No. 753,644. PATENTED MAR. 1, 1904.

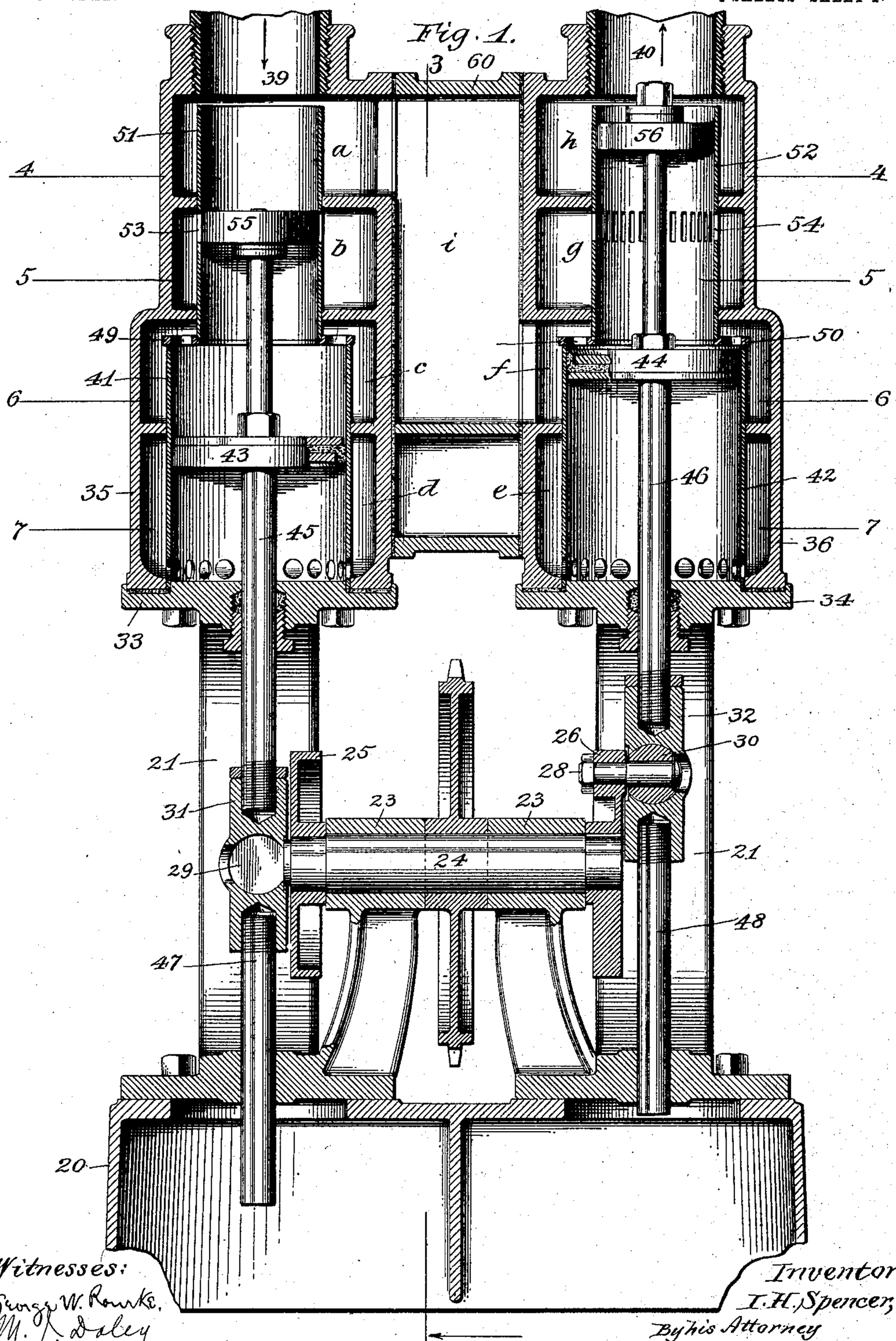
I. H. SPENCER.

MOTOR.

APPLICATION FILED JAN. 5, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1.



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NO MODEL. 4 SHEETS—SHEET 2.

Fig. 2.

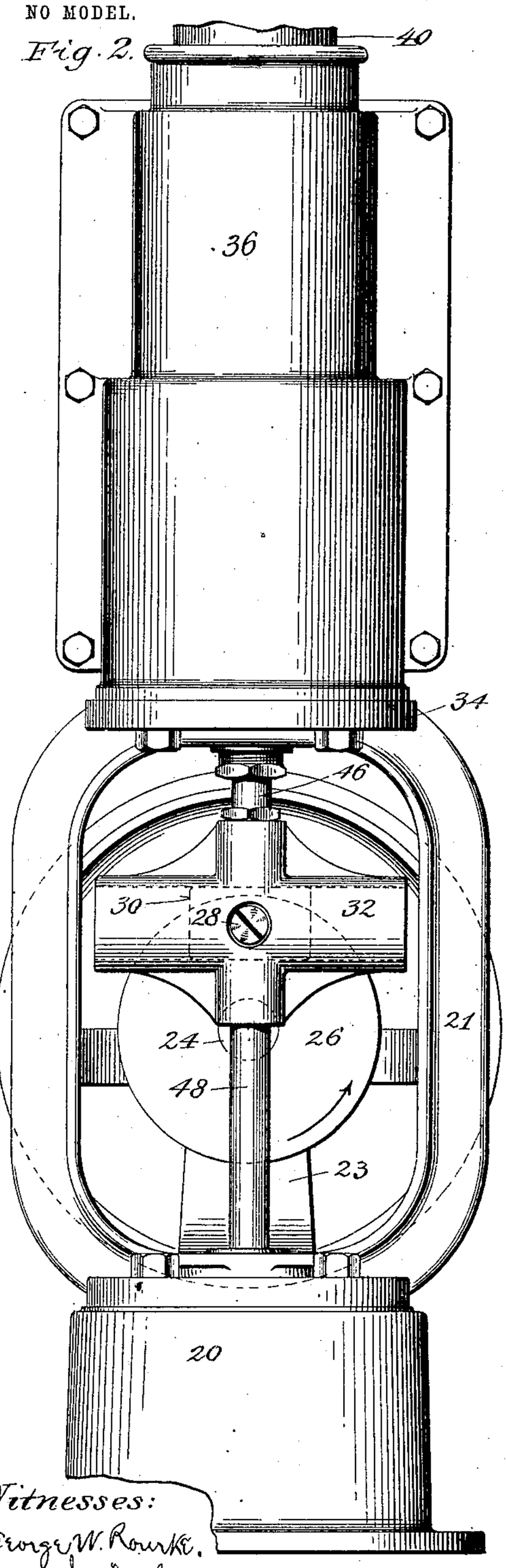
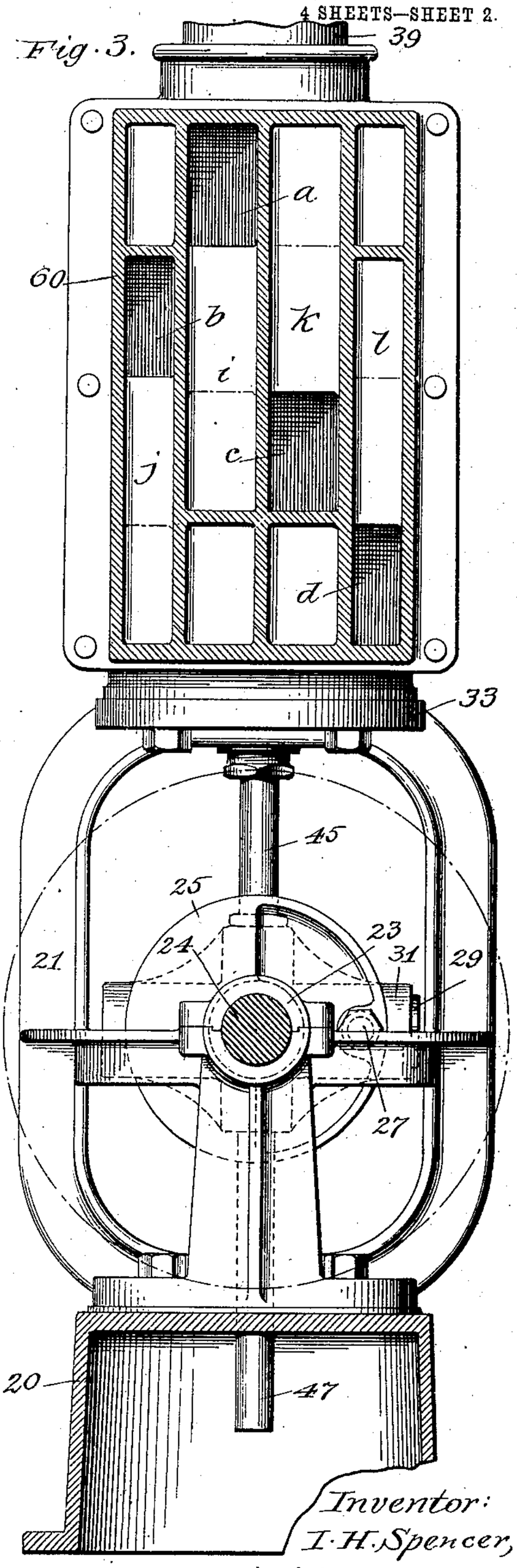


Fig. 3.



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NO MODEL. 4 SHEETS—SHEET 3.

Fig. 4.

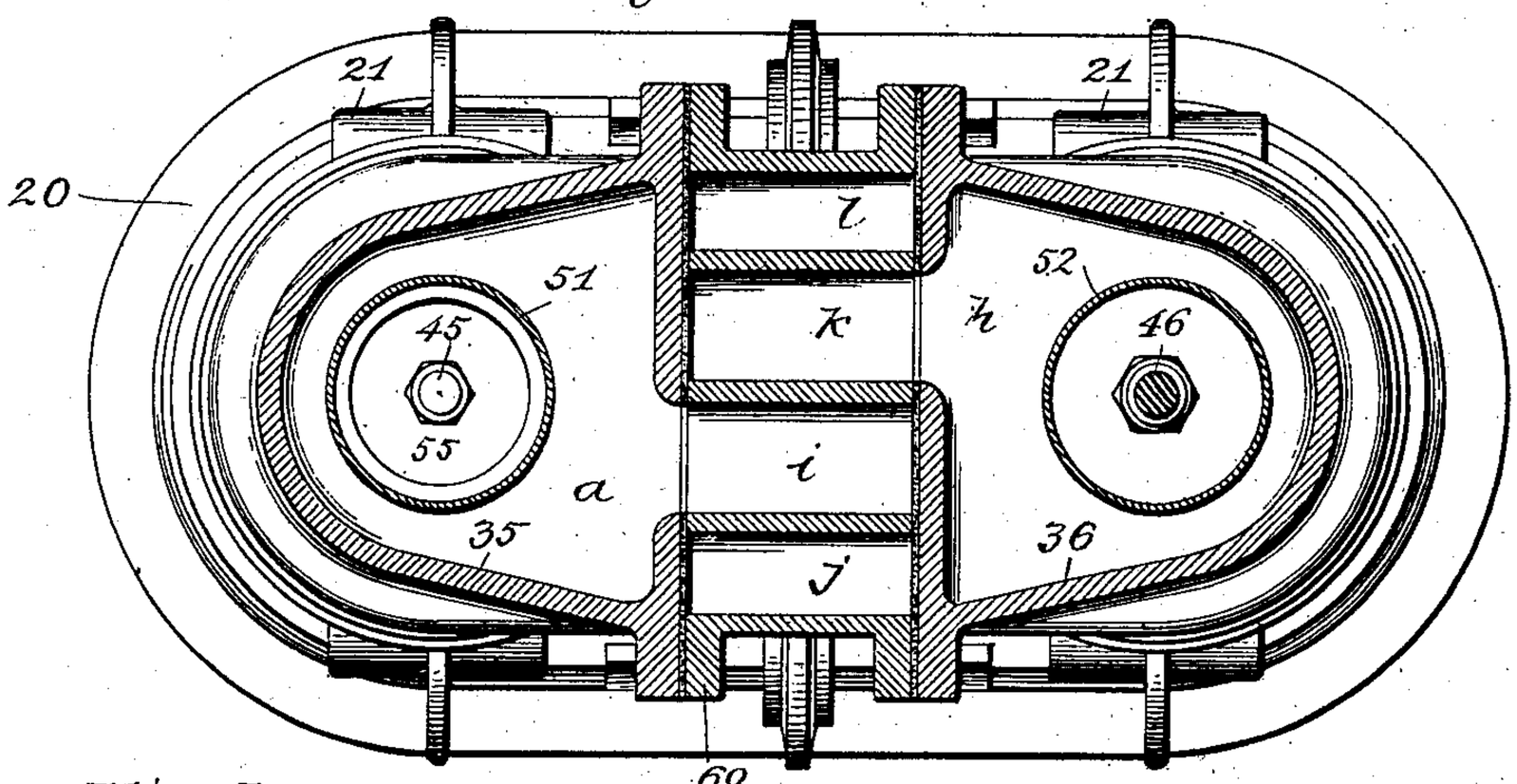


Fig. 5.

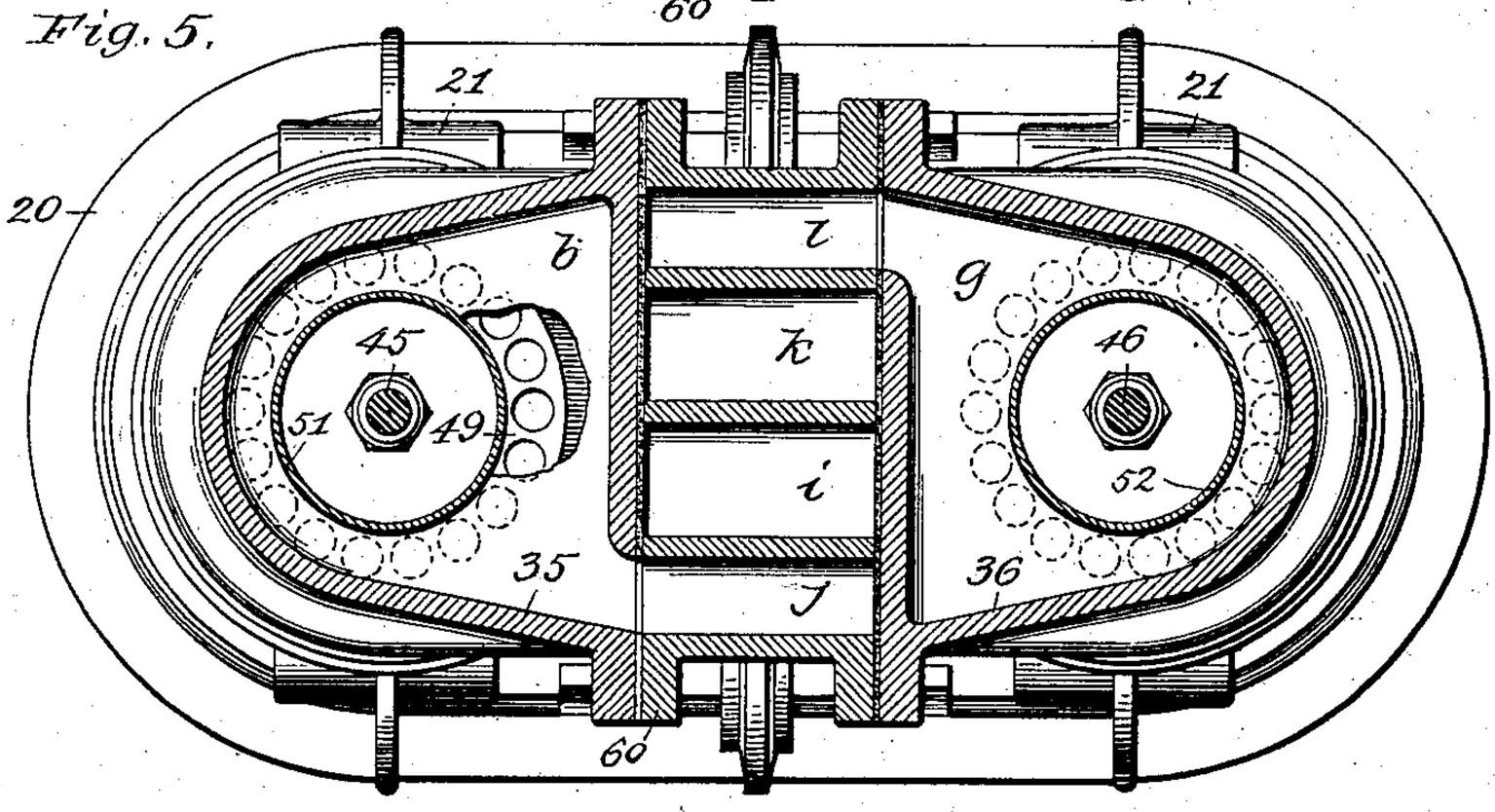
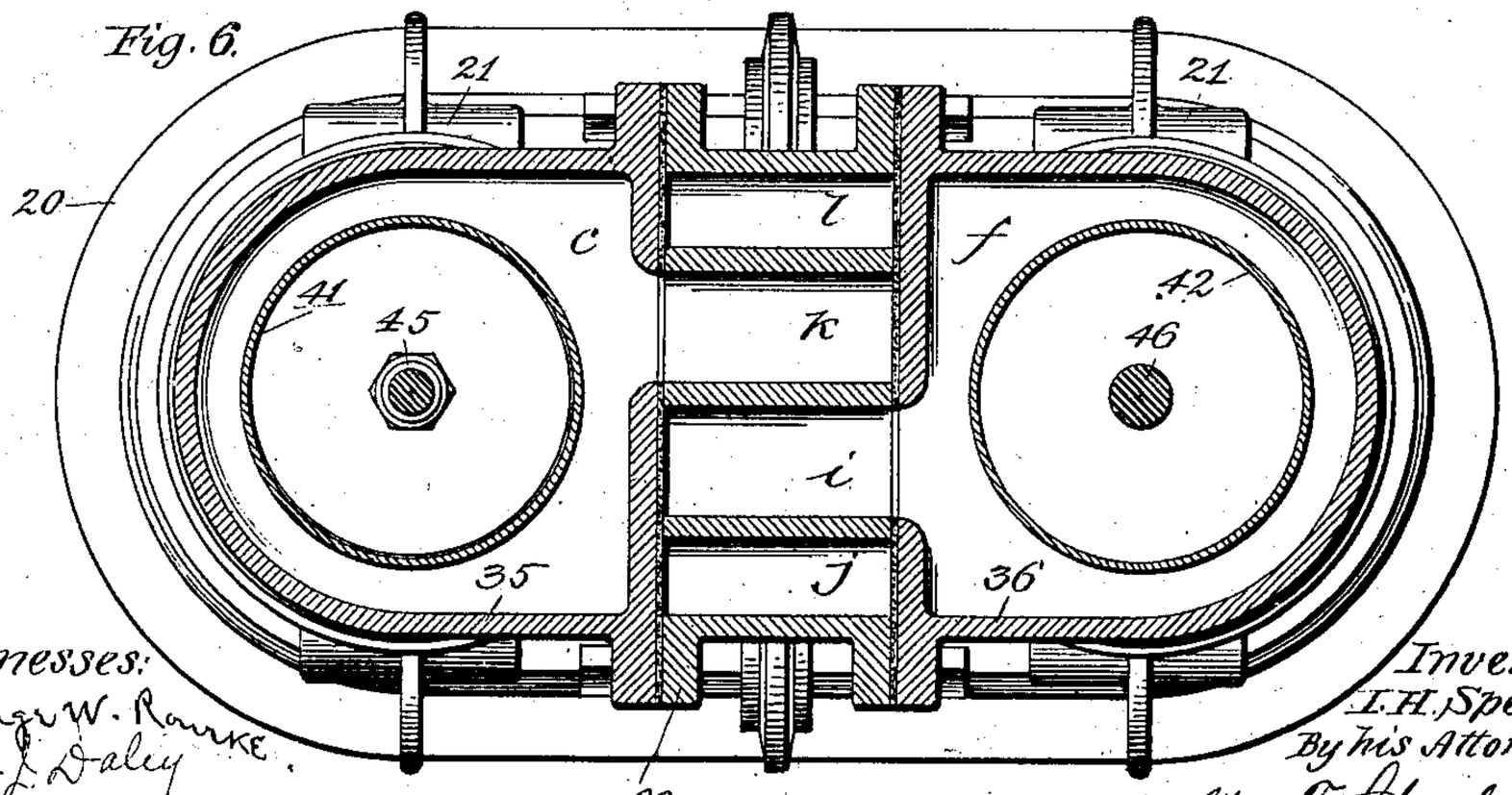


Fig. 6.



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MOTOR.

APPLICATION FILED JAN. 5, 1903.

NO MODEL. 4 SHEETS—SHEET 4.

Fig. 7.

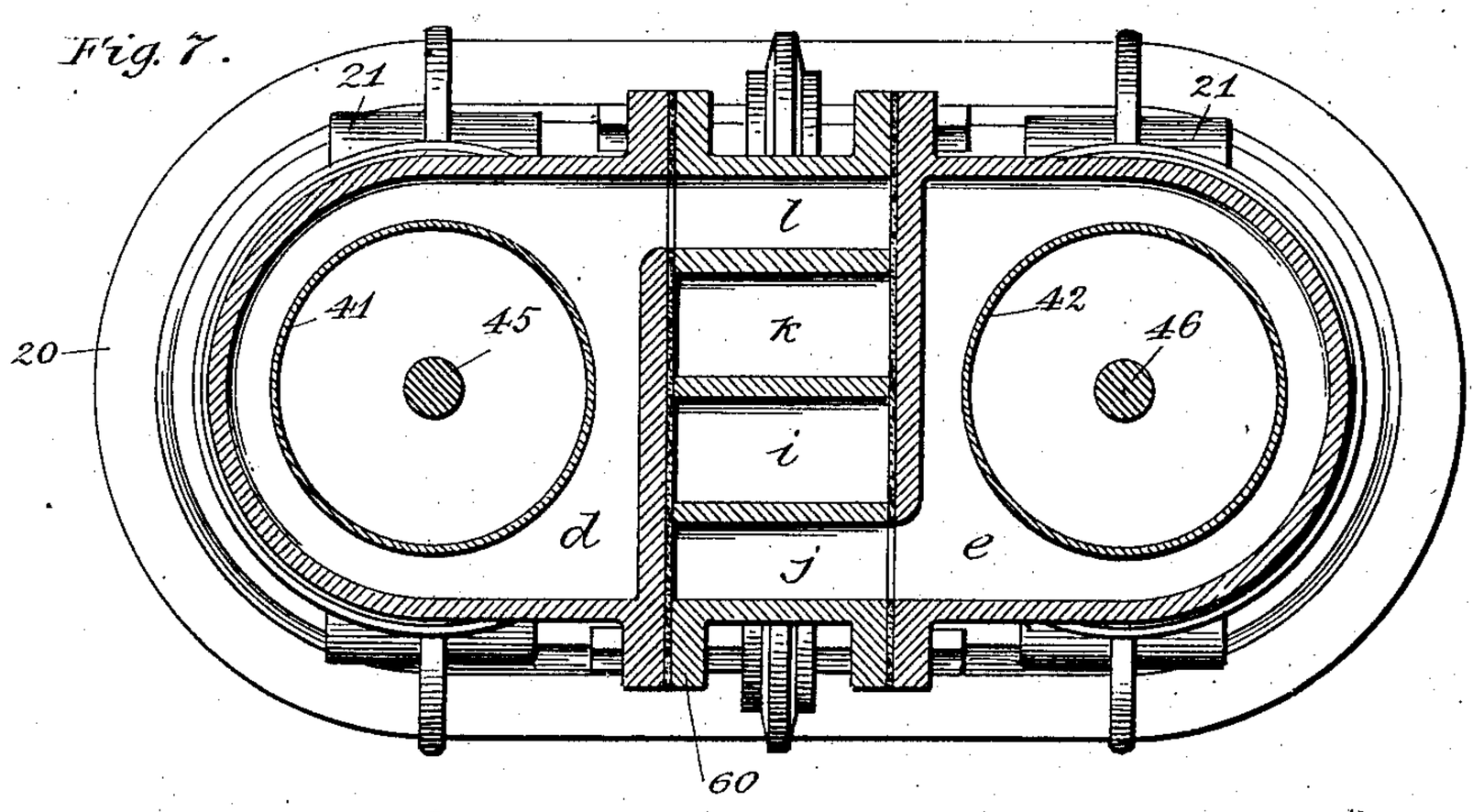


Fig. 8.

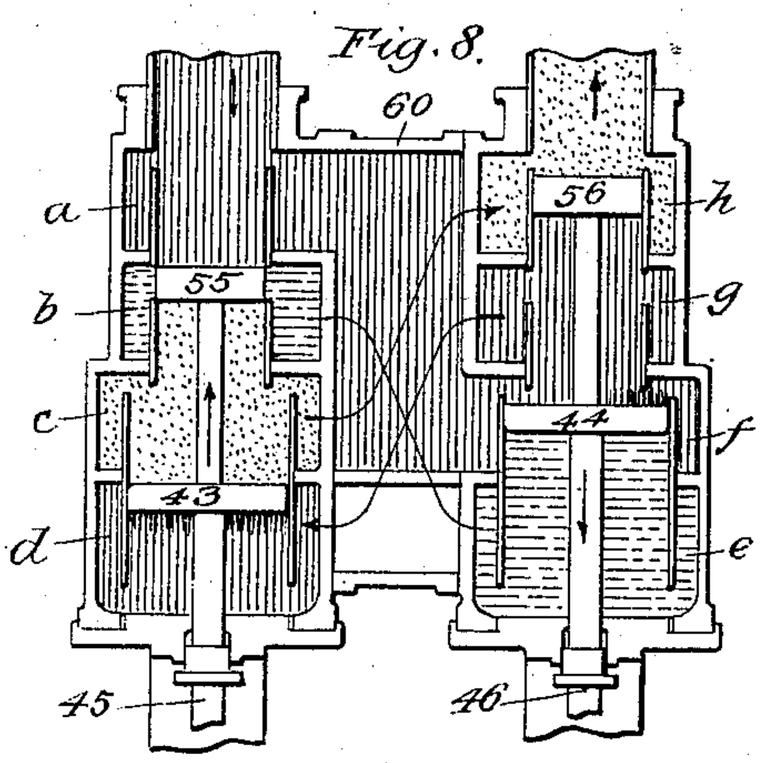


Fig. 9.

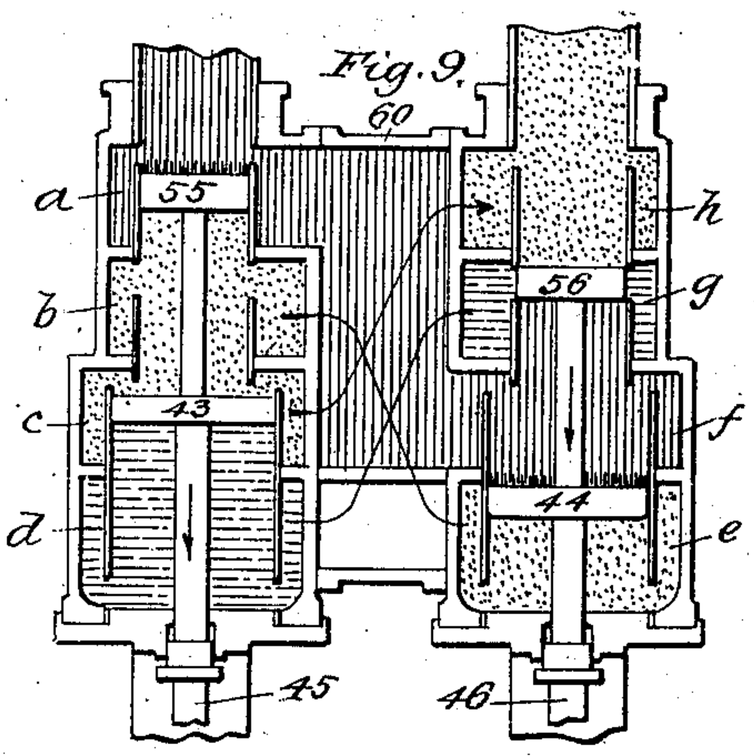


Fig. 10.

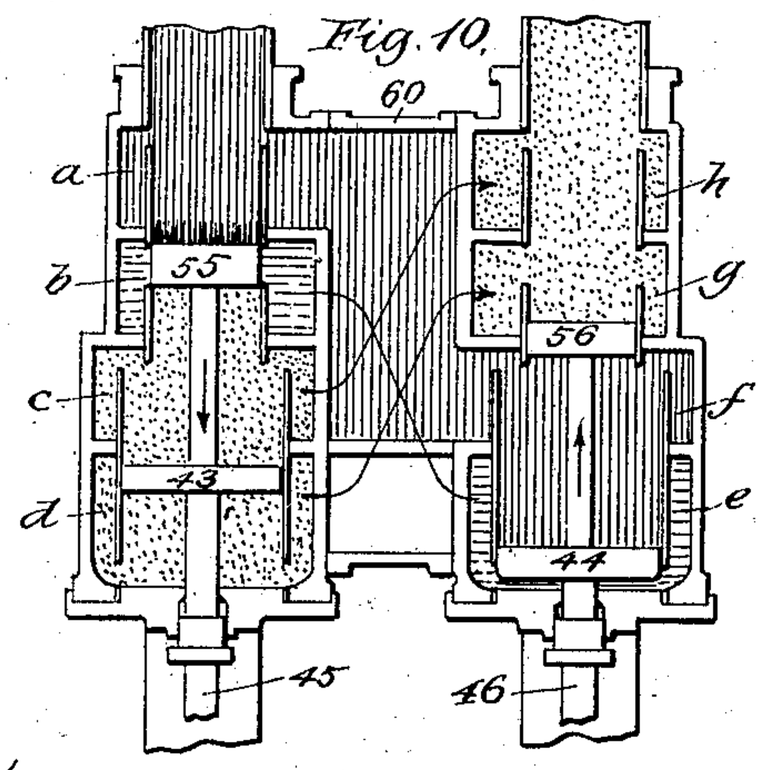
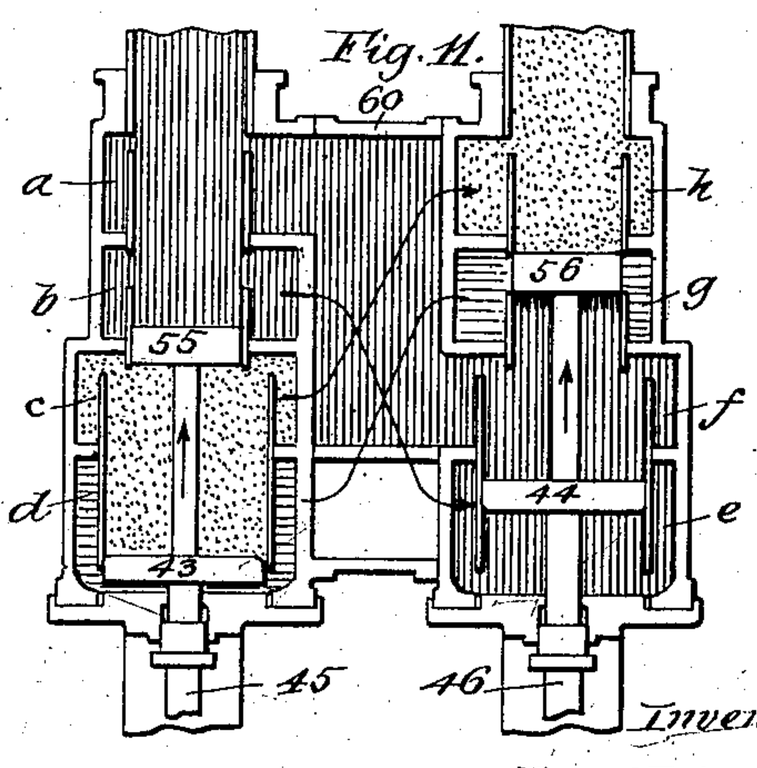


Fig. 11.



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No. 753,644. Patented March 1, 1904.

UNITED STATES PATENT OFFICE.

IRA H. SPENCER, OF HARTFORD, CONNECTICUT.

MOTOR.

SPECIFICATION forming part of Letters Patent No. 753,644, dated March 1, 1904.

Application filed January 5, 1903. Serial No. 137,879. (No model.)

To all whom it may concern:

Be it known that I, IRA H. SPENCER, a citizen of the United States, and a resident of Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Motors, of which the following is a full, clear, and exact specification.

This invention relates to motors, and more particularly to that class thereof in which a fluid under pressure may be used for supplying the motive power; and it has for one of its objects the provision of a machine of this class in which a pair of power-cylinders are employed in connection with a novel valve mechanism or distributing system. More specifically, the organization of this valve mechanism is such that the movement of one power-piston will be directly effective in controlling the fluid or power supply transmitted to the other without the aid of complex movement-producing or transferring devices generally in use in the art, so that, in fact, the power-controlling device for one cylinder will not only have the same amount of movement as the power-piston in the other cylinder, but will also move in unison therewith, thus determining the admission and the exhaust of the power-imparting fluid with a high degree of precision. One of the principal advantages gained by such close regulation and adjustment of the valve mechanism consists in the absence of leakage and in the avoidance of lost motion, which is generally in evidence when levers, links, &c., are used in effecting the necessary valve movement, and also in the absolute certainty with which power will be supplied to either piston by the movement of its mate and the valve carried directly thereby.

My invention has, furthermore, for its object the provision of a pair of cylinder-containing casings which are identical in construction, so that they may be made in quantities and finished alike and are thus interchangeable—a feature which is of great utility in practical work.

Furthermore, my invention comprises as one of its elements a channel-section whereby the ports of the oppositely-faced cylinder-casings may be brought into proper connection, so that the power-imparting fluid will at all times be conducted into its proper course.

Further objects of my invention may be found in the particular construction and organization of some of the component elements of my improved motor, as will be hereinafter described, and pointed out in the claims.

My invention is clearly illustrated in the accompanying drawings, in which—

Figure 1 shows a central longitudinal section of a motor embodying my improvements. Fig. 2 is a side view looking from the right of Fig. 1. Fig. 3 represents a section taken on line 3 3 of Fig. 1. Figs. 4 to 7, inclusive, are horizontal sections taken on lines 4 4, 5 5, 6 6, and 7 7 of Fig. 1, respectively; and Figs. 8 to 11, inclusive, are sections corresponding to Fig. 1, but on a reduced scale, illustrating the motor at different points of the piston-strokes to show the flow and action of the fluid at these periods.

It may be stated at this time that the member or shaft to which power is imparted by my improved motor may be connected with the pistons in any suitable manner and that the mechanism illustrated in the drawings is only the preferred form thereof and is used to facilitate the clear understanding of the particular relationship of the coöperating parts relative to each other, and it should also be understood that while the motor illustrated in the drawings is especially designed for the use of water as its power-imparting medium, yet any other suitable fluid or vapor may be employed.

In the drawings, in which similar characters denote similar parts, 20 denotes a suitable base on which uprights 21 are secured for supporting the motor-cylinders to be hereinafter described. Attached to or forming a part of the uprights 22 are bearings 23 for supporting a power-transmitting member or shaft 24, carrying at its outer ends crank-disks 25 26, which are preferably set at right angles, so that when one piston is on "dead-centers" the other piston will have its maximum efficiency. The crank-disks 25 26 are provided with crank-pins 27 28 in engagement with slides 29 30, which are transversely movable in cross-heads 31 32, the movements of which

are vertically reciprocatory and determined relation to each other by the position of the crank-pins. This particular fact, although common and in frequent use, has been emphasized in the above manner, inasmuch as it performs certain functions pertaining to the valve-sections which are directly dependent upon the maintenance of this relationship.

The tops of the uprights 22 are made in the form of heads 33 34, respectively, for receiving casings 35 36, in which the working cylinders as well as the valve-cylinders are secured. Furthermore, each of these casings is divided into consecutive sections or chambers, preferably four in number, the separating walls or partitions fitting tightly against the respective cylinders. In Fig. 1 of the drawings the casing 35 at the left is what may be termed the "supply-casing," water being induced through a pipe 39 into the first or uppermost chamber *a*, while the correspondingly-disposed chamber *h* of the casing 36 constitutes an exhaust-chamber, from which the waste water may be conducted through a pipe 40. The casings 35 36 are provided with power-cylinders 41 42, the lower ends of which are apertured to maintain constant communication between the interiors of these cylinders and the chambers *d e*, respectively, which surround the same with a water-space sufficient to prevent choking or back pressure.

Mounted for reciprocation in the cylinders 41 42 are pistons 43 44, carried by piston-rods 45 46, respectively, which in turn are secured to the cross-heads 31 32 above mentioned, guide-rods 47 48 being provided at the lower ends of said cross-heads to insure perfect straight-line movements and to prevent cramping.

Disposed above the cylinders 41 42 and preferably positioned relatively thereto by foraminous separators 49 50 are valve-cylinders 51 52, having ports 53 54 in communication with valve-chambers *b g* of the casings 35 36, respectively, and having pistons 55 56 operative therein, these pistons being mounted on and carried directly by the piston-rods 45 46, above referred to, so that their movements will be in unison therewith.

In order to provide conduits for the passage of water between the cylinders or, more properly speaking, between the casings 36 36, I preferably employ what may be called a "channel," interposed between said casings, this channel-section being designated by 60 and comprising a series of compartments *i j k l*, (see Fig. 3,) whereby constant communication may be maintained between the chambers *a f*, *b e*, *c h*, and *d g*, respectively, the several compartments being ported adjacent the channel 60, as is clearly shown in Figs. 1, 3, 4, 5, 6, and 7. Here it will be seen that the chamber *a* opens into the channel-section *i*, which in turn opens into the chamber *f*, so that these chambers are always in communication. Hence it follows that when water under pressure is admitted into the chamber *a* the chamber *f* will also be filled with pressure, and for this reason the chambers *a* and *f* may properly be called "pressure-chambers." In a like manner the chambers *c* and *h* are in constant communication through the channel-section *k*, so that inasmuch as the chamber *h* is directly connected with the exhaust or waste pipe both chambers *c* and *h* may properly be termed "exhaust-chambers." The valve-chamber *b* is connected with the chamber *e* by the channel-section *j*, while constant communication is maintained between the valve-chamber *g* and the chamber *d* through the channel-section 1, as will be readily understood. Now since the chamber *f* always contains water under pressure the cylinder 42 may justly be called the "primary" cylinder, while the chamber *c* is always connected with the exhaust, and the cylinder 41 may therefore be termed the "secondary" cylinder, and in order to safeguard against leakage or waste of water it is essential that the opposite ends of each of the valve-cylinders shall never be in connection with each other, so that the length of the ports in said valve-cylinders must not exceed the thickness of the valve-pistons. At the same time, owing to the fact that when one piston is at dead-centers the other working piston is at half-stroke, the ports in the valve-cylinders should be positioned in alinement with the valve-piston at half-stroke in order to avoid back pressure and to insure pressure-supply for the traveling piston at the right moment.

In connection with the above it should be stated that experience has shown that if for some season the adjustment of the valve-pistons relative to the ports should become deranged air-chambers may be advantageously utilized for relieving the choke of water, which would otherwise result in breaking or stopping the motor, such air-chambers being placed in communication with the valve-chambers *g* and *b*—as, for instance, by direct connection with the channel-sections *j* and *l*, opening into the same.

The operation of my improved motor may be readily understood by referring to Figs. 8 to 11, inclusive, in which the conditions of the water have been graphically represented by different shadings. In Fig. 8 water under pressure is admitted to the chamber *a* and through the channel *i* into the chamber *f*, therefore acting against the upper side of the valve-piston 55 and also filling the space between the pistons 44 and 56. Now inasmuch as the ports 54 are uncovered it follows that water under pressure will also enter and fill the chamber *g* and traverse the channel *l* and into the chamber *d*, thus acting against the under side of the working piston 43, while any water between the pistons may find exit from the chamber *c* through the channel *k*

into the exhaust-chamber *h*, so that the piston-rod 45 will be forced upward by the piston 43 on account of its area being greater than that of the piston 55. For a similar reason the piston 44 is about ready to force the piston-rod 46 downward and will act in this manner as soon as the valve-piston 55 has commenced to uncover the ports 53, when the water beneath the piston 44 will be free to pass through the chamber *e*, the channel *l*, into the chamber *b*, through the ports 53, between the pistons 55 and 43, into the exhaust-chamber *c*. In Fig. 9 the crank-shaft has made a movement of ninety degrees, and the piston-rod 45 has arrived at the upper end of its stroke, while the piston-rod 46 has descended one-half of its stroke. Here the piston 44 is still active in forcing the rod 46 downward, while the valve-piston is about to uncover the ports 54, and thus permit the water under the piston 43 to escape through the chamber *d*, channel *j*, chamber *g*, and ports 54 into the exhaust-chamber *h*. At the same time pressure is applied to the upper side of the piston 55, which will now become in reality a working piston effective in pushing the rod 45 downward, and thus assist the piston 44 in its function of rotating the shaft. In Fig. 10 the piston-rod 46 has arrived at the lower end of its stroke, the valve-piston 55 is at half-stroke, and therefore at its maximum efficiency as a working piston, while at the same time it is about ready to open the ports 53 to permit pressure-water to pass through the chamber *b*, channel *l*, and chamber *e* against the under side of the piston 44, which thus becomes effective in assisting the piston 55 in rotating the shaft. In Fig. 11 the piston-rod 45 is shown at the lower end of its stroke and the rod 46 is at one-half its upstroke, and therefore at its greatest efficiency. The piston 56 is now about to uncover the ports 54 and to permit pressure-water to enter the chamber *g*, channel *j*, chamber *d*, and thus act on the piston 43 during its upstroke, of which Fig. 8, above referred to, shows the half-stroke position.

From the foregoing it will be understood that it is of the utmost importance that the relationship between the travel of the valve-pistons and the ports be closely adjusted, as shown in Fig. 1. Owing to the mechanism regarding the crank-shaft and its connection with the pistons one piston will always be exactly at half-stroke when the other is at dead-centers; but it should be understood also that such relationship is not essential to the proper operation of my improved motor, and a connecting or pitman rod between the crank-pins and the pistons operative therewith, respectively, may be used with equal facility.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a duplex motor, the combination, with a pair of power-cylinders; and double-action pistons operative therein; of a pair of valve-cylinders having ports; valve-pistons moving in unison with said power-pistons, respectively, and for controlling the admission of fluid into one power-cylinder by the movement of the valve-piston in the other valve-cylinder.

2. In a duplex motor, the combination, with primary and secondary cylinders, each comprising sections of different areas; and double-action pistons operative therein; of a channel-section interposed, and for permitting the passage of fluid, between said cylinders; and passages for permitting the admission of fluid into one cylinder, and controlled by the movement of the smaller piston in the other cylinder.

3. In a duplex motor, the combination, with a primary cylinder comprising a pair of alined sections of different areas; and a double-action power-piston operative in one of said sections; of a secondary cylinder; a double-action piston operative therein; a channel-section interposed, and to permit the passage of fluid, between said cylinders; a valve-piston operative in the other section and movable in unison with said power-piston, and for controlling the admission of fluid to the secondary cylinder.

4. In a duplex motor, the combination, with a pair of casings; and double-action piston operative therein, each of said casings having chambers, and each comprising a power-cylinder and a valve-cylinder, the latter having less area than the former; of a channel-section interposed between said casings, and to permit the passage of fluid from the chambers of one casing to those of the other, respectively.

5. In a duplex motor, the combination, with a pair of casings, each having a series of chambers and each comprising a power-cylinder and a valve-cylinder; and double-action pistons operative in the power-cylinders; of a multiple-way channel-section between said casings, and for maintaining communication between the chambers disposed at opposite sides of the working pistons; and means for controlling the admission of fluid into one power-cylinder by the movement of the valve-piston in the other valve-cylinder.

6. In a duplex motor, the combination, with a primary cylinder, comprising sections of different areas, one of said sections having ports; and a valve-piston, the thickness of which is substantially equal to the length of said ports; of a secondary cylinder, comprising a power-section; a piston operative therein; and means for controlling the supply of fluid for the secondary piston by the movement of the primary valve-piston.

7. In a duplex motor, the combination, with a primary cylinder, comprising sections of different areas, one of said sections having ports disposed in alinement with the valve-piston in its half-stroke position; and pistons operative in said section; of a secondary cyl-

inder, comprising a power-section and a valve-section; pistons operative in said sections; and means for controlling the supply of fluid for the secondary piston by the movement of the primary valve-piston, and vice versa.

8. In a duplex motor, the combination, with a pair of casings, each comprising a supply-chamber, an exhaust-chamber, a port-chamber, and cylinders; and double-action pistons operative therein; of conduits between said cylinders; and means for controlling the admission of fluid into the chambers of one casing by the movement of the piston in the other casing.

9. In a duplex motor, the combination, with a pair of casings, each having a supply-chamber, an exhaust-chamber, and a port-chamber intermediate the pressure and the exhaust chambers of each casing; power-cylinders in said casings; a piston operative therein; of conduits between said cylinders and of means for controlling the admission of fluid into the chambers to one casing, by the movement of the piston in the cylinder of the other casing.

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