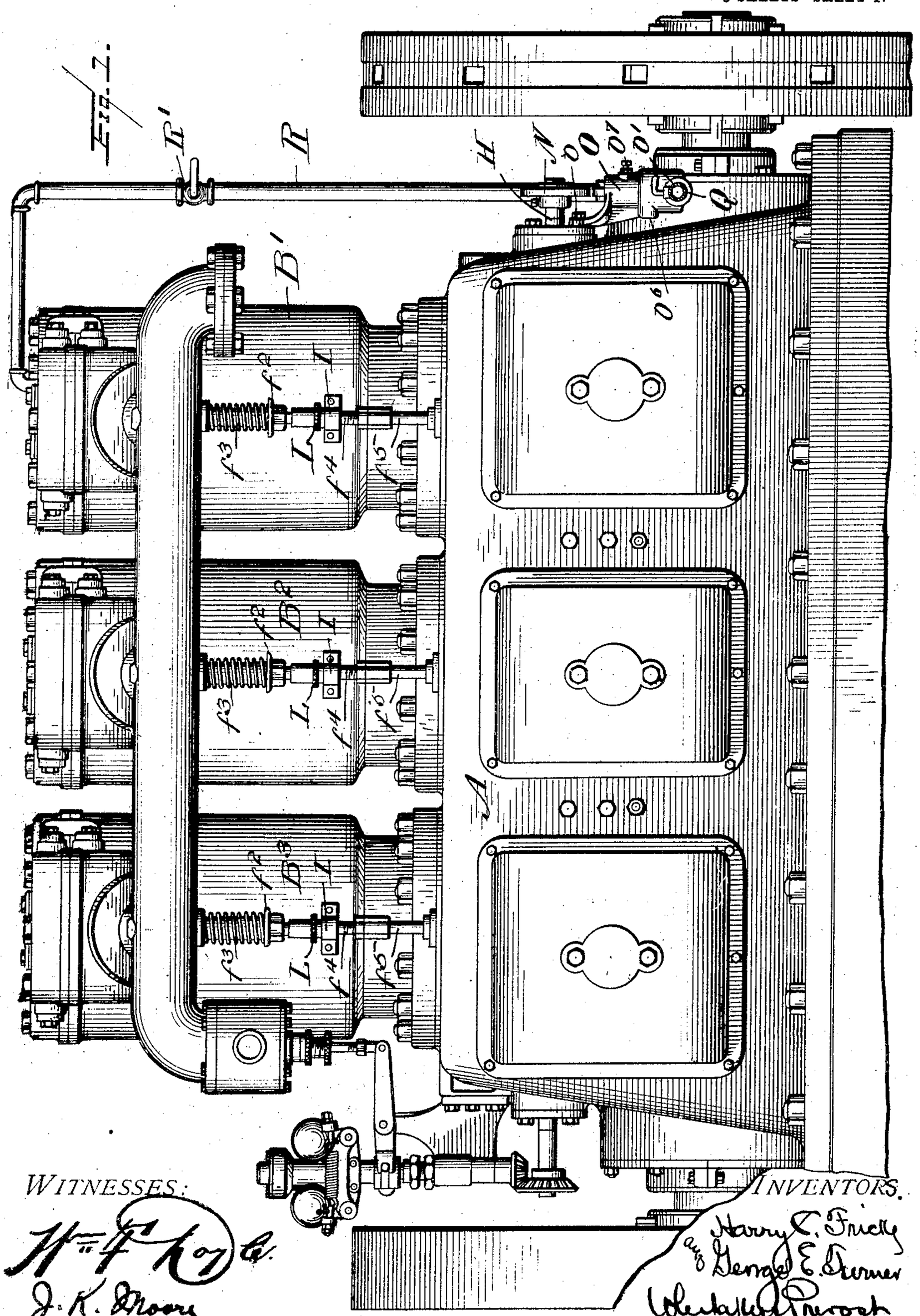
No. 888,007. PATENTED MAY 19, 1908.

H. C. FRICKE & G. E. TURNER.

STARTING MECHANISM FOR EXPLOSIVE ENGINES.

APPLICATION FILED MAR. 23, 1907.

5 SHEETS—SHEET 1.



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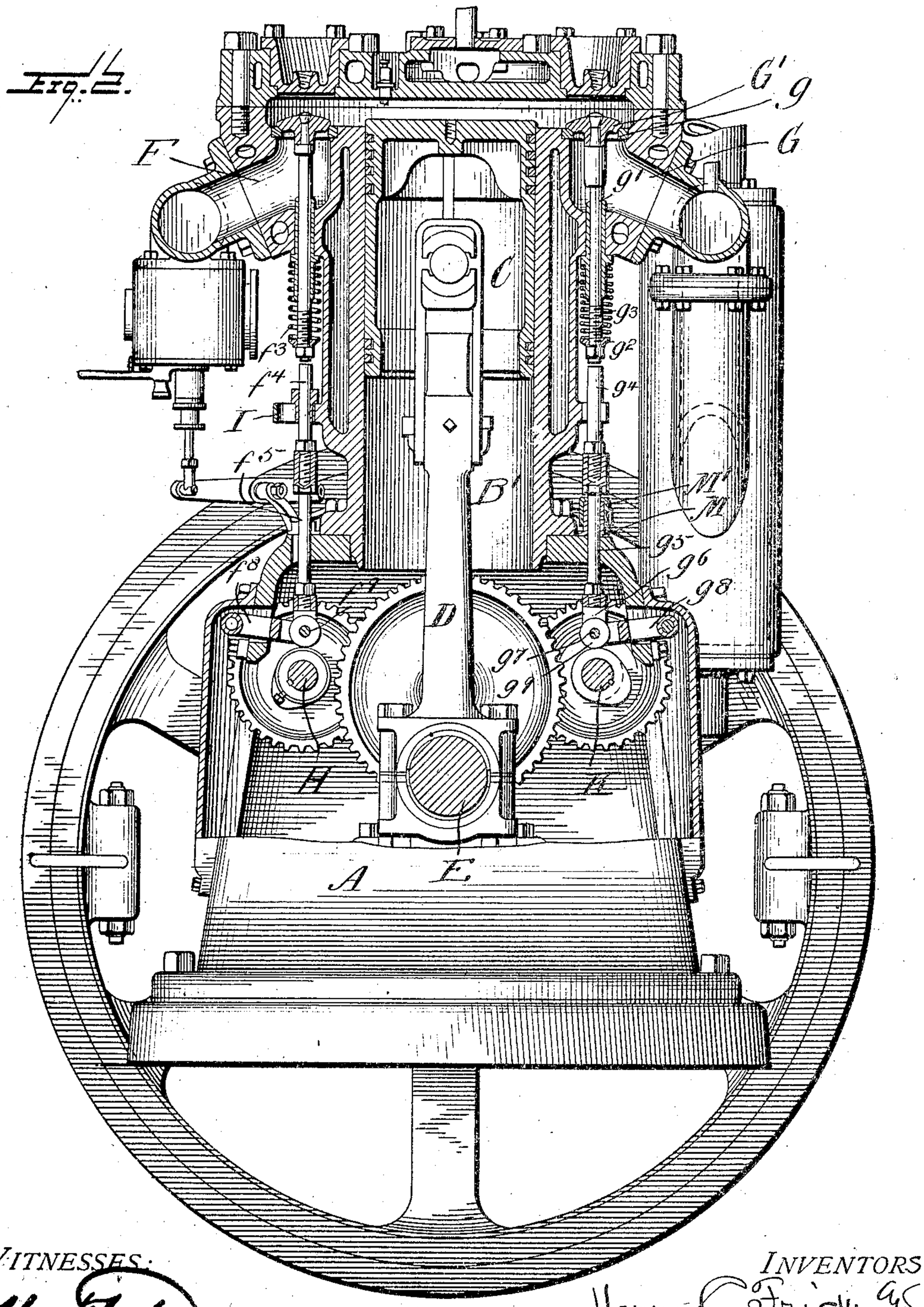
5 SHEETS—SHEET 2.

Fig. 2.



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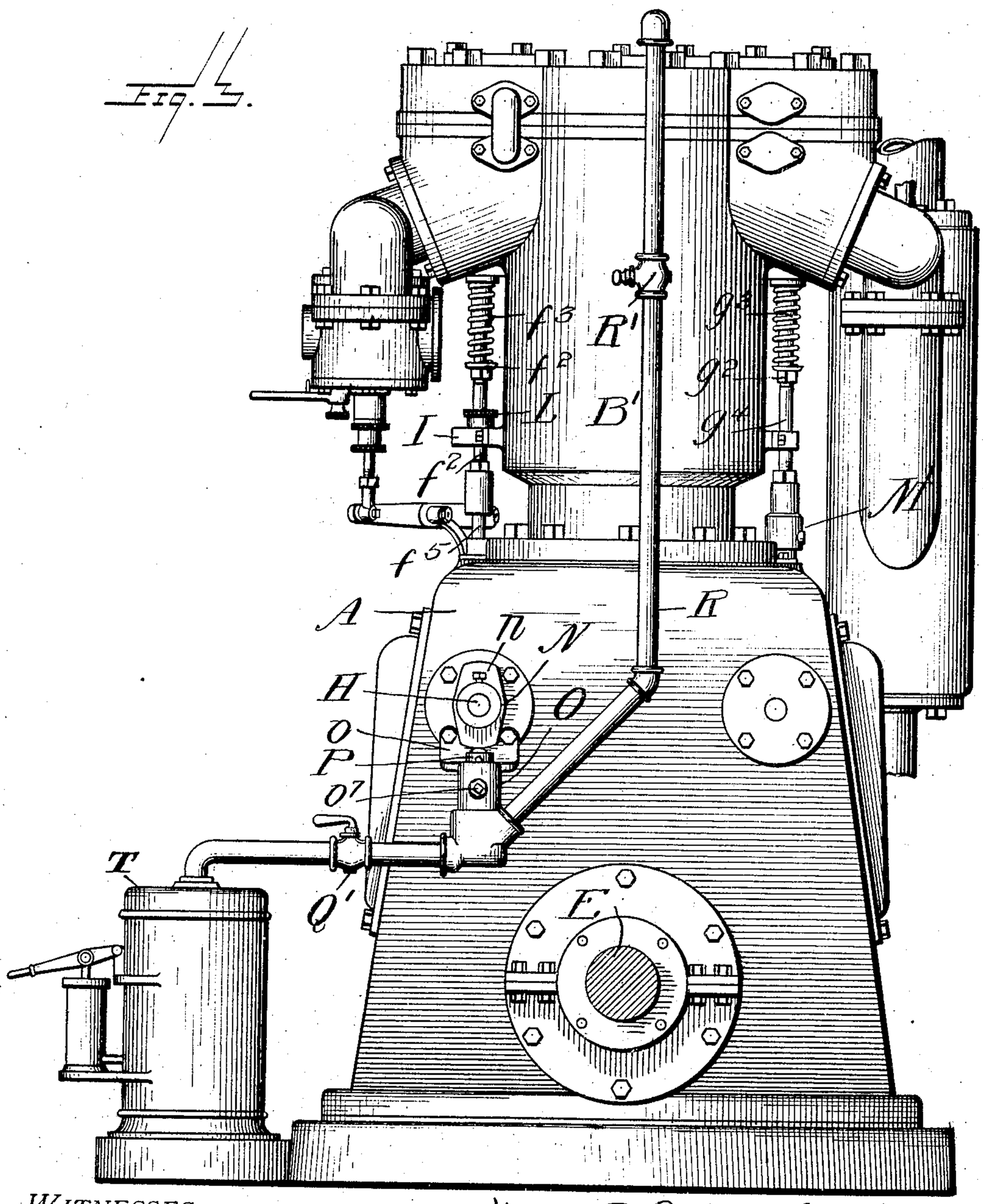
5 SHEETS—SHEET 3.

Fig. 3.



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5 SHEETS—SHEET 4.

Fig. 4.

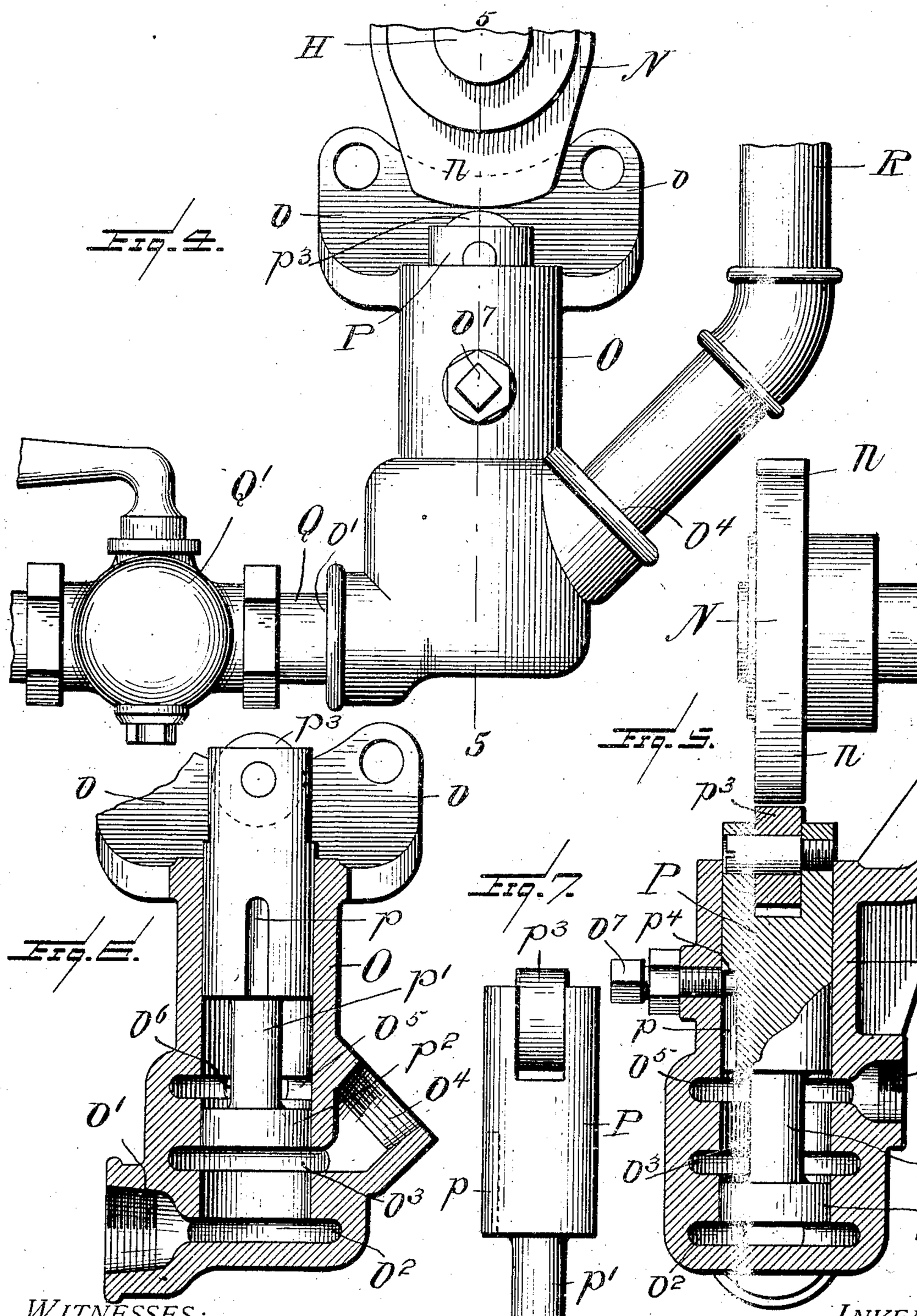

Fig. 5.

Fig. 6.

Fig. 7.

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5 SHEETS—SHEET 5.

Fig. 8.

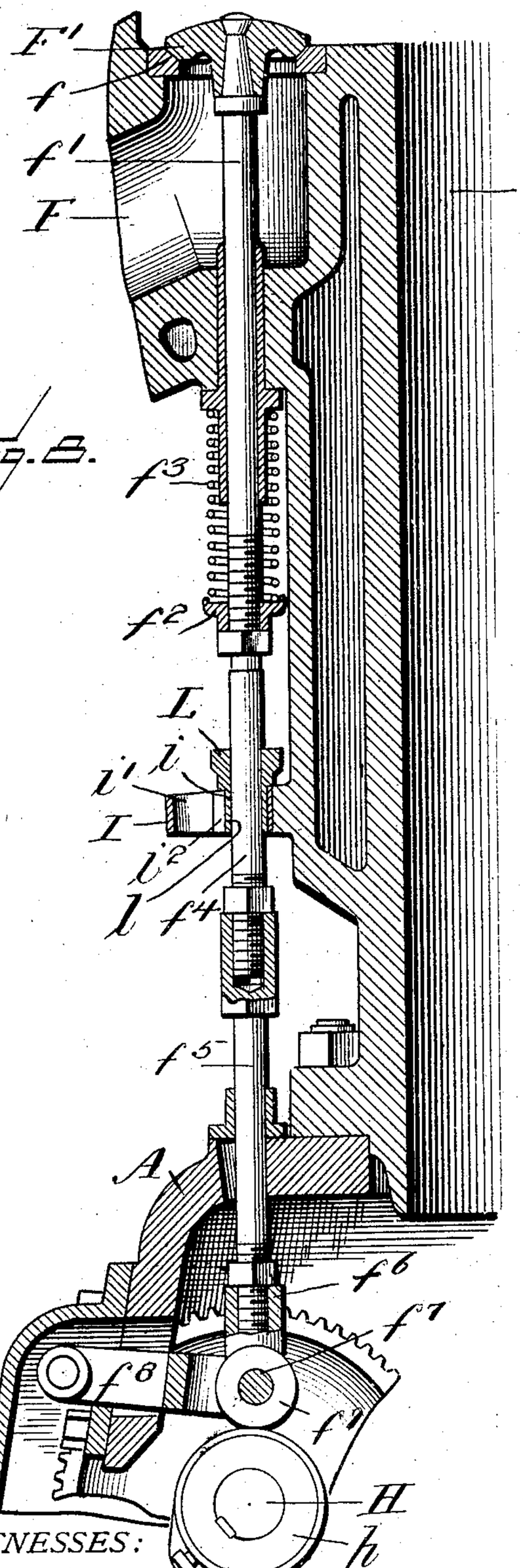


Fig. 9.

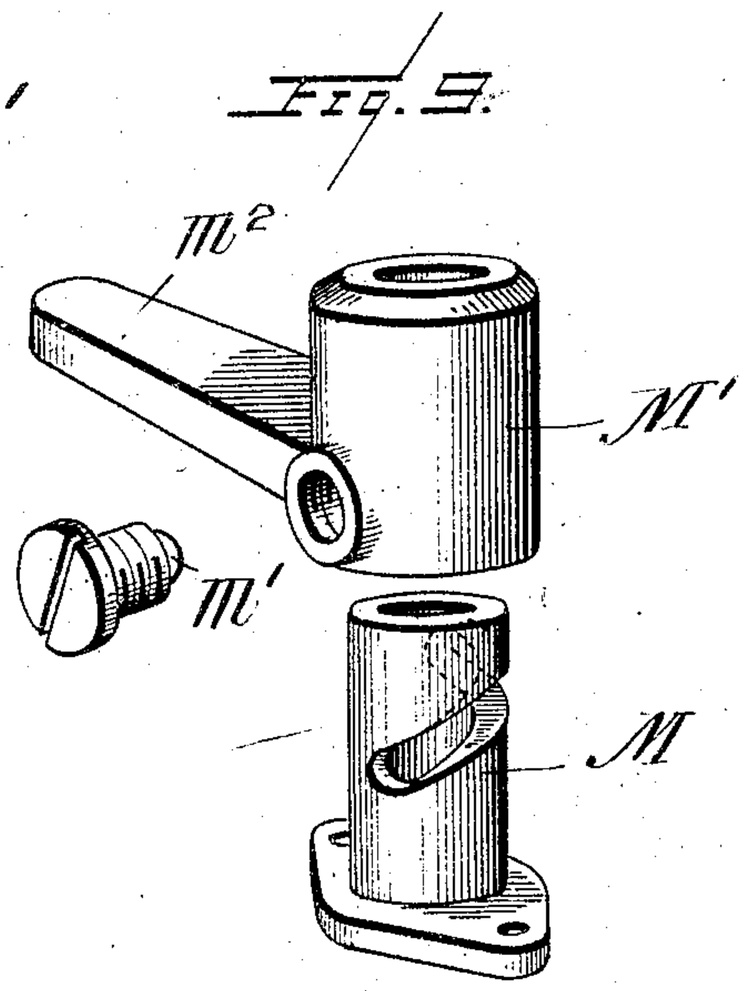
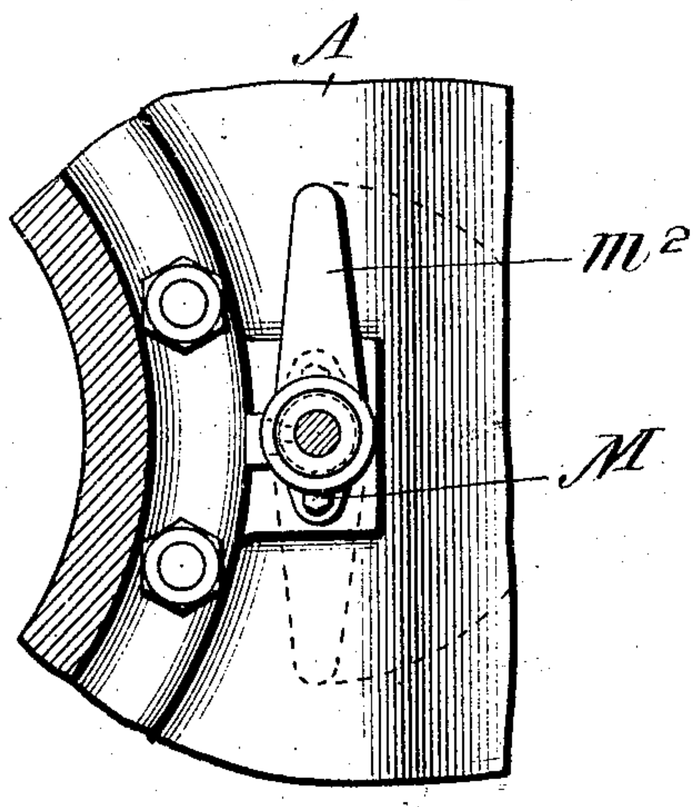


Fig. 10.



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UNITED STATES PATENT OFFICE.

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STARTING MECHANISM FOR EXPLOSIVE-ENGINES.

No. 888,007. Specification of Letters Patent. Patented May 19, 1908.

Application filed March 23, 1907. Serial No. 364,005.

To all whom it may concern:

Be it known that we, HARRY C. FRICKE and GEORGE E. TURNER, citizens of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Starting Mechanism for Explosive-Engines; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

Our invention consists in the novel features hereinafter described reference being had to the accompanying drawings which illustrate one form in which we have contemplated embodying our invention and said invention is fully disclosed in the following description and claims.

The object of our invention is to provide improved means for starting an explosive engine, which may be applied to engines of one, two or more cylinders. To that end we provide means for introducing into one or more of the cylinders a compressed fluid, preferably air, which is passed through a controlling valve mechanism, normally in inoperative position, and which is thrown into operative position by the simple opening of the cut off valve from the compressed fluid supply, said valve mechanism being operated from the engine crank shaft and preferably through one of the ordinary cam shafts for the inlet or exhaust valves, so as to provide for the admission and exhaust of the compressed fluid. We also provide means for disconnecting the cylinder or cylinders, into which the compressed fluid is supplied, and other cylinders of the engine, if desired from the supply of explosive mixture by allowing the inlet valve for explosive mixture for such cylinder or cylinders to remain closed, by breaking or interrupting the connection between the inlet valve or valves and its or their operating devices, and our invention includes other devices, all of which are more specifically described hereinafter.

In the accompanying drawings which illustrate our invention applied to a three cylinder explosive engine of the vertical type, Figure 1 is a side elevation of the engine with our invention embodied therein. Fig. 2 is a vertical transverse sectional view of the engine taken through one of the cylinders. Fig. 3 is an end elevation of the engine. Fig. 4 is an enlarged detail view of the valve mechanism and cut off valve for the compressed fluid. Fig. 5 is a vertical transverse sectional view on line 5—5 of Fig. 4. Fig. 6 is a sectional view of the cam operated valve and valve chest shown in Figs. 4 and 5 taken in a plane at right angles to the plane of section in Fig. 5. Fig. 7 is a detail view of the cam operated valve, detached. Fig. 8 is an enlarged detail view of the mechanism for breaking the inlet valve rod, which we prefer to employ in connection with our invention. Fig. 9 is a detail perspective view of the devices for holding the exhaust valve open. Fig. 10 is a horizontal section of a part of the engine through the exhaust valve, showing the parts illustrated in Fig. 9.

In the drawings A represents the engine base and B′, B², B³ represents the power cylinders, provided with pistons C working therein, connected by piston rods D with the crank shaft E, and through intermediate reducing gearing with the inlet valve operating cam shaft H and the exhaust valve operating cam shaft K, all of which parts may be of any usual or preferred construction.

Each cylinder is preferably provided with mechanism for throwing out of operation or "breaking" the inlet valve rod, so as to permit the inlet valve to remain seated, and for this purpose we prefer to employ the construction shown.

F is the inlet passage for explosive mixture F′ the inlet valve and f the valve seat. The valve F′ has a stem f' provided with a spring f^3 which engages a collar f^2 on the stem and holds the valve normally on its seat.

Below and normally in line with the stem is a valve operating rod, preferably formed in two parts f^4, f^5 adjustably connected. The lower end of this valve rod is provided with a yoke f^6 pivotally connected by a pin f^7 with an arm f^8, the outer end of which is pivoted to the engine base, and pin f^7 carries a friction roll f^9 which engages the cam H. The upper part f^4 of the valve rod extends through a bracket I having preferably two locking apertures i, i' of greater diameter than the rod f^4, said apertures being connected by a slot of smaller diameter but wide enough to permit the rod f^4 to pass. A movable guide L is mounted on the rod f^4 and is movable verti-

cally on the rod and laterally with the rod. The guide L has a turned portion l at its lower end which can be dropped into either of the locking apertures $i\,i'$ to hold the rod in operative or inoperative position. When dropped into aperture i, the rod will be held in line with the valve stem and the valve F′ will be operated by the cam H. To stop the operation of the valve F′, it is only necessary to lift the guide L out of engagement with aperture i and draw the rod f^4 forward, out of line with the valve stem, where it may be locked by dropping the guide L into engagement with the aperture i'. The aperture i' is not essential as the valve rod will remain in operative position by gravity. We also prefer to provide each cylinder with means for throwing its exhaust valve out of operation and holding it in open position, although this is not essential. In the drawings G is the exhaust passage, G′ the exhaust valve, g its seat and g' its stem provided with seating spring g^3, engaging a collar g^2, similar to the inlet valve.

The exhaust valve is operated by a valve rod g^4, g^5 made preferably in two parts connected adjustably, and having at its lower end the yoke g^6 pivoted at g^7 to yoke g^8 and carrying roll g^9 to engage cam K, in all respects like similar parts of the inlet valve mechanism. The lower part of the valve rod extends through a fixed sleeve M on the engine base, having a spiral slot in it, and a rotatable hub M′ is fitted over said sleeve and provided with a handle m^2 and a projection m' to engage said slot, so that when turned in one direction the hub will be raised and when turned in the opposite direction it will be lowered. The hub M′ is arranged to engage a part of the rod g^4 g^5 in this instance, the joint connecting such parts, so that by means of said hub the rod g^4, g^5 and the exhaust valve can be raised out of operative relation with cam K and the valve held in open position as long as desired.

One of the cam shafts H and K (in this instance shaft H) is extended through the crank case or engine base at one end of same and provided with a double cam N having two oppositely arranged cam grades $n\,n$ for operating the compressed fluid valve mechanism. Adjacent to the cam N and below the same is arranged a cylindrical valve chest O, provided with perforated ears o by means of which it is bolted or otherwise secured to the crank case. The valve chest has a cylindrical bore, open at the top and closed at the bottom and is provided with an inlet aperture o' for the compressed air or other fluid, located adjacent to the bottom of the valve chest, and internally threaded to receive an air supply pipe Q from a compressed air tank (not shown) or other source of compressed motor fluid, said pipe being provided with a cut off valve Q′. The inlet aperture o' communicates with an annular supply port o^2 located at the bottom of the cylinder. Above the said inlet port, is the inlet or engine port o^3 communicating with an internally threaded aperture o^4 which receives a pipe R leading to and discharging within the cylinder B′, see Fig. 1. This pipe may enter the cylinder head at the top or side as preferred and is provided with a cutoff valve R′. Above the inlet port is an annular exhaust port o^5 within the valve chest O, which communicates with an exhaust aperture in the wall of the cylinder indicated at o^6.

P represents a piston valve having a cylindrical portion fitting in the upper part of the valve chest bore, and provided with a vertically disposed slot p, which is engaged by a screw o^7 extending through the wall of the valve chest O, and engaging said slot, to prevent the valve from turning but permitting it to move vertically. Below the cylindrical part of the valve is a reduced stem p' which is preferably integral with the valve and carries at its lower end the cylindrical part p^2 which we term a piston head, the stem portion p' being of such length as to form an annular recess connecting the inlet port o^3 and exhaust port o^5 when the valve is in its lowest position as shown in Fig. 5. At its upper end the valve P is provided with a friction roll p^3, so arranged that when the valve is in its lowest position the cam N will just clear said roll.

Supposing the cut off valves Q′ and R′ to be closed, shutting off the admission of compressed air, the valve P will fall by gravity or be pushed by the cam N, into its lowest position and remain there with the roll p^3 out of operative relation with the cam. This position of the parts is maintained at all times when the engine is running under explosive mixture.

If the engine is not running, and it is desired to start it, the operator breaks the inlet valve rod of cylinder B′ as previously described, so as to allow the inlet valve to remain closed, and thus shut off the supply of explosive mixture to the cylinder. One or both of the other cylinders may be allowed to remain in operative condition, but we prefer to break the inlet valve rod of cylinder B^2 so that only one of the cylinders (B^3) shall take the explosive mixture, and to further relieve the engine from load in starting, the exhaust valve of cylinder B^2 is raised by the mechanism described, to relieve compression in that cylinder. The cock R′ is then opened to establish communication between the cylinder B′ and the valve chest O, and the cock Q′ is then opened to admit compressed motive fluid from the tank (shown at T in Fig. 3) or other supply into the lower end of the valve chest O. The admission of compressed fluid immediately acts on the piston head p^2 and lifts the valve P until the roll p^3 engages the

cam N, and places the cam and valve P in operative relation. Each time the valve P is permitted to rise to its highest position the cylindrical part or piston head p^2 will be raised above the inlet port o^3 and will cut off communication between said inlet port and the exhaust port as shown in Fig. 6. The compressed air or other fluid will then pass from the supply port o^2 to the inlet port o^3, thence through the pipe R to the cylinder, at a time when the cylinder piston is raised, and the compressed air will force the piston down and produce a working stroke, at the same time turning cam N so as to bring one of the grades n into engagement with the roll p^3, and depress the valve P into its lowest position when the inlet port o^3 will be in communication with the exhaust port o^5 through the annular passage surrounding the reduced stem p' and the cylindrical part p^2 of the valve will be below the inlet port o^2, thus cutting off communication between the supply port and the inlet port, and the air in the cylinder can exhaust back through the pipe R and out through the exhaust aperture o^6, during the upward stroke of the cylinder piston. During the movements of the piston in cylinder B′ under compressed air, the cylinder B^3 is taking explosive mixture in the usual manner, and as it goes through the steps of suction, compression, ignition and exhaust, the said cylinder B^3 and its piston are soon under operation by the explosive mixture, while cylinder B′ is being operated by the compressed air. The intermediate cylinder B^2 is then brought into operation by the explosive mixture by restoring the inlet valve rod and exhaust valve rod to their normal positions and takes a charge and begins to operate under the explosive mixture. The valves R′ and Q′ are then closed shutting off the supply of compressed air to the cylinder B′, the valve rod is then restored to its normal position, and the cylinder B′ will take up its proper operation under the explosive mixture. As soon as the valve Q′ is closed the valve P will remain down in its lowest position, it being limited in its downward movement by a shoulder p^4 at the upper end of the slot p, engaging the screw o^7 and the roll p^3 will be out of contact with the cam N. It will thus be seen that the starting device itself is thrown into operation by simply opening valves R′ and Q′, and may be instantly thrown into inoperative condition by closing said valves, no other adjustments or operations being required.

While we have shown our improved starting device arranged in connection with a three cylinder engine, it is equally applicable to engines having a greater or less number of cylinders.

What we claim and desire to secure by Letters Patent is:—

1. In an explosive engine, the combination with the cylinder and piston, and means for supplying an explosive mixture thereto, of means for supplying a compressed motor fluid to said cylinder, a valve chest for said fluid supply, a cam operated by the engine, and a valve in said valve chest normally out of operative relation with said cam, said valve being constructed to be forced into operative relation to the cam by the admission of compressed fluid to said valve chest, substantially as described.

2. In an explosive engine, the combination with the cylinder and piston, and means for supplying explosive material thereto, of an auxiliary valve chest, provided with a supply port for compressed fluid, and an inlet port communicating with said cylinder, a rotary cam operated by the engine, a valve in said valve chest normally in inoperative relation to said cam, and having a piston head interposed between the supply port and said inlet port, whereby the admission of compressed fluid will move said valve into operative relation with said cam, substantially as described.

3. In an explosive engine, the combination with the cylinder and piston, and means for supplying explosive material thereto, of an auxiliary valve chest, provided with a supply port, and an inlet port connected with said cylinder, means for supplying compressed motor fluid to said supply port, a cam operated by the engine, a vertically movable valve in said valve chest, normally held by gravity out of operative relation with said cam, said valve having a piston head adjacent to said supply port, whereby the admission of compressed fluid will raise said valve into operative relation with said cam, substantially as described.

4. In an explosive engine, the combination with the cylinder and piston, and means for supplying explosive material thereto, of an auxiliary valve chest provided with a supply port, an inlet port, connected to said cylinder, and an exhaust port, a valve in said cylinder for controlling said ports, said valve having a piston head interposed between the supply port and said inlet port, and a cam operated by the engine adapted to engage a part connected with said valve, means for supplying compressed motor fluid to said supply port, and a controlling valve for said fluid supply, whereby the admission of compressed fluid to said valve chest holds the valve in operative relation to said cam, substantially as described.

5. In an explosive engine, the combination with the cylinder and piston, and means for supplying explosive material thereto, of an auxiliary valve chest provided with a supply port, an inlet port connected with the cylinder, and an exhaust port, means for supplying compressed motor fluid to said supply port, a cutoff valve for the fluid supply, a valve in said valve chest, having a piston

head interposed between the supply port and the inlet port, a reduced portion adapted to establish communication between the inlet and exhaust ports, and having a part extending outside of said valve-chest and provided with a friction roll, and a cam operated by the engine, located above said friction roll, said valve being held normally by gravity in inoperative relation with said cam, whereby the admission of fluid will raise and hold said valve into operative relation with said cam, substantially as described.

6. In an explosive engine, the combination with the cylinder provided with an inlet valve for explosive material, a spring normally seating said valve, a cam operated by the engine, a rod located in line with the stem of the inlet valve and interposed between the same and said cam, and means for breaking said inlet valve rod, to cause the inlet valve to remain seated, of an auxiliary valve chest provided with an inlet port connected with said cylinder and a supply port connected with a supply of compressed motor fluid, an auxiliary cam operated by the engine, and a valve in said valve chest, having a cam engaging part normally out of engagement with said cam, said valve being constructed to be forced into operative relation with said cam by the admission of motor fluid to said valve chest, substantially as described.

7. In a multi-cylinder explosive engine, the combination with the cylinders and pistons therefor, of an inlet valve and an exhaust valve for each cylinder, cam operated rods for operating said valves, devices for throwing the inlet valve rods out of engagement with the inlet valves, and devices for locking the exhaust valves in operative position, of an auxiliary valve chest, having an inlet port connected to one of said cylinders, and a supply port, connected with a supply of compressed motor fluid, for starting the engine, an auxiliary cam operated by the engine, a valve in said valve chest for controlling the ports thereof, held normally out of operative relation with said auxiliary cam, and provided with a piston head interposed between the supply port and said inlet port, substantially as described.

8. The combination with an internal combustion engine, of valve mechanism for operating the same as an explosion engine, valve mechanism adapted for operating the engine as a compressed air engine but normally out of operative condition during the operation of the engine as an internal combustion engine and means whereby the admission of air to the last named mechanism throws it into operative condition.

9. The combination with an internal combustion engine, of valve gear adapted for operating the engine as an explosion engine, an air admission valve for the engine cylinder, devices normally disconnected during the operation of the engine as an internal combustion engine, for actuating said valve at proper times, and means whereby the admission of compressed air to said valve throws said disconnected devices into operative connection.

10. The combination with an internal combustion engine, of valve mechanism for operating it as an explosive engine, a valve for admitting compressed air to the engine-cylinder, an engine-operated cam for actuating said valve at intervals, devices normally out of operative position for transmitting the motion of the cam to the valve, and means whereby the admission of compressed air automatically moves said devices into operative position.

11. The combination with an internal combustion engine, of valve mechanism adapted for operating the engine as an explosion engine, a valve for admitting non-explosive fluid under pressure, means for controlling the movement of said valve and adapted to be thrown into operative position by the admitted fluid under pressure, and devices for controlling the access of fluid under pressure to said means.

In testimony whereof we affix our signatures, in the presence of two witnesses.

HARRY C. FRICKE.
GEORGE E. TURNER.

Witnesses:
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HARRY F. AFFELDER.