R. A. MAPLES.

EXPLOSIVE ENGINE.

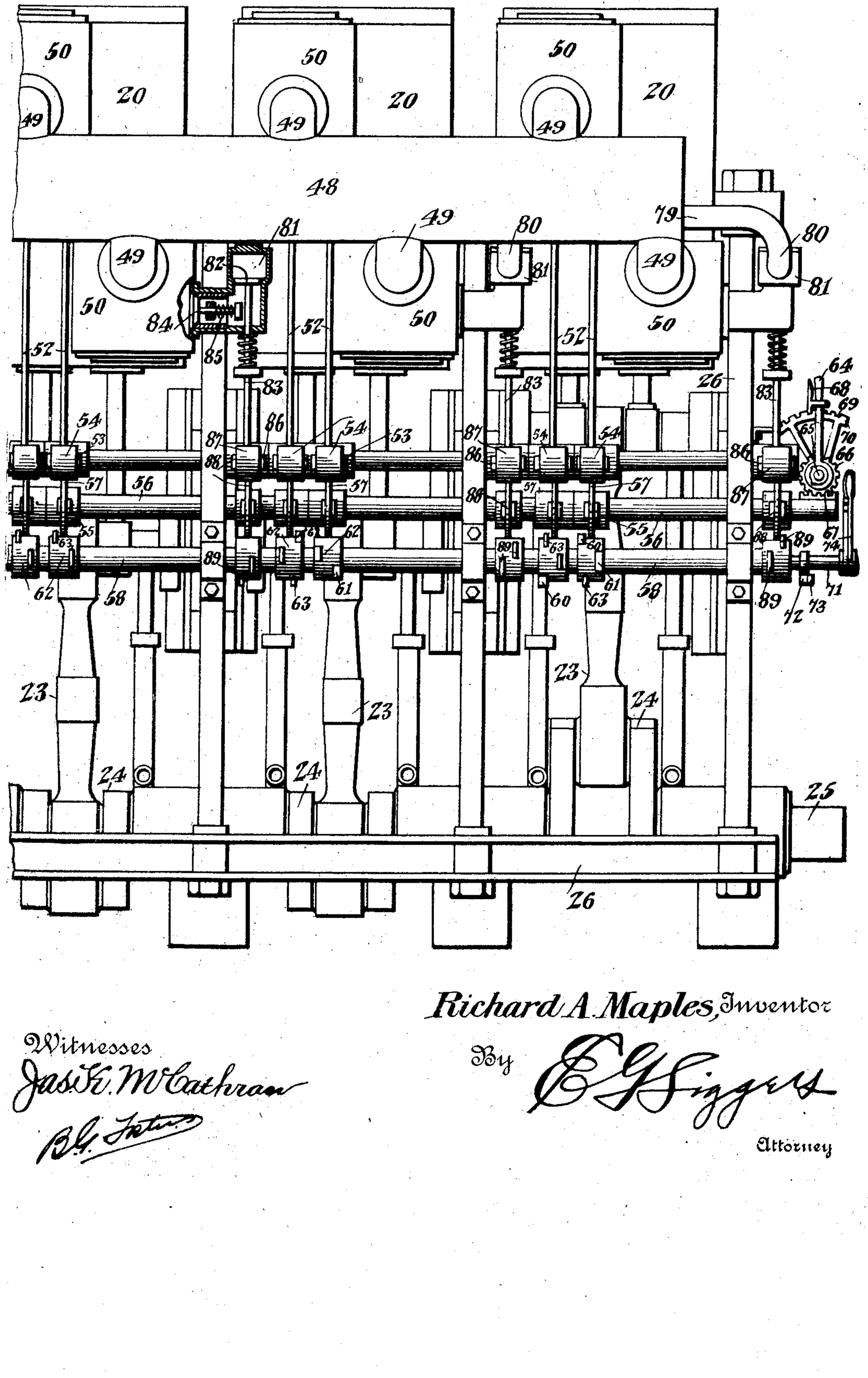
APPLICATION FILED APR. 29, 1907.

905,727.

Patented Dec. 1, 1908.

6 SHEETS—SHEET 1.

Fig. 1.



Witnesses

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B. L. Peters

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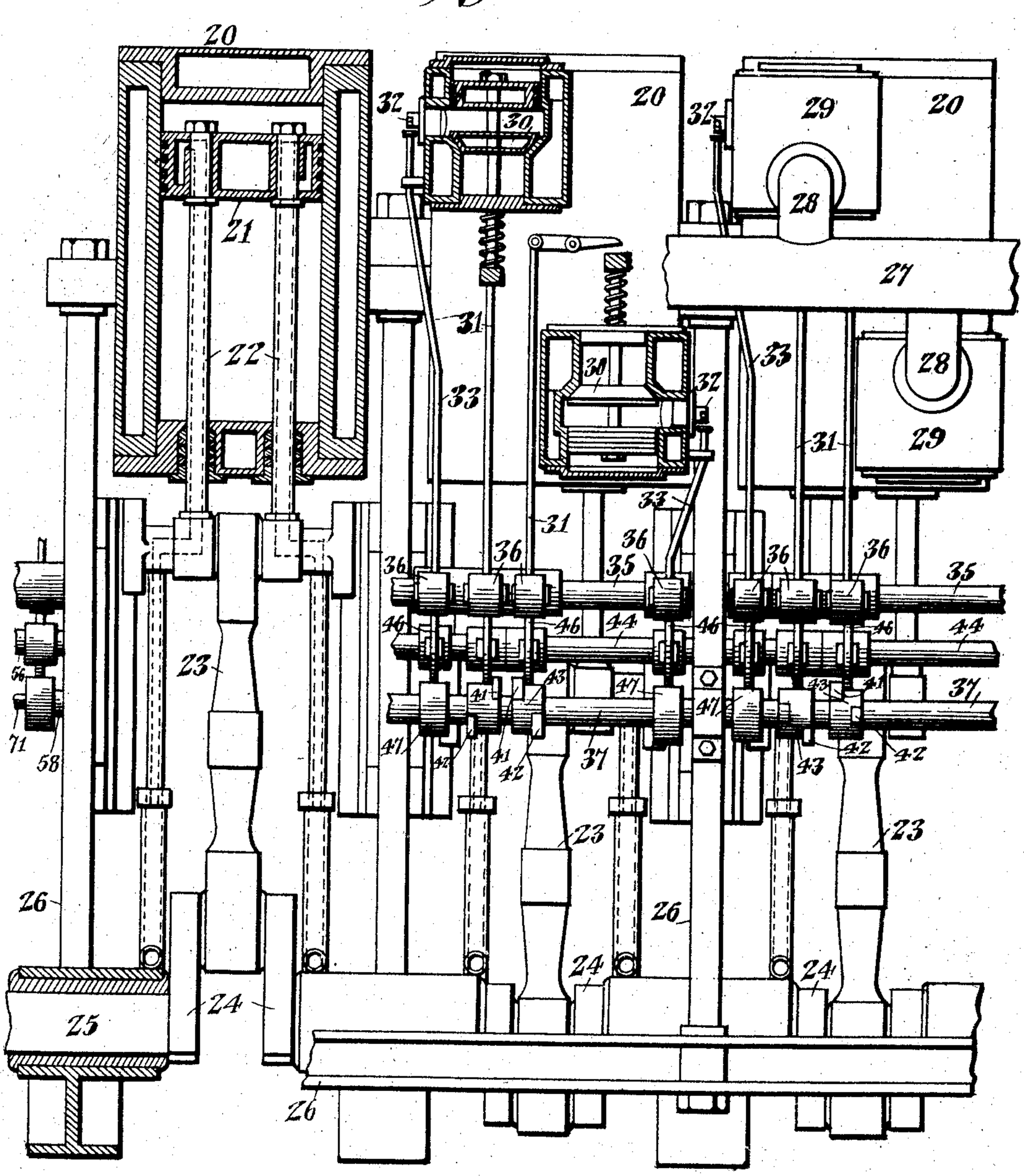
6 SHEETS—SHEET 2.

Fig. 2.



Witnesses
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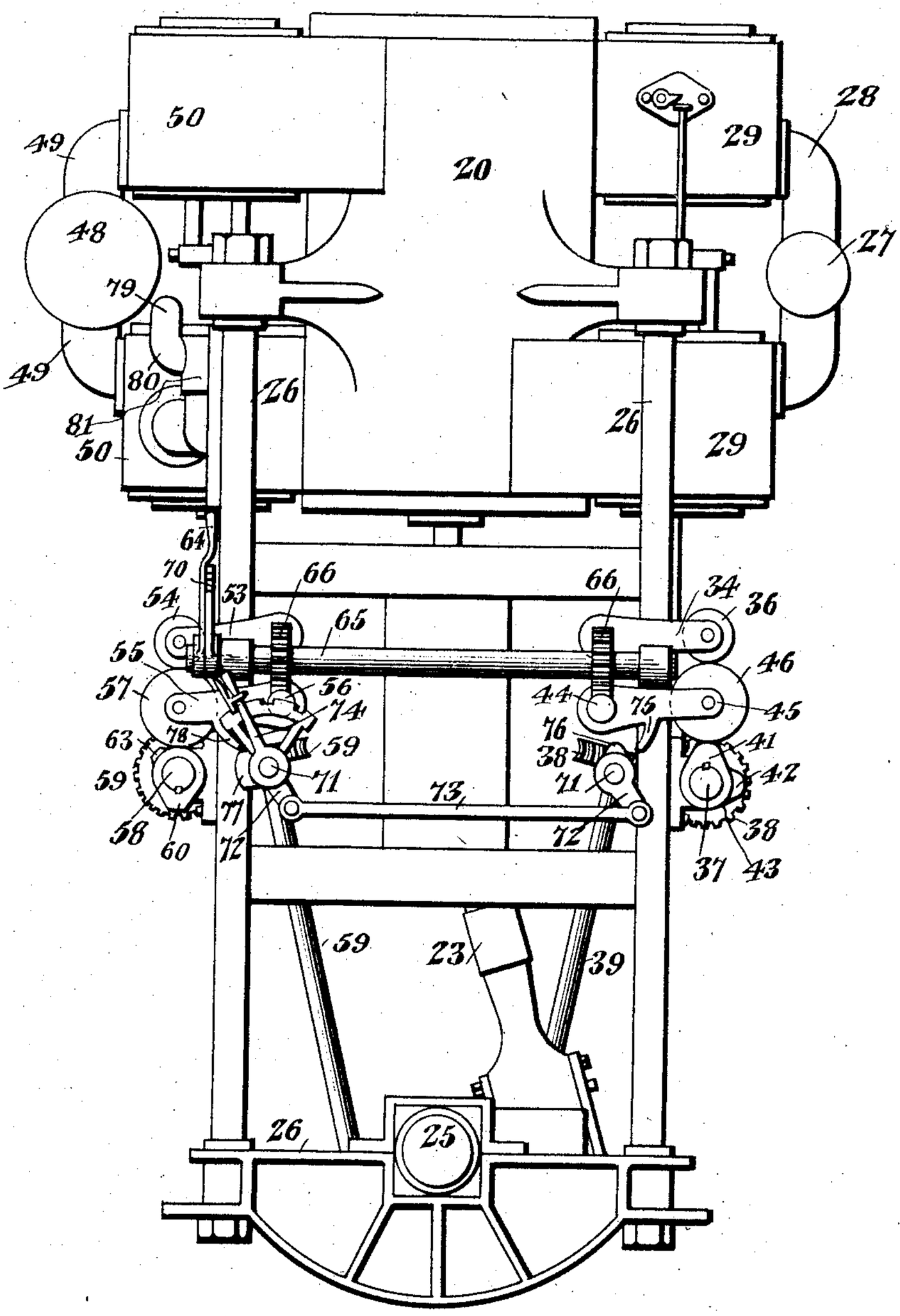
6 SHEETS—SHEET 3.

Fig. 3.



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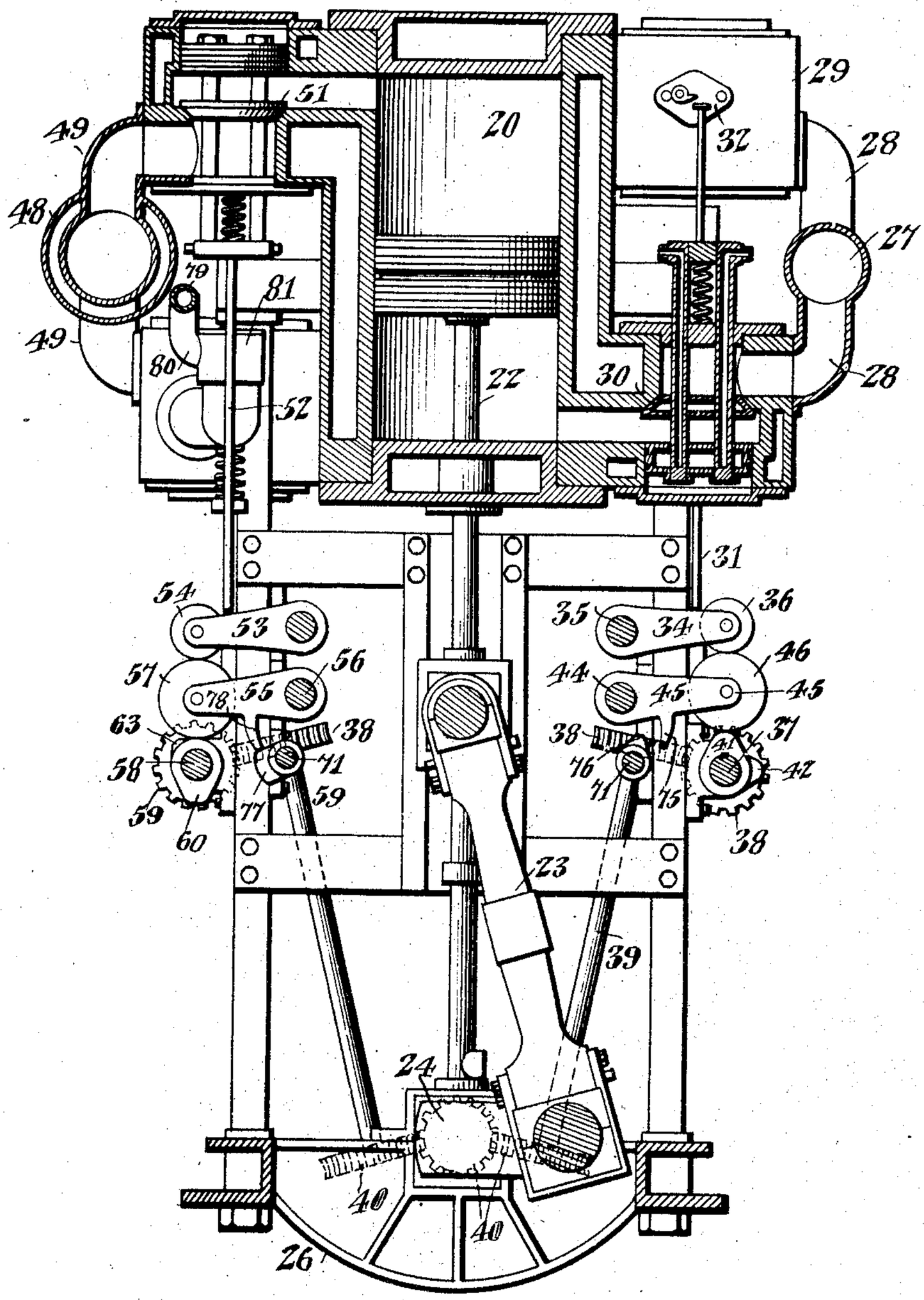
6 SHEETS—SHEET 4.

Fig. 4.



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6 SHEETS—SHEET 5.

Fig. 6.

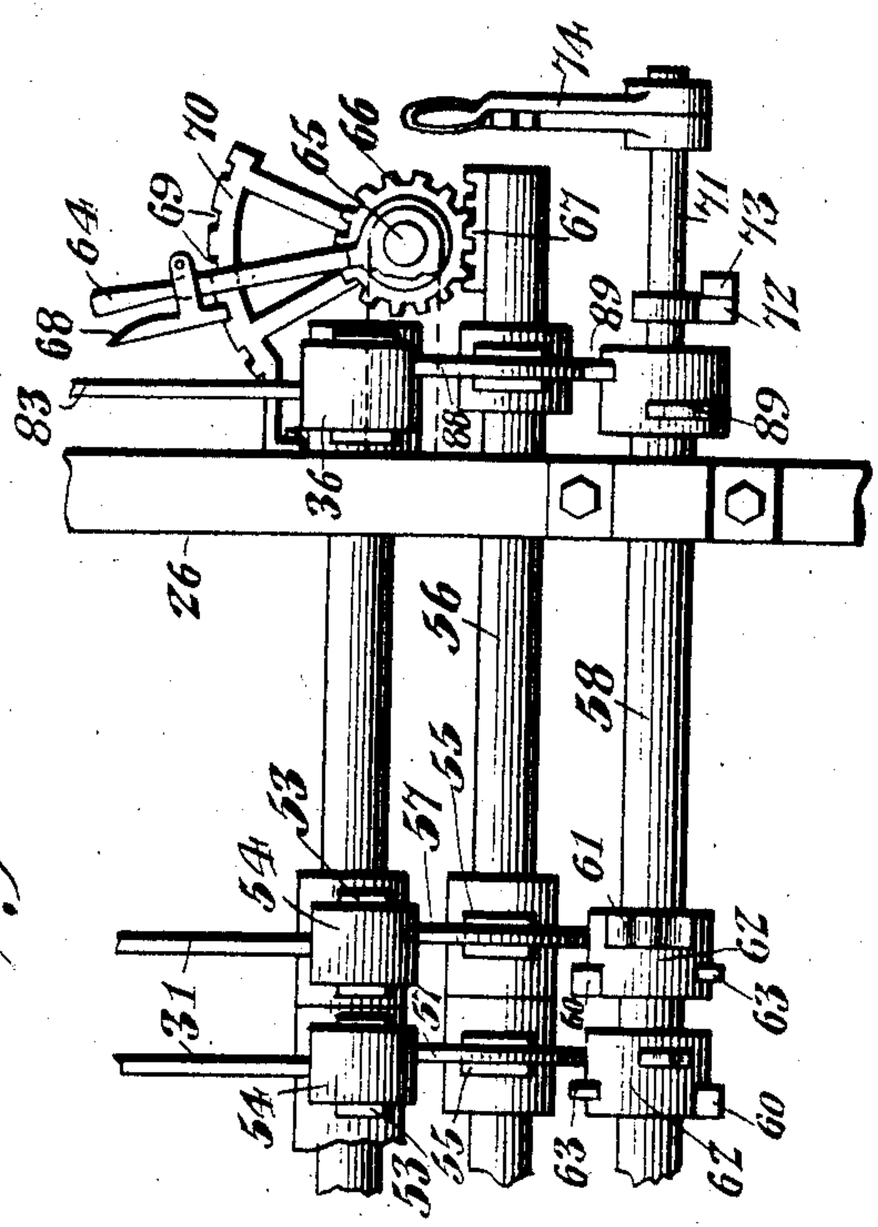


Fig. 8.

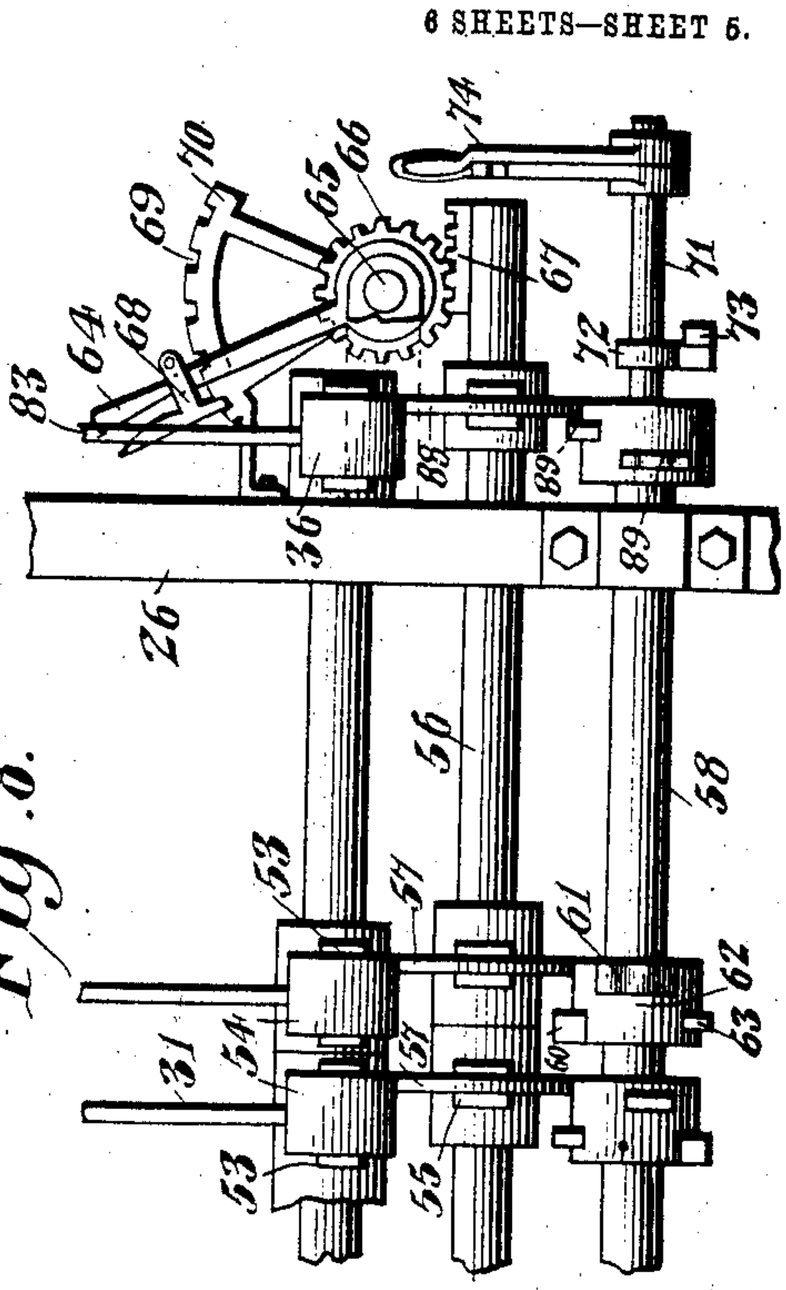


Fig. 5.

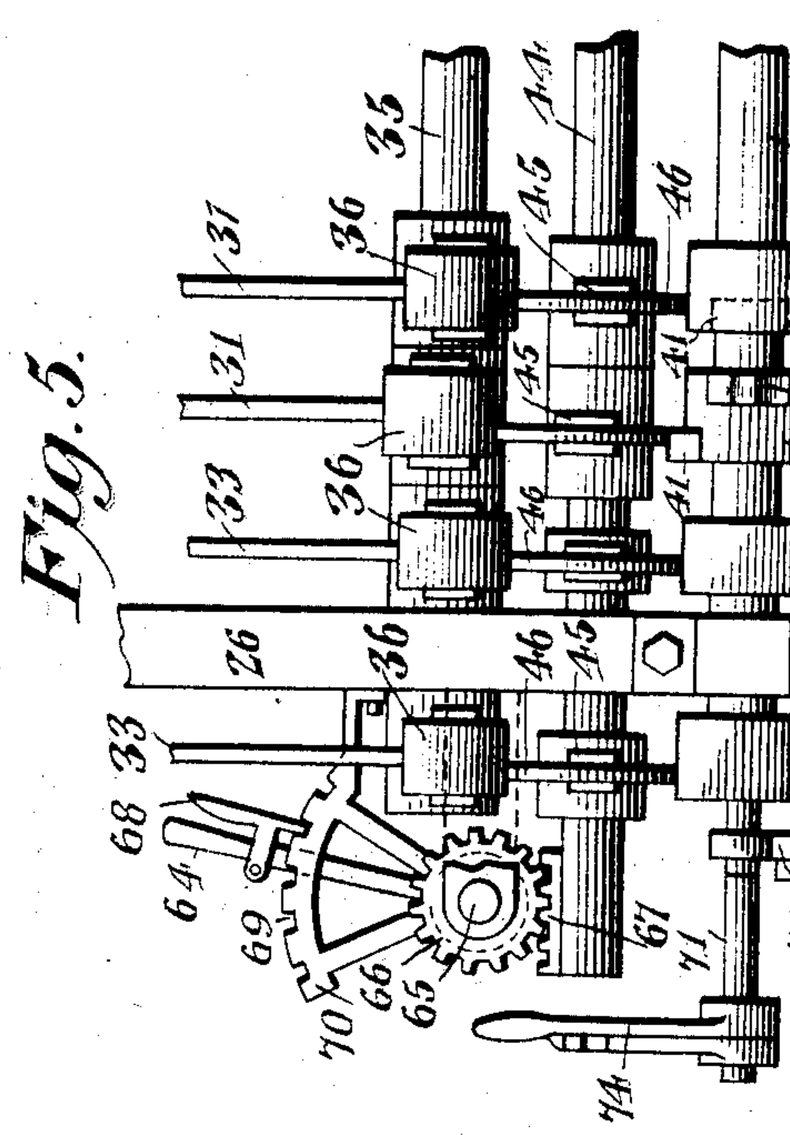
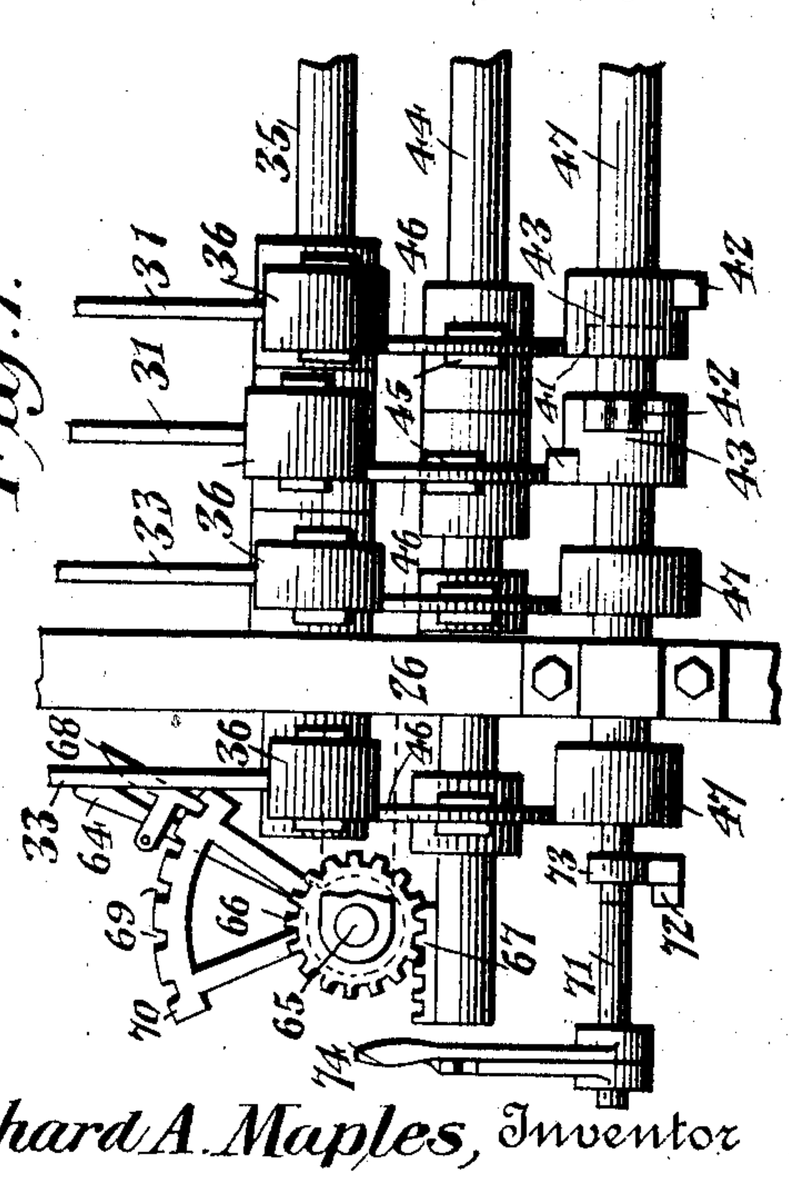


Fig. 7.



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6 SHEETS—SHEET 6.

Fig. 11.

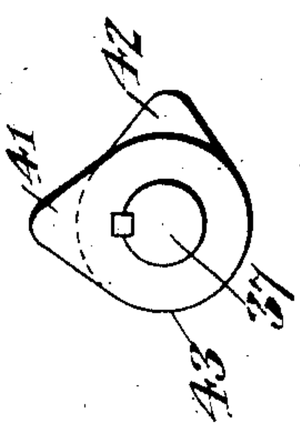


Fig. 13.

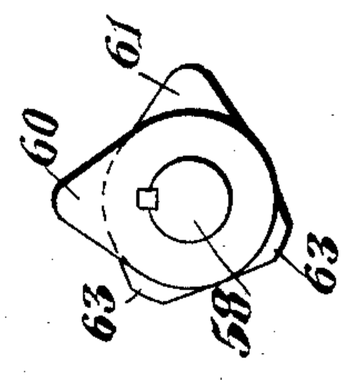


Fig. 15.

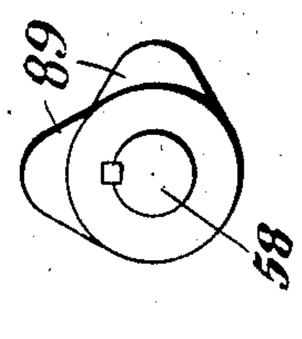


Fig. 10.

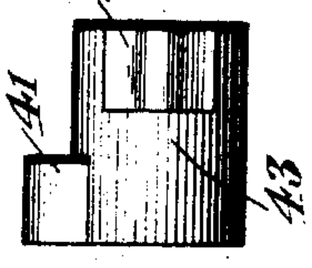


Fig. 12.

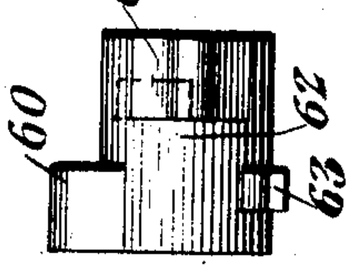


Fig. 14.

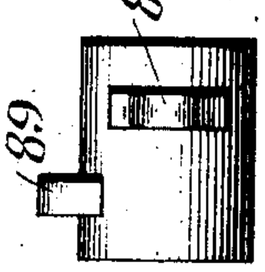


Fig. 9.

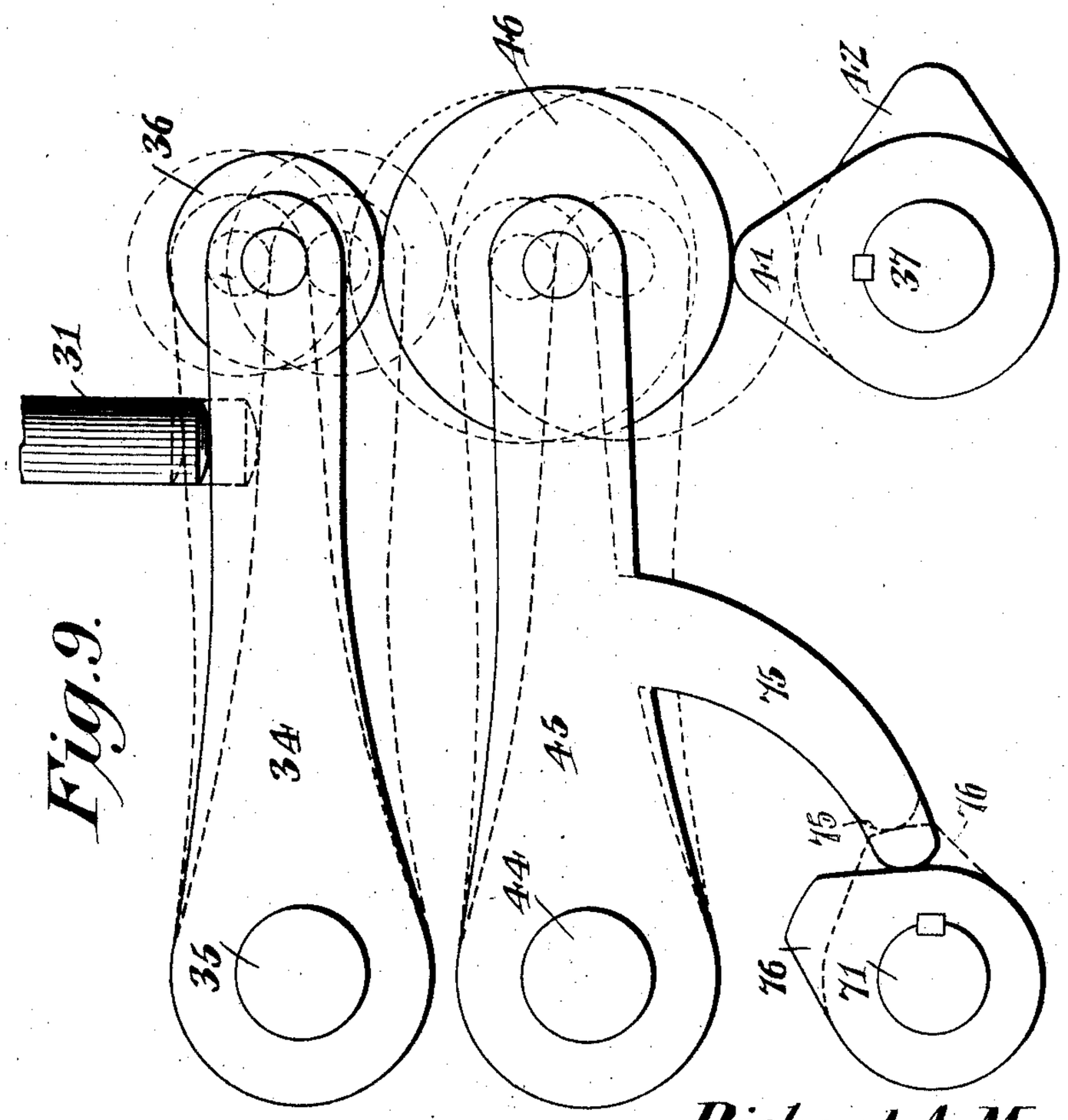


Fig. 19.

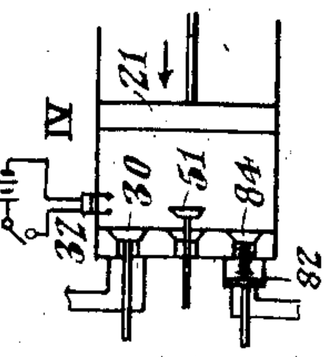


Fig. 18.

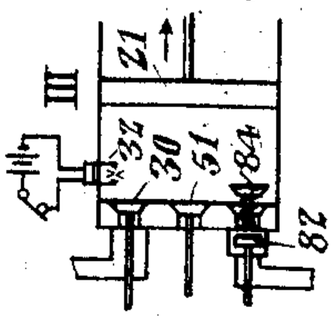


Fig. 17.

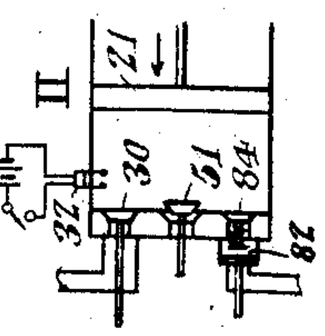
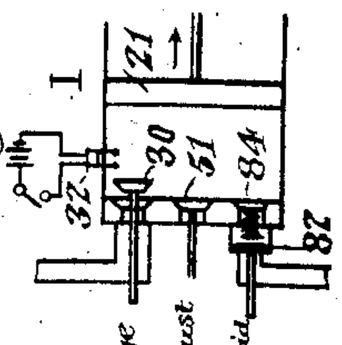


Fig. 16.



Witnesses

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UNITED STATES PATENT OFFICE.

RICHARD ALEXANDER MAPLES, OF CLINTON, IOWA.

EXPLOSIVE-ENGINE.

No. 905,727. Specification of Letters Patent. Patented Dec. 1, 1908.

Application filed April 29, 1907. Serial No. 370,841.

To all whom it may concern:

Be it known that I, RICHARD ALEXANDER MAPLES, a citizen of the United States, residing at Clinton, in the county of Clinton and State of Iowa, have invented a new and useful Explosive-Engine, of which the following is a specification.

In explosive engines of the larger types, where the starting of the engine by manual power is impracticable, it is the ordinary practice at present to start and effect the initial operation of the engine by air or other motive fluid under pressure. So far as I am aware, this heretofore has required the complete alteration of a certain number of the usual four cycle cylinders of the multiple cylinder explosive engine into two cycle air engines. These units operated by air or motive fluid were depended upon until the remaining units became operative, and thus one section of the engine would be operating by exploding charges and the remainder would be operating upon the order of the steam engine. The latter units are then reconverted into units of the explosive type, whereupon the complete engine becomes operative as an explosive engine. This arrangement has drawbacks, for portions of the engine only can possibly operate in the ordinary manner until the remainder is mechanically reconverted from a two cycle air engine to a four cycle explosive engine. It thus requires considerable time to develop the full power of the engine.

It is one of the primary objects of the present invention to provide a novel combination whereby air or other motive fluid under pressure is employed for starting but the four cycle operation of the units of the engine is not altered, and as soon as any unit is in proper condition to operate as an explosive engine, a charge will be exploded therein, while the air or motive fluid will be automatically cut off. As a result, the engine as a whole soon becomes operative without mechanically changing it, no conversion of certain sections thereof takes place, and the power of the engine can be more quickly and economically developed.

A further and important object is to provide novel valve controlling and actuating means, whereby the various changes in the order of succession in the operation of the valves can be readily effected with ease and expedition, and as a result, the engine can be speedily and effectively stopped, started and reversed.

An embodiment that is at present considered the preferred one is illustrated in the accompanying drawings, wherein:—

Figure 1 is a view in elevation of the exhaust side of a portion of a multiple cylinder explosive engine. Fig. 2 is a view partly in elevation, and partly in section of the intake side of said engine. Fig. 3 is an end elevation of the same. Fig. 4 is a cross sectional view. Fig. 5 is a detail elevation on an enlarged scale, illustrating the relation of the valve operating mechanism on the intake side of one of the cylinders in one position. Fig. 6 is a corresponding view of the valve mechanism on the exhaust side of the engine. Fig. 7 is a view similar to Fig. 5, but illustrating the parts in a different relation. Fig. 8 is a corresponding view of the valve mechanism on the exhaust side. Fig. 9 is a detail view of one of the valve actuating mechanisms. Fig. 10 is a side view of one of the intake valve cams. Fig. 11 is an end view of the same. Fig. 12 is a side elevation of an exhaust valve actuating cam. Fig. 13 is an end elevation of the same. Fig. 14 is a side elevation of one of the cams, which actuates the motive fluid admitting means. Fig. 15 is an end elevation thereof. Figs. 16–19 inclusive are diagrammatic views illustrating the operation of the different parts during a four cycle movement of the engine.

Similar reference numerals designate corresponding parts in all the figures of the drawings.

In the preferred embodiment of the engine, six cylinders, as usual, are employed, three being illustrated in Figs. 1 and 2, and designated 20. It will of course be evident that any number may be employed as desired. Within the cylinders operate the usual reciprocatory pistons 21 connected by piston rods 22 and pitmen 23 to the angularly set cranks 24 of the engine shaft 25. The various parts are mounted in a suitable frame designated as a whole by the reference numeral 26. A supply conduit 27 extends along the intake side of the engine, and has branches 28 leading to valve casings 29. In these casings are located suitable intake controlling valves 30 operated by longitudinally movable stems 31. Ignition mechanism

32 is also located on this side of the engine, and is operated through the medium of longitudinally movable stems 33.

The lower ends of the various stems, as shown particularly in Figs. 4, 5, 7 and 9 rest upon swinging arms 34 loosely journaled on an axle or shaft 35 and having rollers 36 on their outer ends. Beneath said rollers and spaced therefrom is a shaft 37 extending longitudinally along the intake side of the engine and geared, as shown at 38, to a shaft 39, which is in turn, geared as shown at 40 to the engine shaft. Upon the shaft 37 are fixed sets of cams, each set comprising raised portions 41 and 42 disposed in proper relation, and leaving between them, a track or guideway 43 that is concentric to the axis of the shaft 37. Another shaft 44 has loosely journaled thereon, a series of selectors comprising arms 45 having rollers 46 journaled on their outer ends. The rollers respectively coöperate with the cams 41 and 42 of the different sets, and as the shaft 44 is longitudinally movable, each roller may be placed in a position to operate upon the intermediate tracks 43 or upon either of the cams 41 and 42. The corresponding selectors, which effect the operation of the ignition mechanism stems 33, operate against suitable eccentrics 47 fixed to the shaft 37.

The exhaust side of the engine, shown in Fig. 1, has a common exhaust conduit 48, to which are connected branches 49 leading from the upper and lower ends of the cylinders through valve casings 50. The casings contain suitable exhaust controlling valves 51, from which depend stems 52. The lower ends of these stems bear upon swinging actuated arms or elements 53 having rollers 54 journaled on their free ends. Selector arms 55, loosely journaled upon a longitudinally movable shaft 56, have rollers 57 that operate against the rollers 54. Another cam shaft 58, journaled along the exhaust side of the engine frame, is operated through suitable gearing 59 from the engine shaft, and is provided with sets of oppositely disposed cams 60 and 61, leaving a concentric track 62 between them. It will be observed that the cams 60 and 61 are comparatively broad, and that directly opposite to them are comparatively narrow relief cams 63, these cams being employed for relieving compression in the ordinary well known manner, and utilized, as hereinafter explained. It will thus be observed that the intake and exhaust valve controlling mechanisms are very similar in character and operation.

In order to effect the shifting of the selectors, any suitable mechanism may be employed. Thus in the present embodiment, a lever 64 is fixed to a transversely disposed shaft 65, and said shaft has gear wheels 66 coöperating with racks 67 fixed to the ends of the shafts 44 and 56. Thus upon the operation of the lever 64, the shafts 44 and 56 will be moved longitudinally. They are adapted to be held in the different positions by means of a dog 68 pivoted on the lever 64 and engaging in the notches 69 of a quadrant rack 70 associated with the lever. For the purpose of holding the selectors elevated and out of the way of the various cams during the shifting operation, the following mechanism is preferably employed. Located below each set of selectors is a rock shaft 71, and these rock shafts have cranks 72 at their ends that are connected by a cross link 73. A lever 74 is fixed to one of the shafts. The selector arms 45 on one side of the engine are provided with depending fingers 75, and the shaft 71 adjacent thereto is provided with cams 76 arranged to engage the fingers. The opposite shaft is also provided with cams 77 that coöperate with corresponding fingers 78 depending from the adjacent selector arms. It will be observed, however, that the cams 76 are shorter than the cams 77 and that said cams 77 will engage and operate against the fingers 78 before the cams 76 operate upon the fingers 75. Thus if the lever 74 is actuated, the cams 77 will first engage the fingers 78, and raise the selector arms 55 and rollers 57 away from the coacting cams and the continued movement will carry the cam 76 against the fingers 75 and raise the selector arms 45. When these different sets of arms have been elevated, the lever 64 can be moved, thus carrying the selectors in either direction desired.

Upon the exhaust side of the engine, as shown more particularly in Figs. 1, 3 and 4, is a pipe 79 for conducting motive fluid, and this pipe has branches 80 leading to valve casings 81. One of these valve casings is shown in section in Fig. 1, and it will be observed that it has a mechanically operated valve 82 provided with a depending valve stem 83, and an inwardly opening automatic valve 84 normally held closed by a spring 85. The depending stems 83 of the different mechanical air or motive fluid controlling valves rest upon swinging arms 86 having rollers 87 at their outer ends, and selector rollers 88 corresponding in all respects to those already described bear against the rollers 87 and coöperate with sets of cams 89 mounted on the cam shaft 58. It will be observed that the cams 89 are comparatively narrow, being substantially the width of the rollers 88 and having spaces on their outer sides, in which said rollers can operate. Now it is desired to strongly emphasize this fact, that the air cams 89 of each cylinder are disposed in alternation with the intake cams 41 and 42 of the same cylinder. This is important in order to clearly comprehend the operation of the engine, which is of the four cycle type, as already outlined. In this type of engine, it is well known that

upon the first stroke of the engine, a charge will be drawn into the cylinder, upon the second stroke, this charge will be compressed, on the third stroke, the charge will be fired or exploded, and the exhaust takes place upon the fourth stroke.

In the present mechanism, if the lever 64 is in its central position, as illustrated in Fig. 1, the various selector rollers 46, 57 and 88 will be in their central or neutral positions, and if the engine were turned over, there would be no valve action. If, however, it is desired to start the engine, said lever is moved in one direction or the other one notch of the quadrant 70. The parts will then be in the relation shown in Figs. 5 and 6, and remembering that the air or motive fluid controlling valves operate in alternation with the intake valves on the same side of the piston, the cycle of operation will be substantially as disclosed in Figs. 16–19 inclusive, it being understood that at least one of the cylinders and pistons will be at the start of or on the explosive stroke of a four cycle movement. Consequently as shown in Fig. 18, the air valve 82 will be opened, thus admitting air to the cylinder to effect this stroke of the piston, the valve 84 opening under pressure of air or motive fluid. Upon the succeeding stroke, the exhaust valve 51 will be opened to permit the escape of the air. Upon the third stroke, (the engine being driven by the compressed air in another cylinder), the intake valve 30 will be opened by its cam operating through the interposed selector, actuating element and stem 31. A charge will thus be introduced into the cylinder, and upon the return stroke, this charge will be compressed but the relief cam 63 will now be in a position to slightly open the exhaust valve 51 and relieve a part of this compression in a manner well understood. This completes the cycle, and on the first stroke of the next cycle the air valve 82 will again be opened. However, at the same time, the igniter 32 is operated, and it is possible and even probable that the charge slightly compressed will be exploded. If an explosion takes place, the force of such explosion will hold the automatic valve 84 closed. Consequently the supply of air will not be utilized, but if an explosion does not take place, the valve 84 opening under the pressure of air or motive fluid will again admit such air or motive fluid to the cylinder and again effect the stroke of the piston. Following the above described operation, the exhaust valve 51 will again be opened to permit the escape of the exploded gases or of the air as the case may be.

With this mechanism, it is to be observed that throughout the various cylinders, as soon as any one unit is in condition to explode a charge, the charge will be ignited. On the other hand, if the explosion fails to occur, the supplemental motive fluid will automatically take its place to drive the engine. Consequently for instance, in a six cylinder engine, air or motive fluid need be introduced upon one side of each piston only, and in any case, this air or motive fluid is admitted upon the explosion stroke of the four cycle engine, so that it never interferes with the intake of the charge. Moreover, admission depends, as already shown, upon the explosion, and it will be evident that the engine is economical not only in the charges introduced but in the amount of air employed. The only real loss occurs in the relief of compression during the compression stroke, and it is possible, though probably not practicable, to eliminate the relief, but it would require air or motive fluid under great pressure to effect a high compression of the charge. Consequently it is believed to be preferable to employ the relief cams. Having now started the engine in this manner, as soon as the ordinary succession of explosion begins to take place, and the necessity of supplemental motive fluid is eliminated, the lever 64 is moved to the second notch. This carries the selector rollers 88 entirely out of the path of movement of the cams 89, and consequently cuts out or makes inactive the motive fluid controlling valves 82. At the same time, the selector rollers 57 which control the operation of the exhaust valves, are moved so that they are out of the path of movement of the relief cams 63. However, the ordinary intake and exhaust is not in any manner changed for the cams 42 and 60 are broad enough to engage with the rollers 46 and 57 when in their intermediate or end positions. The only effect therefore of the second movement is to cut out the relief cams and the relief action of the exhaust valves and maintain inactive the mechanical valves 82 which control the supply of motive fluid. To stop the engine, all that is necessary is to return the selectors to their intermediate or neutral positions and a reversal can be easily effected by moving the lever in the opposite direction. While it is believed to be best to utilize all the cylinders on one side of each piston, in a six-cylinder engine, it will of course be understood that a less number of cylinders may be employed and if desired the air or motive fluid can be admitted to a cylinder on opposite sides of the piston as well as on one side only.

Outside of the advantages secured by the general combination, the mechanism employed for operating the valves and changing their succession of movement, is highly desirable. With the means disclosed there is no necessity of shifting the cams or the valve stems, the intermediate selectors eliminating this necessity. Furthermore the cams can be made comparatively narrow and the amount of movement of the selectors is comparatively small.

From the foregoing, it is thought that the construction, operation and many advantages of the herein described invention will be apparent to those skilled in the art, without further description, and it will be understood that various changes in the size, shape, proportion, and minor details of construction, may be resorted to without departing from the spirit or sacrificing any of the advantages of the invention.

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

1. In a four cycle explosive engine, the combination with a cylinder and a piston operating therein, of means for admitting a charge upon one stroke of the piston, means for exploding a charge upon another stroke of the piston, a valve for admitting motive fluid on the latter stroke, a set of operating devices for the valve, said devices being relatively shiftable into and out of coaction with each other, an exhaust valve, a set of relatively shiftable devices for operating the exhaust valve, and common means for effecting the relative shifting movement between the devices of both sets, said means carrying the devices of the first set into coaction simultaneously with those of the second set and also carrying the devices of the first set out of coaction while retaining those of the second set in coaction.

2. In a reversible four cycle engine, the combination with a cylinder and a piston operating therein, of means for admitting a charge upon one stroke of the piston, means for exploding a charge upon another stroke of the piston, a valve for admitting motive fluid on the latter stroke, a selector for operating the motive fluid valve, a pair of spaced cams for actuating the selector, said selector and cams being relatively shiftable to bring either cam into coaction with the selector accordingly as the engine is reversed and being also relatively shiftable to maintain both cams out of coaction with the selector, an exhaust valve, a second selector for operating the exhaust valve, a pair of exhaust cams and a pair of oppositely set relief cams for actuating the second selector, said cams and second selector being relatively shiftable to bring said different exhaust and relief cams into coaction with the selector accordingly as the engine is reversed and being also relatively shiftable to maintain the relief cams out of coaction while the exhaust cams remain in coaction with the selector, and common means for effecting the relative shifting movement between the selectors and their respective cams, said means simultaneously bringing the first selector into coaction with one of its cams when the other selector is in coaction with both an exhaust and a relief cam, said means also maintaining the first selector out of coaction with both of its cams and the second selector out of coaction with both of the relief cams while retaining said second selector in coaction with either of the exhaust cams.

3. In a four cycle explosive engine, the combination with a cylinder, and a piston operating therein, of a motive fluid inlet valve and an exhaust valve, a plurality of separate actuating devices for the different valves, a single cam shaft, a narrow cam on the cam shaft for effecting a relief opening of the exhaust valve, another narrow cam on the shaft for effecting the successive opening of the motive fluid inlet valve, a broad cam on the cam shaft for effecting an exhaust opening of the exhaust valve, and common means for effecting a relative shifting movement between the actuating devices and the cam shaft to place the exhaust cam, the motive fluid inlet cam and the relief cam in coaction with their respective actuating devices, and for effecting the relative shifting movement to place the motive fluid inlet cam and the relief cam out of coaction with their respective actuating device while the exhaust cam and actuating device remain at all times in coöperative relation.

4. In a reversible four cycle engine, the combination with a cylinder, and a piston operating therein, of mechanism for introducing charges, exploding the charges and exhausting the same, said mechanism being shiftable to reverse the engine, mechanism for admitting motive fluid on the explosion or working stroke only of the piston, and common means for shifting the charge admitting, exploding and exhausting mechanism to reverse the engine and for actuating the motive fluid supply means, and for permitting and cutting off the supply of motive fluid when said engine is running in either direction.

5. In a reversible four cycle engine, the combination with a plurality of cylinders, and pistons operating therein, of mechanism for successively introducing charges into, exploding the charges in and exhausting them from the cylinders, said mechanism being shiftable to reverse the engine, mechanism for successively admitting motive fluid to the cylinders on the explosion or working strokes only of the pistons, said mechanism being automatically held inoperative by the explosion when the same takes place, and common means for shifting the charge admitting, exploding and exhausting mechanism to reverse the engine, and for operating the motive fluid supply mechanism to permit and cut off the supply of the motive fluid to the different cylinders when said engine is running in either direction.

6. In a reversible four cycle engine, the combination with a plurality of cylinders, and a plurality of pistons operating therein, of an intake valve for each cylinder, an actu-

ating device for each valve, a pair of reversing cams for each actuating device, an exhaust valve for each cylinder, an actuating device for each exhaust valve, a pair of reversing exhaust cams for each actuating device, a pair of reversing relief cams for the actuating device of each exhaust valve, ignition mechanism for each cylinder, a motive fluid supply pipe for each cylinder, an actuating device for each motive fluid supply valve, a pair of reversing cams for operating each of the said last mentioned actuating devices on the working strokes of the pistons when the ignition mechanism is operated, and common means for effecting a relative shifting movement between the actuating devices and the cams to effect the reversal of the engine, to position the intake, exhaust, relief and motive fluid supply cams in simultaneously coöperating relation with their actuating devices, and to position the relief and motive fluid supply cams out of coaction with their actuating devices while retaining the same coaction between the intake and exhaust cams and their actuating devices.

7. In a four cycle explosive engine, the combination with a plurality of cylinders and pistons operating therein, of intake valve controlled means for admitting explosive charges to each cylinder, a valve controlled exhaust for each cylinder, ignition mechanism for each cylinder, valve controlled means for admitting motive fluid to each cylinder, means for operating the intake valves once on every second revolution of the engine, means for operating the ignition mechanism once on every second revolution of the engine and in alternation with the operation of the intake valves, means for operating the motive fluid supply controlling valves once on every second revolution and on the revolutions during which the ignition mechanism is operated, means operating the exhaust valves once on every revolution of the engine to respectively relieve compression and permit the exhausts to take place, and common means for throwing into and out of action the valves controlling the motive fluid supply and simultaneously cutting in and out the relief operations of the exhaust valves.

In testimony, that I claim the foregoing as my own, I have hereto affixed my signature in the presence of two witnesses.

RICHARD ALEXANDER MAPLES.

Witnesses:

F. B. KING,

CHAS. S. HARRIS.