exhaust ports is such that the working piston of one cylinder controls the supply and exhaust of another cylinder and has its supply and exhaust in turn controlled by the working piston of some other cylinder of the series. To this end each cylinder of the series is provided at one end with the usual supply and exhaust port 1^a (see Figs. 3, 5, and 6) and a passage leading therefrom to the chamber 11 of the reversing-valve 12, and from opposite points in said reversing-chamber 11 a corresponding passage leads to a port 2^a in a companion cylinder, which latter port is controlled by the piston of said second cylinder. Each cylinder is also provided with a port 3^a, (see Fig. 2,) communicating with the motive-fluid-supply chamber 14, and an exhaust-port 4^a, leading to the atmosphere, (see Fig. 2,) and said several ports may be in the same plane and so located as to be covered at all times by the piston of the cylinder.

8 8 indicate the cylinder-pistons, each of which is provided with two chambers 8^a 8^b, occupying different portions of the piston, the first, 8^a, arranged to open and maintain communication between supply-port 3^a and port 2^a during a certain portion of the travel of the piston, and the second chamber 8^b arranged to connect said port 2^a with the exhaust-port 4^a during a certain other portion of the travel of the piston. As a result of said arrangement of ports and chambers in the piston it will be seen that each piston constitutes a valve which controls the supply and exhaust ports of a cylinder other than its own. In order to balance the piston against lateral pressure incident to the location of supply or pressure port 3^a and passage 8^a, a passage or port 8^c of equal area (see Fig. 2) is formed on the opposite side of the piston 8, and the same communicates with the passage or port 8^a through the hollow wrist-pin 7^a, which connects the pitman 7 and piston 8.

Referring now to Fig. 6 of the drawings, where the ports and passages are shown in dotted lines, it will be noted that the passages (four in number) leading from the ports 2^a of the cylinders converge to the valve-chamber 11, and the passages leading therefrom to the ports 1^a diverge to the respective cylinders, and by reference to Fig. 5 (which is a horizontal section on parts of two different planes) it will also be noted that the passages leading from the pair of cylinders on the one side open vertically one above the other, but at a certain distance apart in a vertical direction, and the two sets of ports open into valve-chamber 11 at a position approximately forty-five degrees on each side of a center line drawn through the axis of chamber 11 and the axis of the intermediate shaft or drill-spindle 5. 12 indicates the reversing-valve, which is located in said chamber 11 and controls the relative connection of the passages 1^a 2^a, leading from the cylinders, to the said chamber of the reversing-valve. This valve, which is preferably of the plug type, (see Fig. 4,) is provided with two sets of passages 12^a and 12^b, the first of which, 12^a, pass directly through the valve from side to side, and the others, 12^b, pass through the valve in a plane at right angles to the plane of the first-named passages, but instead of passing in a plane at right angles to the axis of the valve the passages dip so that each port 12^b opens on the wall of the valve 12 at the same level as one of the ports 12^a and at the opposite point on the level of the other port 12^a, the vertical distance between the ports 12^a 12^a being equal to the vertical distance between the ports 1^a 1^a and 2^a

2^a, which lead from the cylinders to the valve-chamber 11. The valve 12 being in position in the valve-chamber 11, its four ports or passages will connect the four passages or ports 1^a of the cylinders with the four ports or passages 2^a of said cylinders, and the position of the plug-passages 12^a 12^b will determine the character of the connection and the direction of rotation. In order to more graphically illustrate the connection of the ports 1^a 2^a of the cylinders where they enter valve-chamber 11 with each other and with the valve 12 and its ports 12^a 12^b, diagrams, Figs. 8 and 9, have been introduced into the drawings, the diagram Fig. 8 illustrating the relation of the valve and ports when the motor is working in the direction of the arrow, Fig. 6, and diagram Fig. 9 illustrating the relation of the valve and ports when the motor is reversed. In the diagrams Figs. 8 and 9 the symbols F' F^2 F^3 F^4 indicate the points where the passages leading from the ports 1^a of the respective cylinders 1, 2, 3, and 4 enter the valve-chamber, and the symbols H' H^2 H^3 H^4 indicate the points where the passages leading from the ports 2^a of the respective cylinders 1 2 3 4 enter the valve-chamber, while the broken lines indicate how the said ports are connected by the position of the valve 12. By a comparison of Figs. 3 and 6 of the drawings, the first of which is a vertical section on the line *c c*, Fig. 1, and the second a horizontal section on the line *x x*, Fig. 2, it will be seen that the pistons of cylinders 1 and 3 are coupled to one crank-shaft, and the pistons of cylinders 2 and 4 are coupled to another crank-shaft, the cranks of said shafts being opposite on the same shaft and at right angles on the opposite shaft.

Referring now to Figs. 2, 3, and 6 and bearing in mind the relation of the ports of the several cylinders, as illustrated by the diagram Fig. 8, also assuming that the motor is working in the direction indicated by the arrow, Fig. 6, it will be seen that as the piston of cylinder 2 moves backward communication will be established by the chamber 8^b of said piston between the exhaust-port 4^a and the port 2^a in the cylinder of said piston, and this establishes communication between the back end of cylinder 1 and said exhaust-port, (on the diagram Fig. 8 from H^2 to F',) and this communication is kept open until the crank of said piston has moved one hundred and eighty degrees, by which time the piston of cylinder 1 has made one complete backward stroke and is at the back end of the cylinder. The piston of cylinder 2 then moves farther forward and establishes communication, by means of the chamber 8^a of said piston, between the ports 2^a and 3^a of said cylinder 2, and this admits the pressure from pressure-chamber 14 through ports 3^a 2^a of cylinder 2 and 1^a of cylinder 1, back of the piston of said cylinder 1. This admission of pressure back of the piston of cylinder 1 is continued until the piston of cylinder 2 has returned to the position shown in Fig. 6, when the pressure is shut off and the exhaust again opened, as previously noted.

By again referring to diagram Fig. 8 and following out the above-noted operation with each cylinder it will be seen that the piston of cylinder 1 controls the piston of cylinder 4, (diagram Fig. 8, H' to F^4,) the piston of cylinder 4 controls the piston of cylinder 3, (diagram Fig. 8, H^4 to F^3,) the piston of cylinder 3 controls the piston of cylinder 2, (diagram Fig. 8, H^3 to F^2,) and the piston of cylinder 2 controls the piston of cylinder 1, (H^2 to F',) as before set forth.

In order to reverse the motor, the reversing-valve is rotated through ninety degrees, (see Fig. 5,) when the relation of the passages connecting the ports 1^a 2^a will be changed from the illustration given in diagram Fig. 8 to that given in diagram Fig. 9, in which the piston of cylinder 1 controls the piston of cylinder 2, (diagram Fig. 9, H' to F^2,) the piston of cylinder 2 controls the piston of cylinder 3, (diagram Fig. 9, H^2 to F^3,) the piston of cylinder 3 controls the piston of cylinder 4, (diagram Fig. 9, H^3 to F^4,) and the piston of cylinder 4 controls the piston of cylinder 1, (diagram Fig. 9, H^4 to F'.)

The arrangement and operation of the motor being such as before pointed out, the power will be transmitted from the pinions 6^a 6^a of the crank-shafts 6 6 through the intermediate pinion 5^a to the intermediate shaft and drill-spindle 5 and thence by pinion 5^b to master-gear 10^a and main drill-spindle 10.

It will be noted that by so constructing the working cylinders and pistons that one shall control the supply and exhaust of another of the series separate valves are dispensed with and a more compact machine of less dimensions is obtained without loss of power and with an increased number of drill-spindles better located for working in corners, angles, and confined spaces.

Having thus described our invention, what we claim, and desire to secure by Letters Patent, is—

1. In a fluid-pressure motor, the combination of a plurality of cylinders arranged around a common center, each cylinder having a port at one end and also a plurality of ports located within the travel of its piston, one of said latter ports of each cylinder connected by a suitable passage with the end port of another cylinder of the series, a reversing-valve interposed in the passages which connect the several cylinders, and a piston for each cylinder of the series said piston having ports or passages adapted to establish communication between the plural ports of the cylinder located within its travel, substantially as and for the purposes specified.

2. In a fluid-pressure motor the combination with a cylinder having a supply-passage leading thereto, a supply-passage leading therefrom, and a pressure-port, the two lat-

ter so located as to be covered by the piston during its working stroke, of a piston having a port or passage adapted to establish communication between the pressure-port and the supply-passage leading from said cylinder and opposite thereto a port in the piston adapted to balance the lateral pressure on the piston; substantially as and for the purposes specified.

3. In a fluid-motor, the combination of four cylinders arranged in parallel relation around a common center, each of said cylinders having ports so located as to be covered by its piston during its working stroke, passages which connect the several cylinders with each other, a reversing-valve interposed in said connecting-passages, pistons for the respective cylinders, and a series of cranks with which said pistons are connected said cranks set at right angles to each other, substantially as and for the purposes specified.

4. In a fluid-pressure motor, the combination of four cylinders arranged around a common center, each cylinder having a port at one end, and a passage leading therefrom to a valve-chamber, each of said cylinders having also a plurality of ports located within the travel of its piston, a passage leading from one of said latter ports of each cylinder to said valve-chamber, the passages leading from one pair of said cylinders opening into the valve-chamber above each other in the same plane but at substantially right angles to the passages leading from the other pair of cylinders, a valve having two sets of ports therethrough in planes at right angles, one of said sets of valve-passages dipping or extending diagonally through the valve, and a piston for each cylinder said piston having ports adapted to establish communication between the plural ports of its cylinder, substantially as and for the purposes specified.

In testimony whereof we affix our signatures, in presence of two witnesses, this 27th day of July, 1900.

HENRY H. VAUGHAN.
CHARLES HARRIS JOHNSON.

Witnesses:
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GEO. I. MCELDOWNEY.