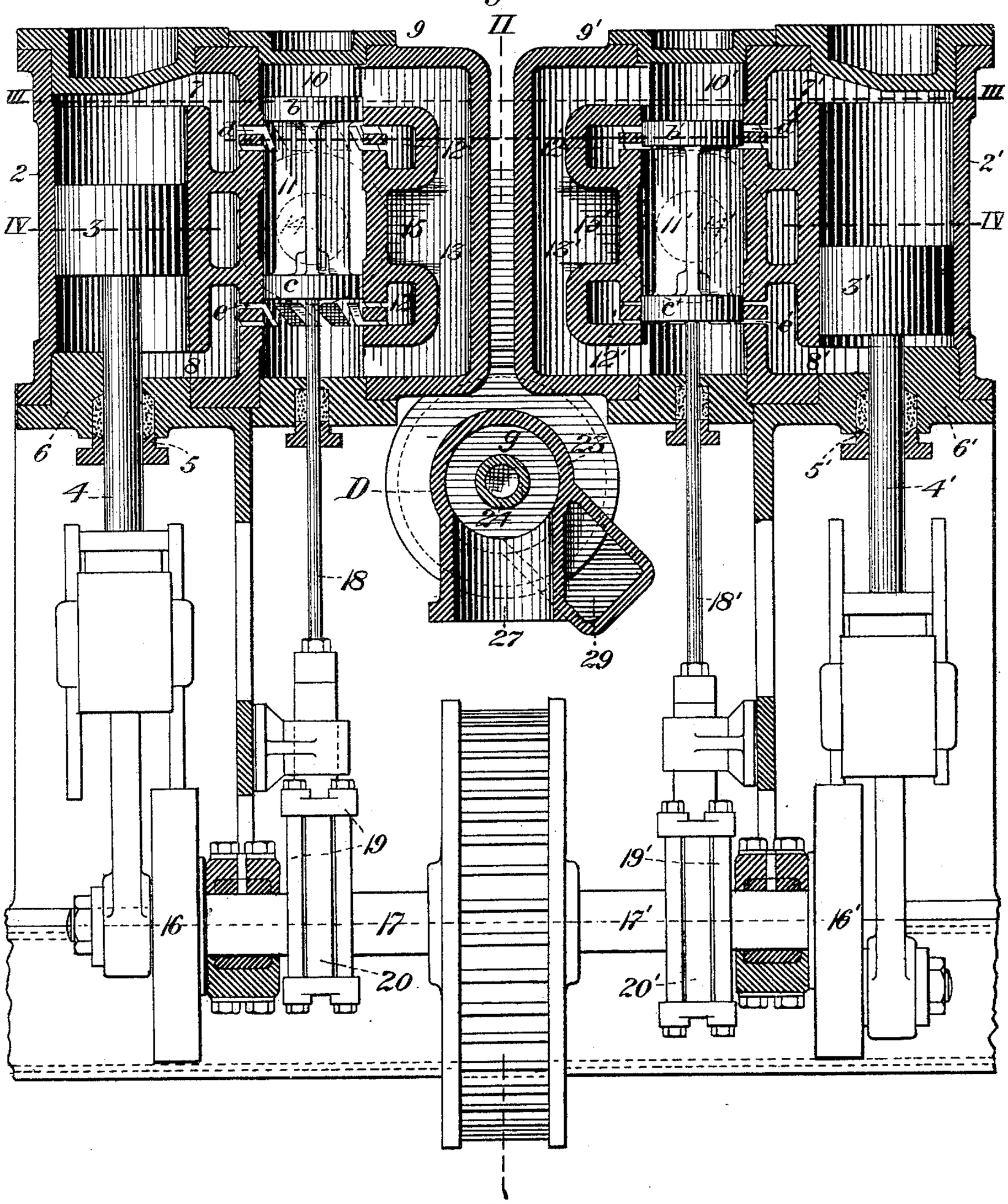
(No Model.) 4 Sheets—Sheet 1.

W. H. MADDOCK.

HYDRAULIC MOTOR.

No. 461,082. Patented Oct. 13. 1891.

Fig. 1.



WITNESSES.

Thomas W. Bakewell

N. B. Conwin

INVENTOR.

William H. Maddock

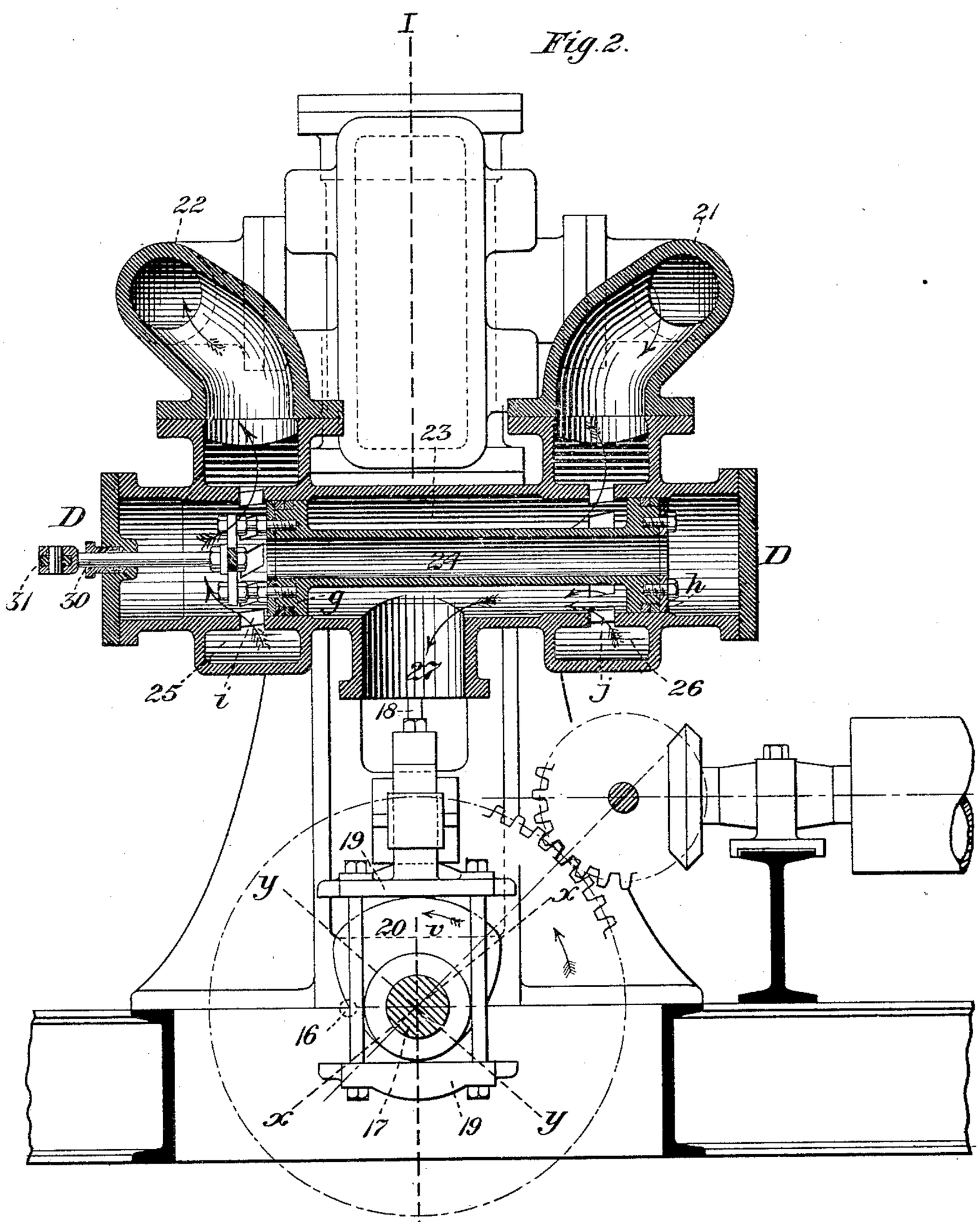
(No Model.) 4 Sheets—Sheet 2.

W. H. MADDOCK.

HYDRAULIC MOTOR.

No. 461,082. Patented Oct. 13, 1891.

Fig. 2.



WITNESSES.

Thomas W. Bakewell

S. Sherwood

INVENTOR.

William H. Maddock

(No Model.) 4 Sheets—Sheet 3.

W. H. MADDOCK.

HYDRAULIC MOTOR.

No. 461,082. Patented Oct. 13, 1891.

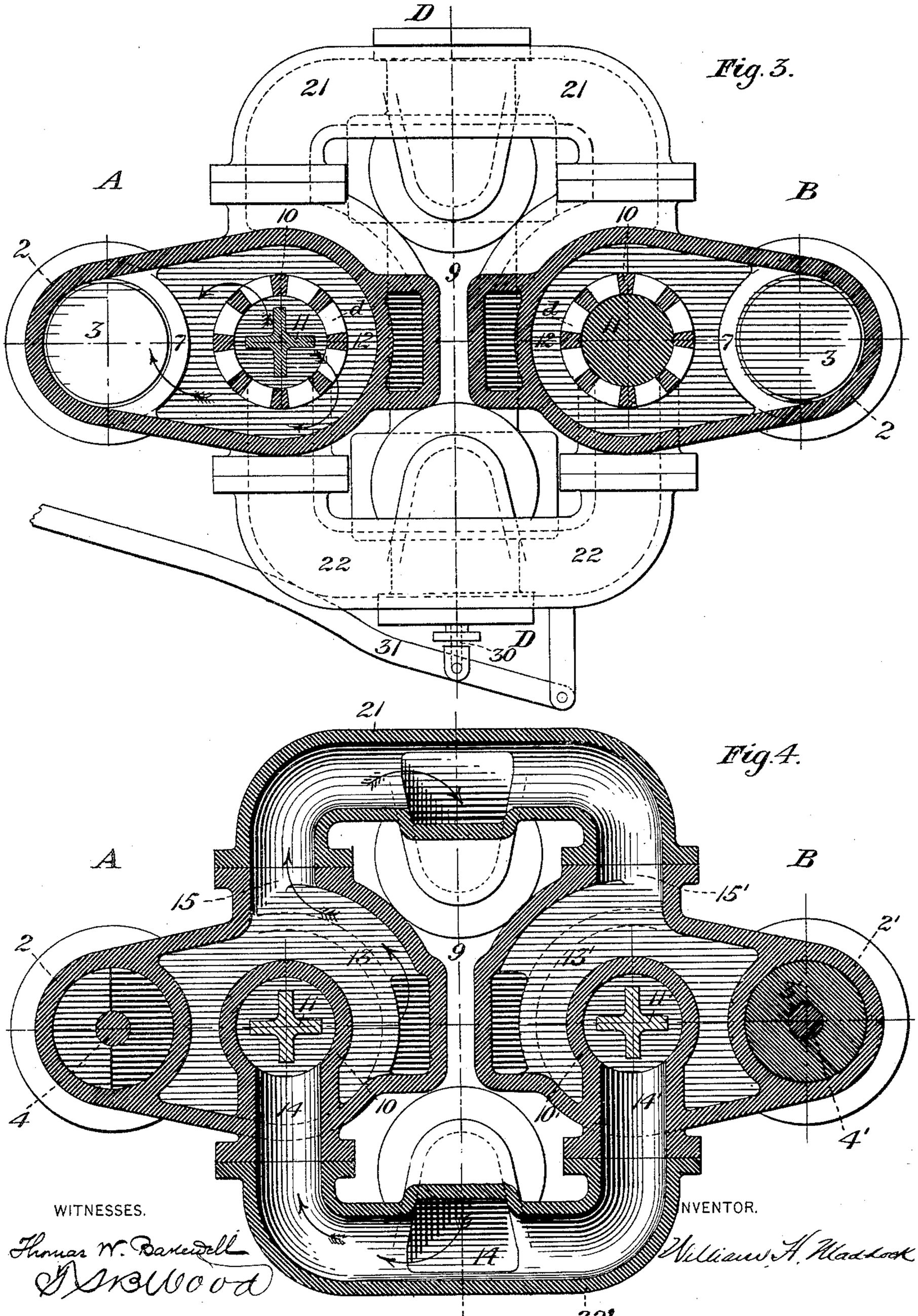


Fig. 3.

Fig. 4.

WITNESSES.

Thomas W. Bakewell

D. Sherwood

INVENTOR.

William H. Maddock

(No Model.) 4 Sheets—Sheet 4.

W. H. MADDOCK.

HYDRAULIC MOTOR.

No. 461,082. Patented Oct. 13, 1891.

Fig. 6.

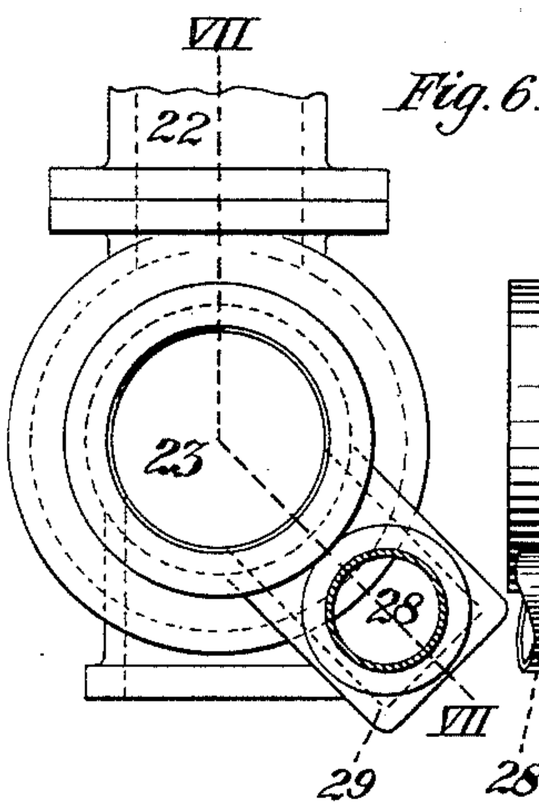


Fig. 5.

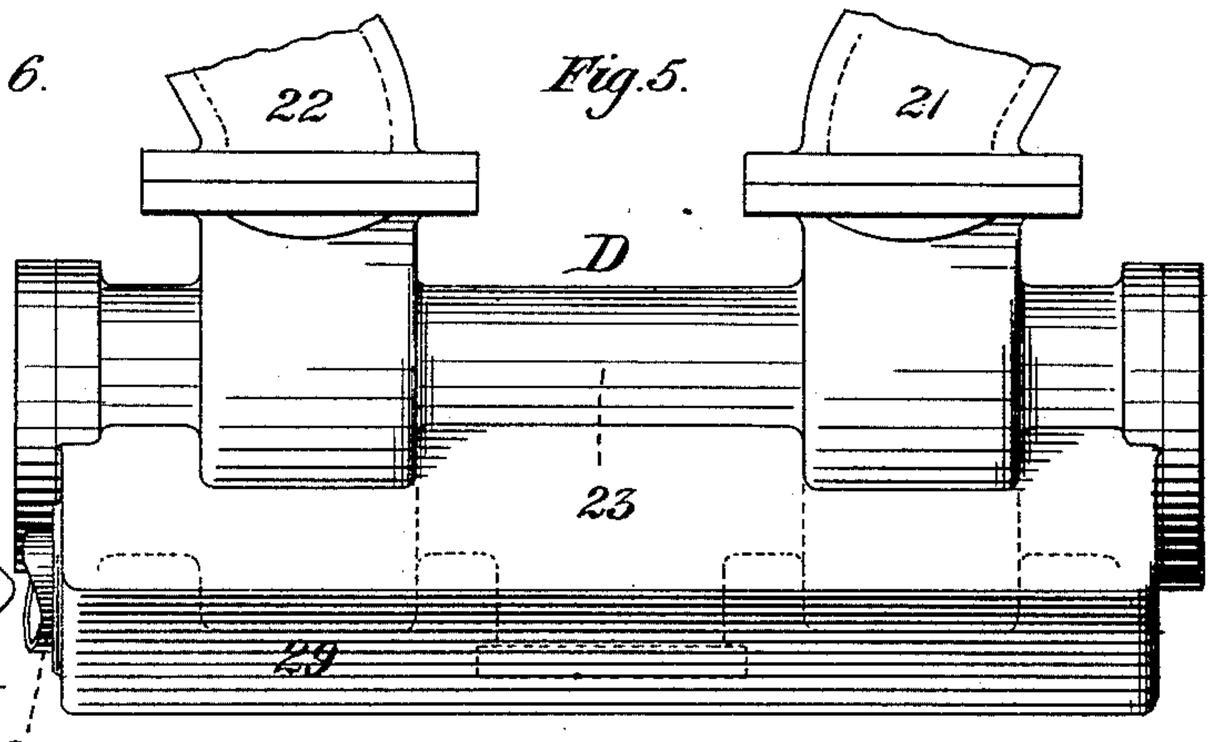


Fig. 8.

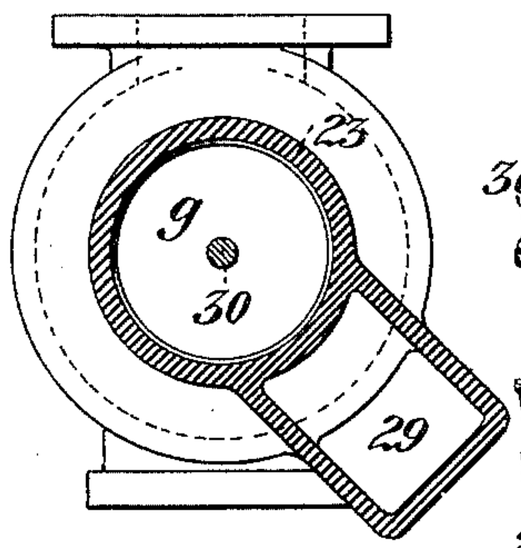


Fig. 7.

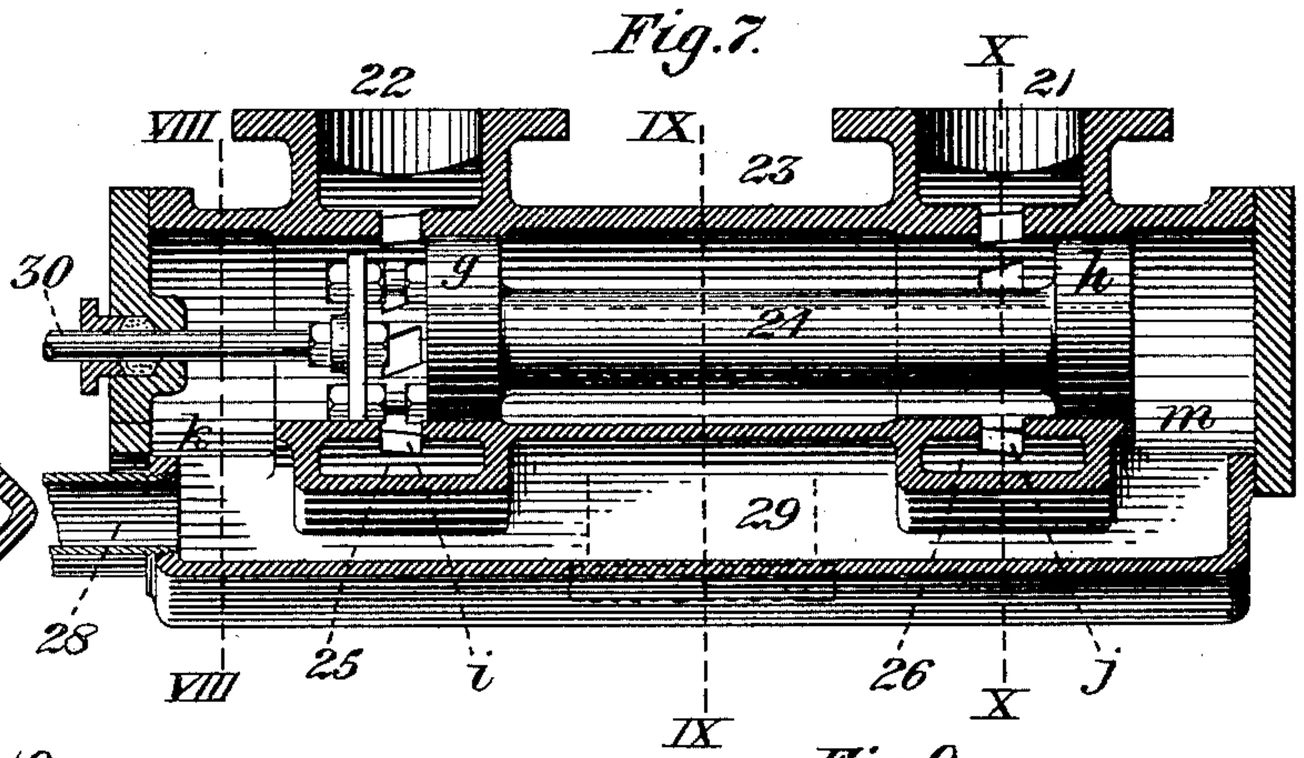


Fig. 10.

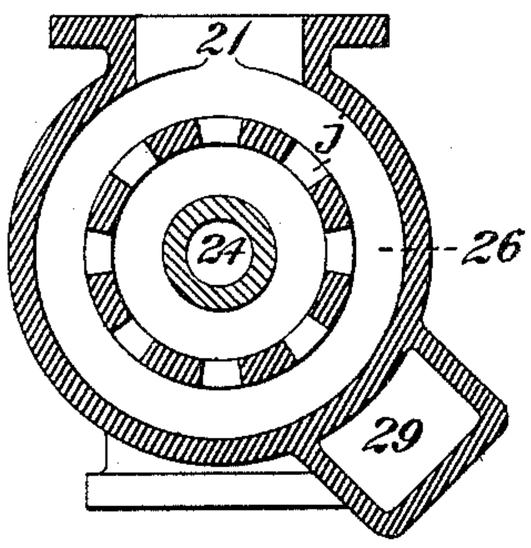
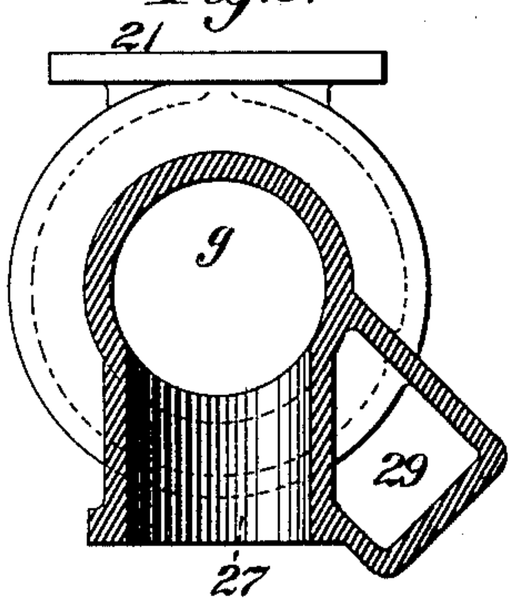


Fig. 9.



WITNESSES.

Thomas W. Bakewell

A. H. Atwood

INVENTOR.

William H. Maddock

UNITED STATES PATENT OFFICE.

WILLIAM H. MADDOCK, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR TO THE WHEATLAND IRON COMPANY, OF WHEATLAND, PENNSYLVANIA.

HYDRAULIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 461,082, dated October 13, 1891.

Application filed September 20, 1890. Serial No. 365,597. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM H. MADDOCK, of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Hydraulic Motors, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a vertical sectional view of the motor, showing the cylinders and pistons and valves, one of the pistons being at its full stroke and the other at the middle of its stroke, the section being on the line I I of Fig. 2. Fig. 2 is a vertical cross-section on the line II II of Fig. 1. Figs. 3 and 4 are horizontal sections on the lines III III and IV IV of Fig. 1. Fig. 5 is a side elevation of the reversing-valve. Fig. 6 is an end elevation thereof. Fig. 7 is a sectional elevation thereof, the section being on the line VII VII of Fig. 6. Figs. 8, 9, and 10 are vertical cross-sections on the lines VIII VIII, IX IX, and X X, respectively.

Like symbols of reference indicate like parts in each.

In the drawings I show two hydraulic motors A and B, coupled together with the same crank-shaft. Both motors are constructed in the same manner and a description of the details of one will serve for both.

2 is the motor-cylinder, 3 is the piston, and 4 is the piston-rod, which projects through a stuffing-box 5 in the cylinder-head 6. At the ends of the cylinder are ports 7 and 8, which extend around a considerable portion of the circumference of the cylinders, so as to afford a relatively large area for the admission and exhaust of water. The valve-chest 9 is preferably cast integrally with the cylinder, and has an internal valve-cylinder 10, in which is a piston-valve 11, having heads *b c* at the ends, and an intermediate stem of contracted cross-sectional area. Near the ends of the cylinder 10 are rows of lateral ports *d* and *e*, which open respectively into annular passages 12, communicating, respectively, with the ports 7 and 8 at the ends of the cylinder 2. Each of these rows of ports is of relatively large area as compared with the cross-section area of the cylinder 2, so as to conform to the area of the ports 7 and 8 and to afford a quick supply and exhaust. Thus the cross-sectional area of the cylinder may sixty-three (63) square inches and the area of each series of ports twenty-eight (28) square inches.

The ends of the valve-cylinder are open and communicate with the chamber 13 of the valve-chest surrounding the valve-cylinder. A water-passage 14 enters the middle of the valve-cylinder 10, through the walls of the valve-chest and of said cylinder, and another passage 15 leads from the chamber 13. The passages 14 and 15 lead to opposite ends of a valve-chamber D, as hereinafter described.

The parts of the cylinder 2 and valve-chest 9, and the several partitions forming the chambers and ports above described, may be cast in a single piece, as shown in Figs. 1, 3, and 4. The piston-rod of the cylinder 2 is connected to the crank 16 on the main shaft 17 of the motor, and the valve-stem 18 of the valve 11 is connected to a yoke or eccentric-box 19, which incloses a cam 20 on the main shaft. The side straps or bars of said yoke may fit against the faces on both sides of the cam, the periphery of which bears against the lateral straps or bars at the end of the yoke. The outline of the cam is shown in Fig. 2. A considerable portion of its circumference, about one-quarter ($\frac{1}{4}$,) (the highest portion,) is formed substantially on the arc of a circle whose center is in the axis of the main shaft, and an opposite portion of equal arc (the lowest portion) is similarly formed in concentric circular outline on a shorter radius. These portions of the circumference of the cam are included between the lines *x x* and *y y* of Fig. 2. Between these circular portions of the cam its outlines converge somewhat rapidly in curved lines. The middle of the highest part of the cam is preferably set about ninety degrees of arc in advance of the crank. From this construction it follows that during about one-quarter of the revolution of the main shaft the valve will be at its most advanced position, during the next quarter-revolution the valve will be rapidly retracted to its extreme back position, at which it will remain during the next

quarter-revolution, and during the succeeding quarter-revolution it will rapidly advance to its extreme forward position.

Suppose now that water under pressure be admitted to the valve-cylinder 10 through the port 14, and that the parts are in the position shown in Fig. 2 and at A in Fig. 1, the piston 3 being at the middle of its downstroke. The water will then pass through the ports *d* into the annular chamber 12 and thence to the cylinder 2 on the upper side of the piston, which it will force down, so as to turn the crank-shaft with the crank and cam in the direction of the arrow *v*. The water displaced from the lower end of the cylinder 2 will escape through the lower chamber 12 and ports *e* to the chamber 13 and thence through the port 15 to the exhaust-passage of the engine. For one-eighth of the revolution of the cam (one-quarter of the downstroke of the piston) the valve 11 will remain substantially in the position illustrated, so as to afford free communication between the supply-passage 14 and the ports *d* and between the chamber 13 and the ports *e*. At the end of this period, when the piston has traveled three-fourths of its downstroke, the cam begins to draw the valve down very rapidly, and when the piston completes its downstroke the valve will be moved to the middle of its downstroke, so that the heads *b* and *c* shall cover the ports *d* and *e*, respectively. Then as the piston begins its upstroke the cam, still moving the valve down, will cause the heads *b* and *c* to pass below their ports, so as to put the ports *e* into communication with the pressure-supply port 14 and the ports *d* into communication with the exhaust. The valve reaches its most widely-open position when the piston has completed one-quarter of its upstroke. It begins to close when the piston completes three-quarters of its stroke, and it closes at the end of the stroke of the piston. From this description the cycle of the successive operations of the engine will be understood.

As shown in Fig. 1 and in the figures on the third sheet of the drawings, the two motors are coupled together, their passages 15 being connected by a U-shaped pipe 21 and the passages 14 connected by a similar pipe 22. The parts of both motors are similarly constructed and arranged, and are indicated by the same reference-figures, distinguished by the prime (′) mark. Their pistons and valve-rods are connected with the same crank-shaft; but the cylinder-piston and valve of one motor are set one-quarter stroke in advance of the corresponding parts of the other.

I shall now describe the construction and operation of the valve D, by which I can throttle the water-supply to the motors or reverse the direction of their motion. The valve-chamber 23 is cylindrical in form, and is provided with a piston-valve 24, having two heads *g h*, connected by a hollow stem, the bore of which extends through the heads. The pipes 21 and 22 are connected, respectively, by branches with annular chambers 25 and 26 near the ends of the valve D, with which they communicate through the ports *i* and *j*. An exhaust-passage 27 leads from the middle of the valve-chamber between the valve-heads *g h*, and a water-supply pipe 28 enters a passage 29 in the valve-casing, which communicates with the ends of the valve-cylinder through ports *k* and *m*. The stem 30 of the valve extends through the head of the valve-chamber, and may be connected with a lever 31, by which the valve may be moved lengthwise. The valve is so constructed that the heads *g h* are separated for a space equal to the distance between the ports *i j*, so that by moving the valve in its chamber it may be set so that the heads shall cover and close these ports, or so that they shall be in either of the two positions on opposite sides of their respective ports. When the valve is set in the position shown in Fig. 2, the pipe 22 is in communication through the ports *i* with the water-supply pipe 28, while the pipe 21 through the ports *j* is in communication with the valve-chamber between the valve-heads and with the exhaust-passage 27. The motive-fluid is thus supplied to the motors through the pipe 22 and ports 14 14′, as above described, while the exhaust takes place through the ports 15 15′ and pipe 21. If it be desired to reverse the direction of the motor, the valve 24 is moved to the left in Figs. 2 and 7 sufficiently to cause the heads *g* and *h* to pass over the ports *i j* to the left sides thereof. This puts the ports *j* in communication with the water-supply passage 29, and the ports *i* in communication with the exhaust-passage 27. The water-supply then passes to the motors through the pipe 21, ports 15 15′, passage 13, while the exhaust takes place through the ports 14 14′ and pipe 22. The consequence is that the direction of motion of the motors is reversed, and the action of the pistons and their controlling-valves 11 11′, under these conditions, will be understood by the skilled engineer by reference to Fig. 1. The water-supply may be throttled to any desired degree by moving the valve 24, so that its heads *g h* shall partially close the ports *i* and *j* and may be cut off altogether by setting the valve, so that these heads shall close the ports. As shown in Figs. 2 and 7, these ports are cut diagonally in the valve-chamber, so that they shall be closed gradually when the valve is moved. The purpose of making the valve-stem hollow is to balance the valve and to prevent it from moving lengthwise in its chamber at the ends of the strokes of the pistons, as it would tend to do were its ends closed.

The power required for operating the motor may be applied to the water by suitable pumps, (not shown,) which may be used either with or without an accumulator.

The advantages of my invention will be appreciated by those skilled in the art.

By employing a motor-valve quick to open and close at the beginning and end of its stroke I secure a motor of great power, capable of running equally well at high and low rates of speed, and of great utility as applied to the driving of the parts of rolling-mill feed-tables, cranes, and other mechanism, where a motive agent capable of developing high power and easy to control is demanded. The construction of the admission and exhaust ports of large area relatively to the area of the cylinder contributes also to this end.

Another important feature of advantage of the apparatus consists in the fact that the two motors are the same in construction and may be cast from the same pattern, so that the cost of manufacture is reduced to a minimum.

Other points of advantage resulting from the construction of the apparatus in the manner indicated in the following claim will be apparent to the skilled engineer.

I claim—

A hydraulic motor comprising two motors A and B, their valves and valve-operating devices, the water-supply passages 14 and 14′ for said valves, and the U-shaped pipe 22 connecting them, the exhaust-passages 15 and 15′, and the U-shaped pipe 21 connecting them, combined with a throttle and reversing valve D common to both motors, substantially as described.

In testimony whereof I have hereunto set my hand this 4th day of September, A. D. 1890.

WILLIAM H. MADDOCK.

Witnesses:
THOMAS W. BAKEWELL,
W. B. CORWIN.