905,822.

R. A. MAPLES.

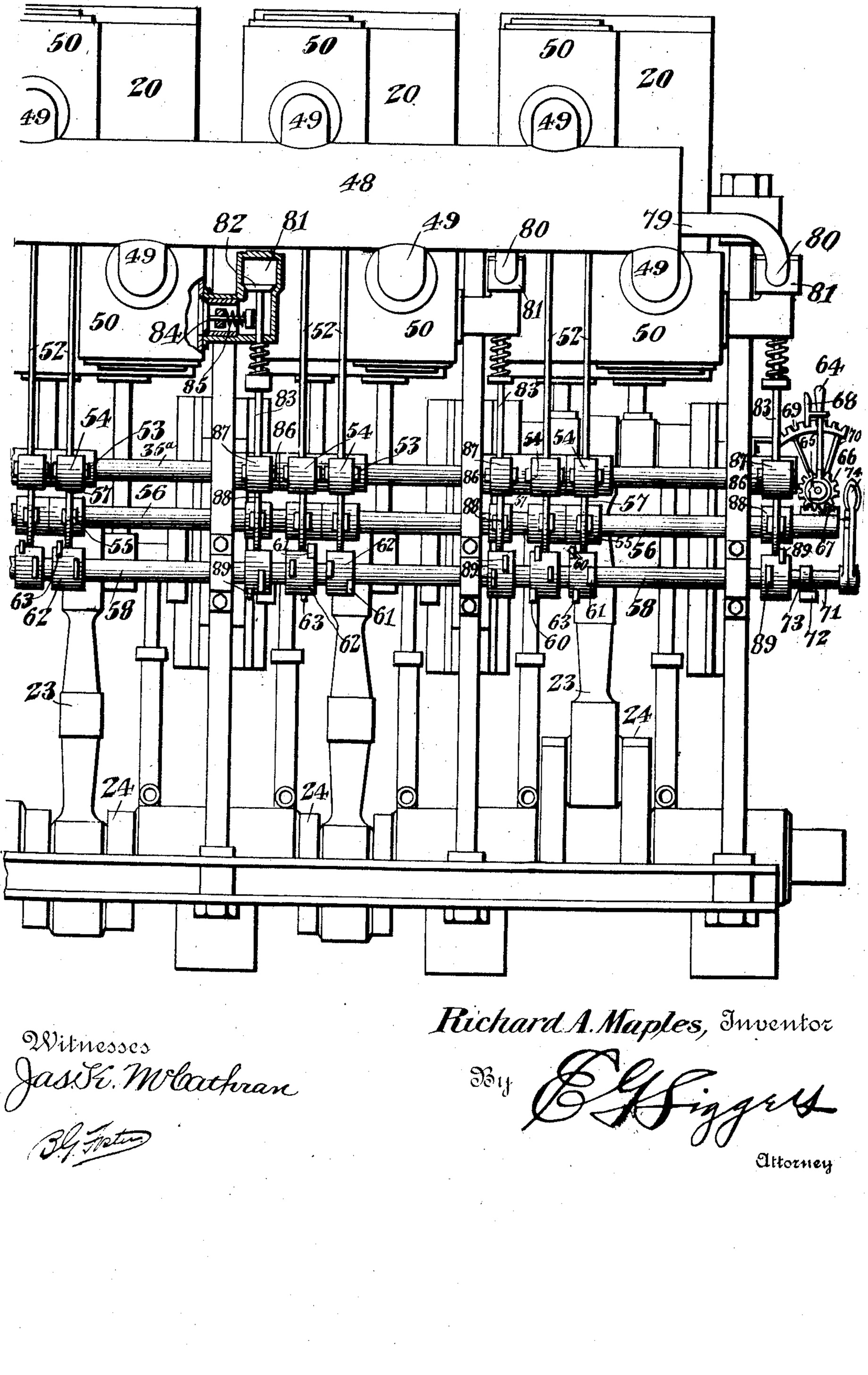
EXPLOSIVE ENGINE.

APPLICATION FILED JULY 23, 1907.

Patented Dec. 1, 1908.

6 SHEETS—SHEET 1.

Fig. 1.



Witnesses

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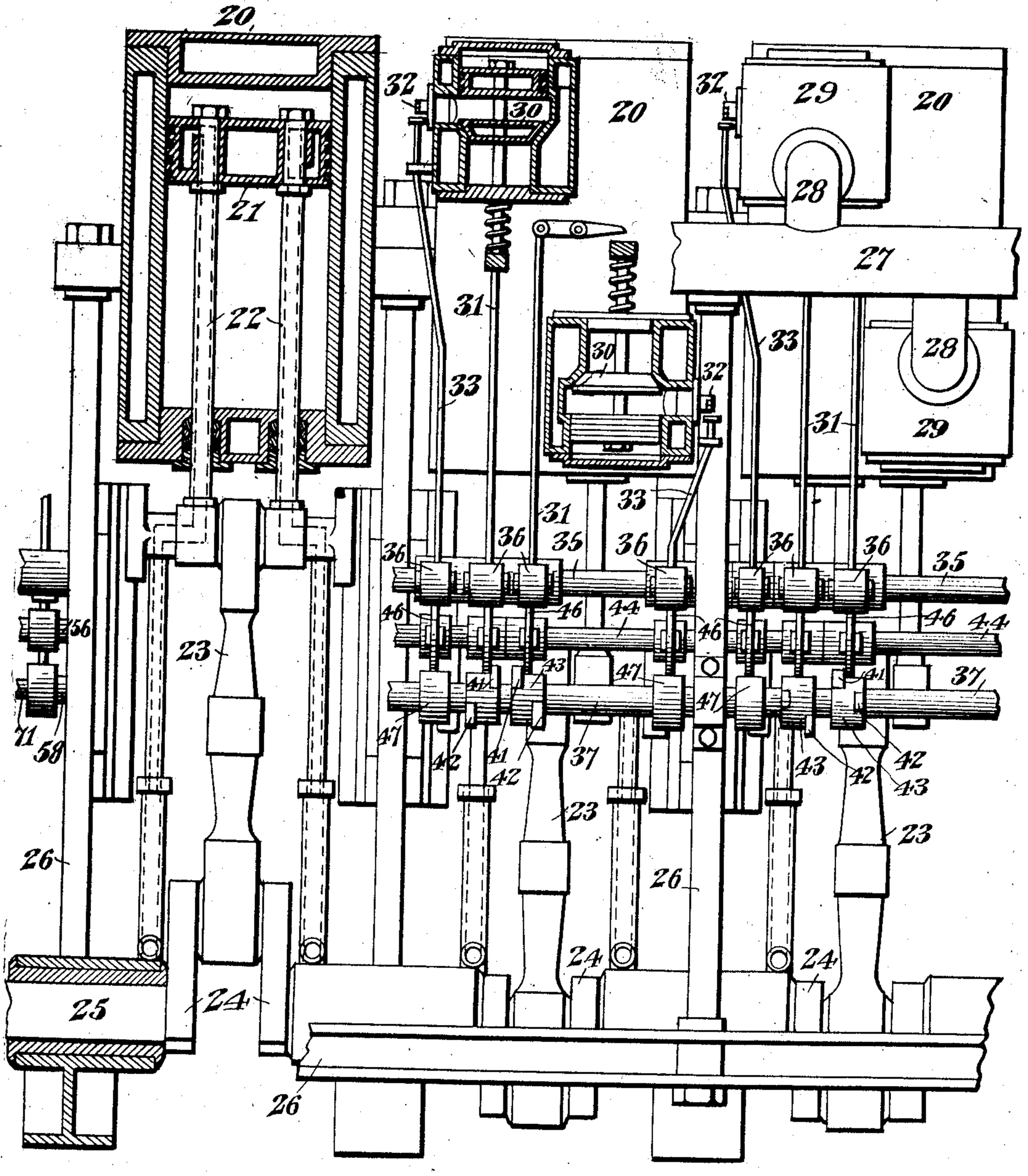
6 SHEETS—SHEET 2.

Fig. 2.



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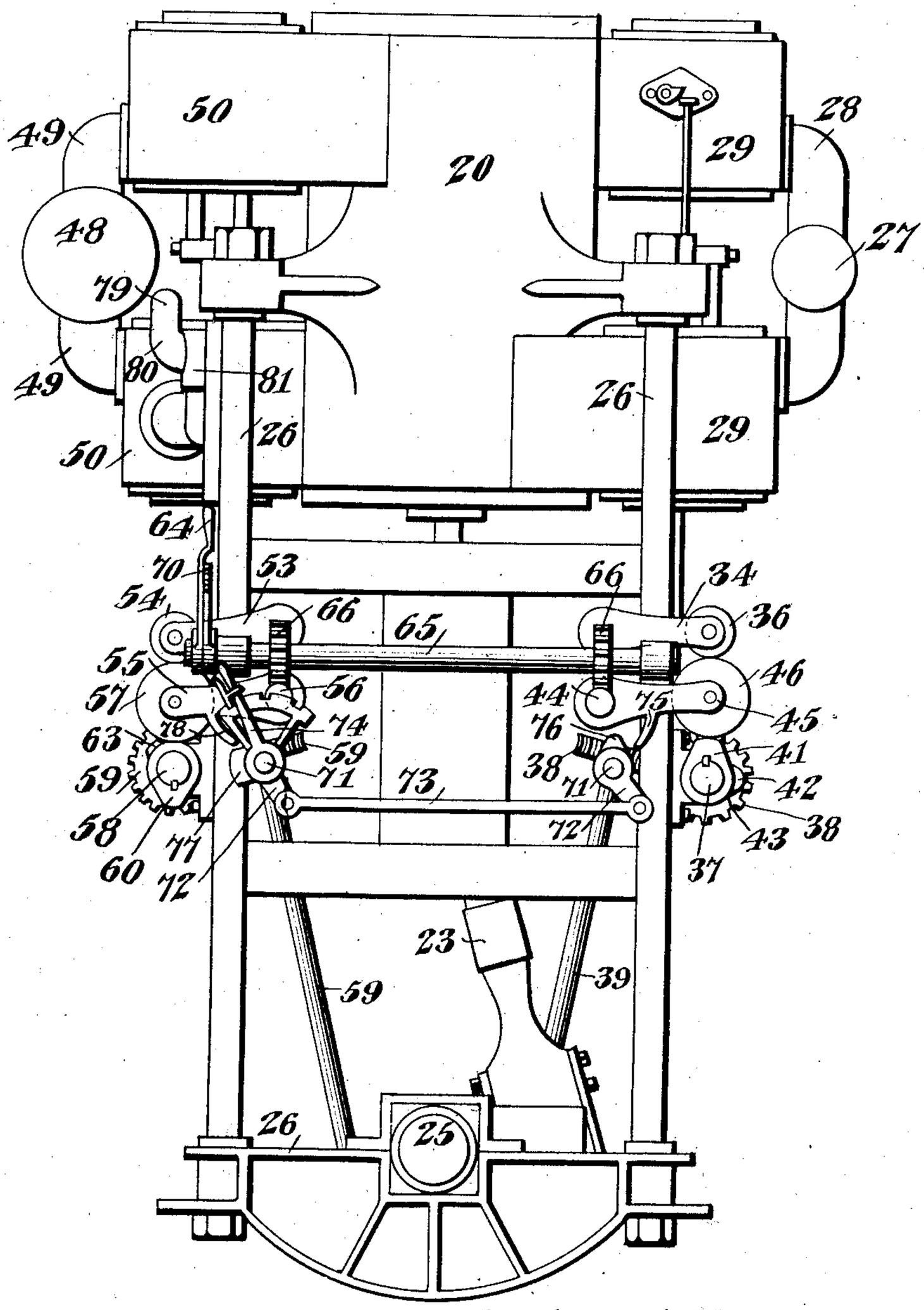
6 SHEETS—SHEET 3.

Fig. 3.



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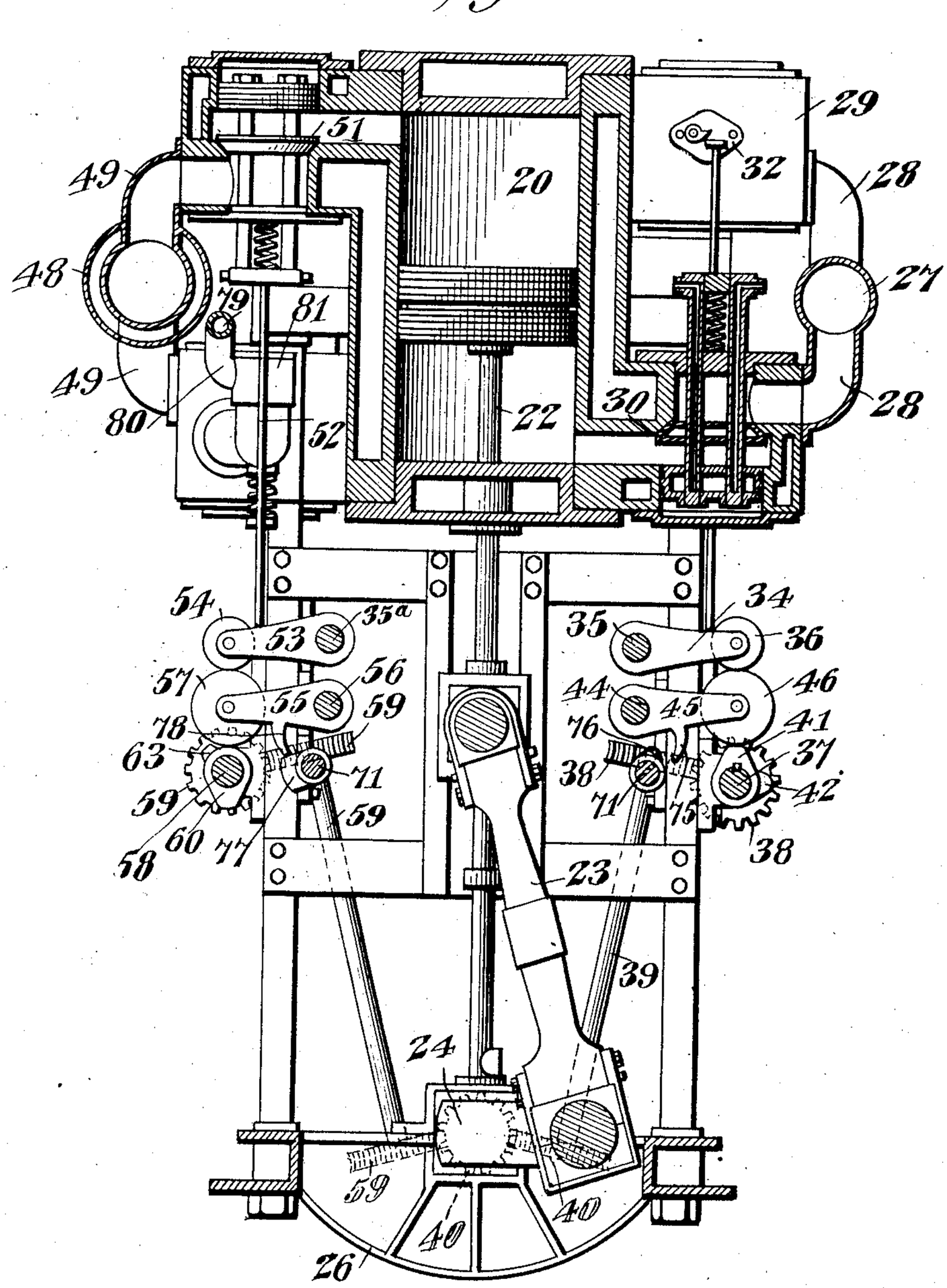
6 SHEETS—SHEET 4.

Fig. 4.



Witnesses

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6 SHEETS—SHEET 5.

Fig. 6.

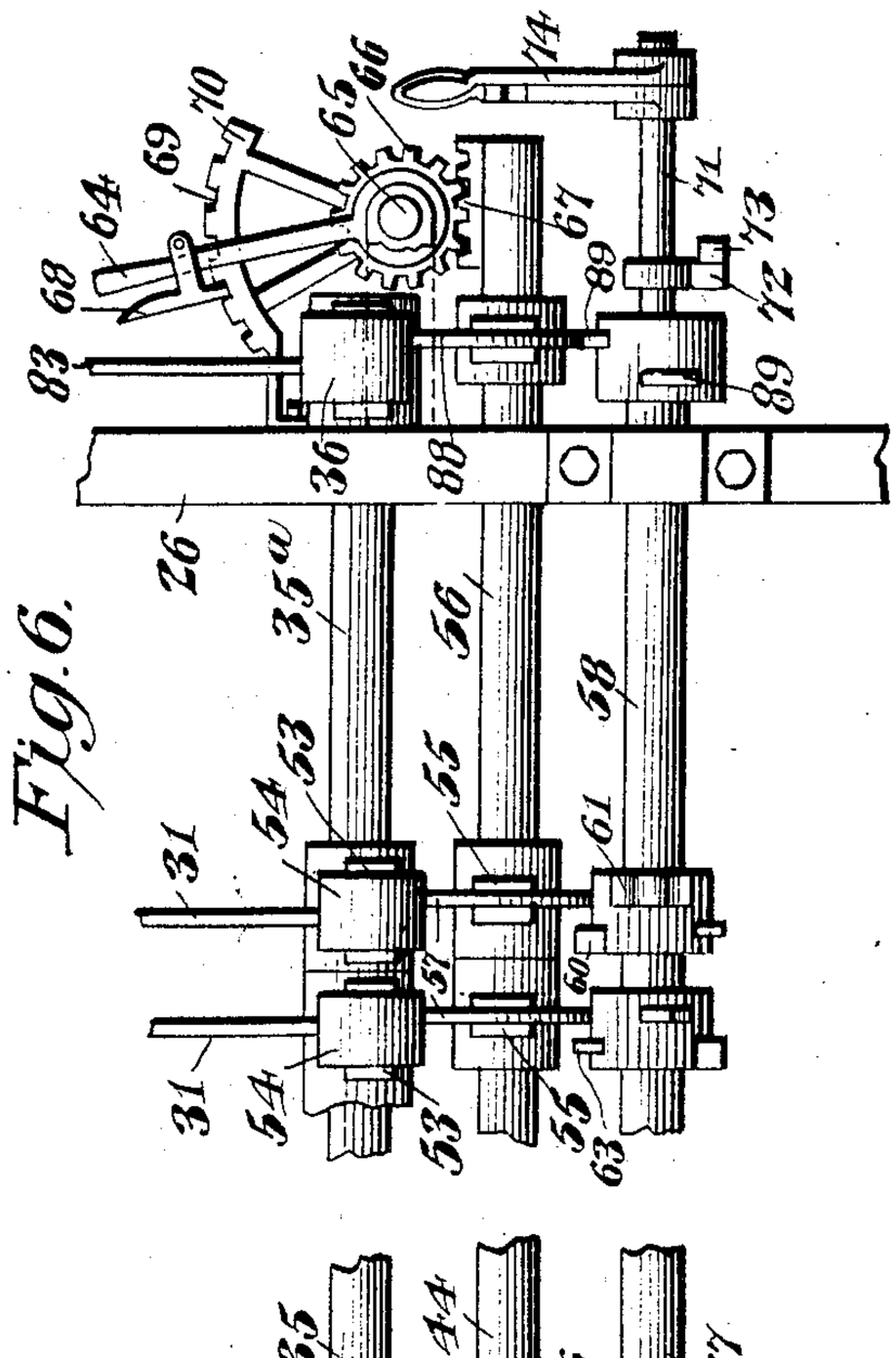


Fig. 8.

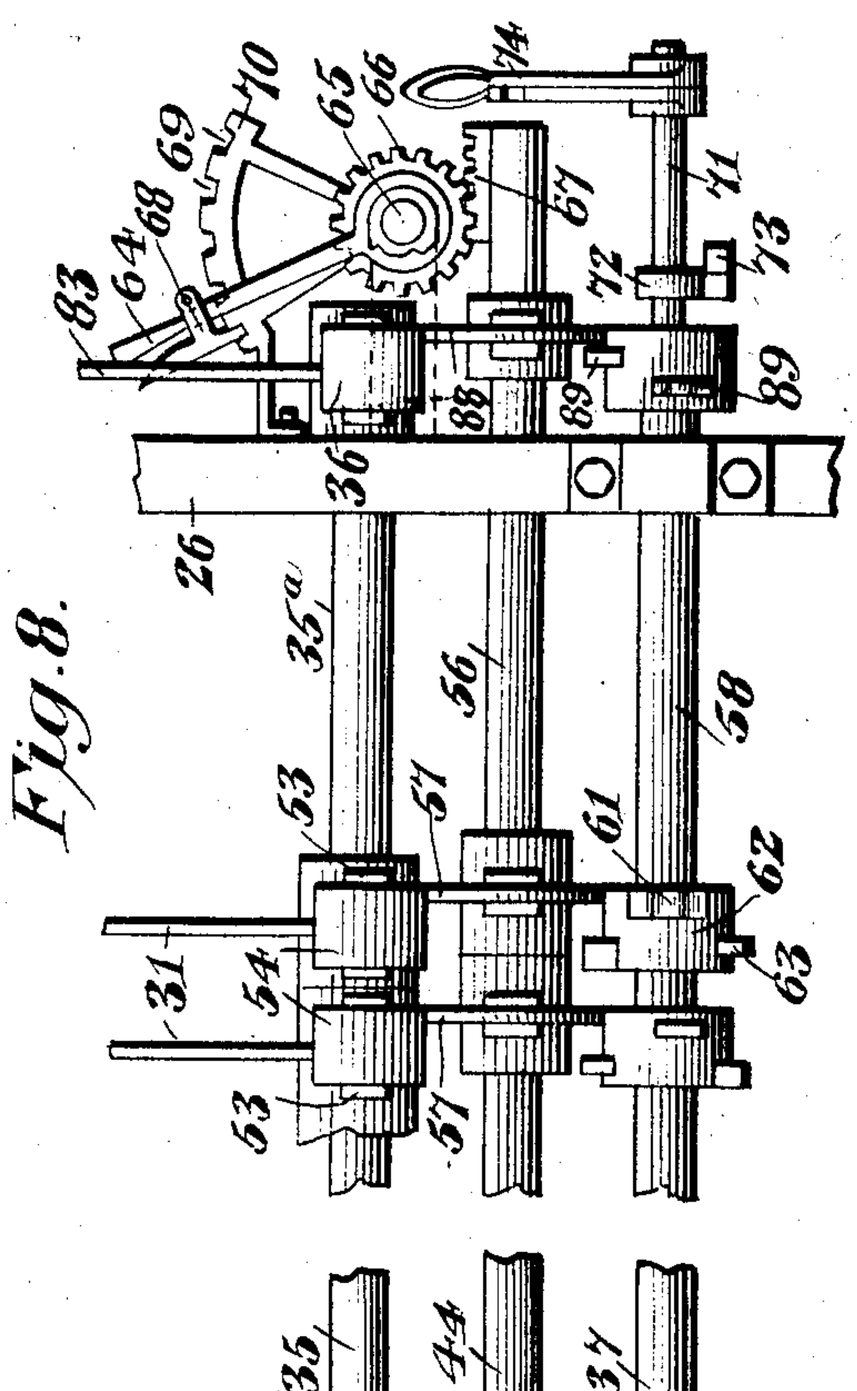


Fig. 5.

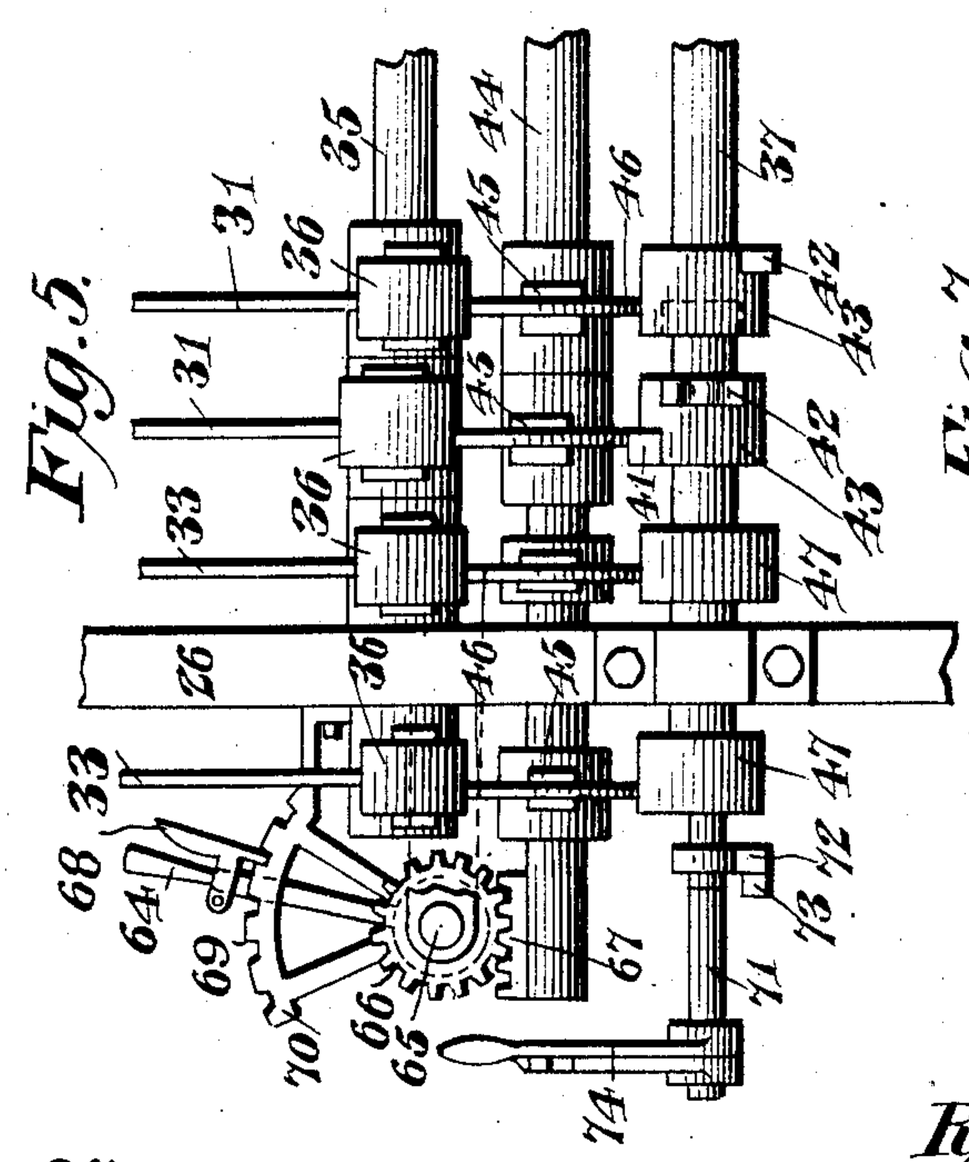
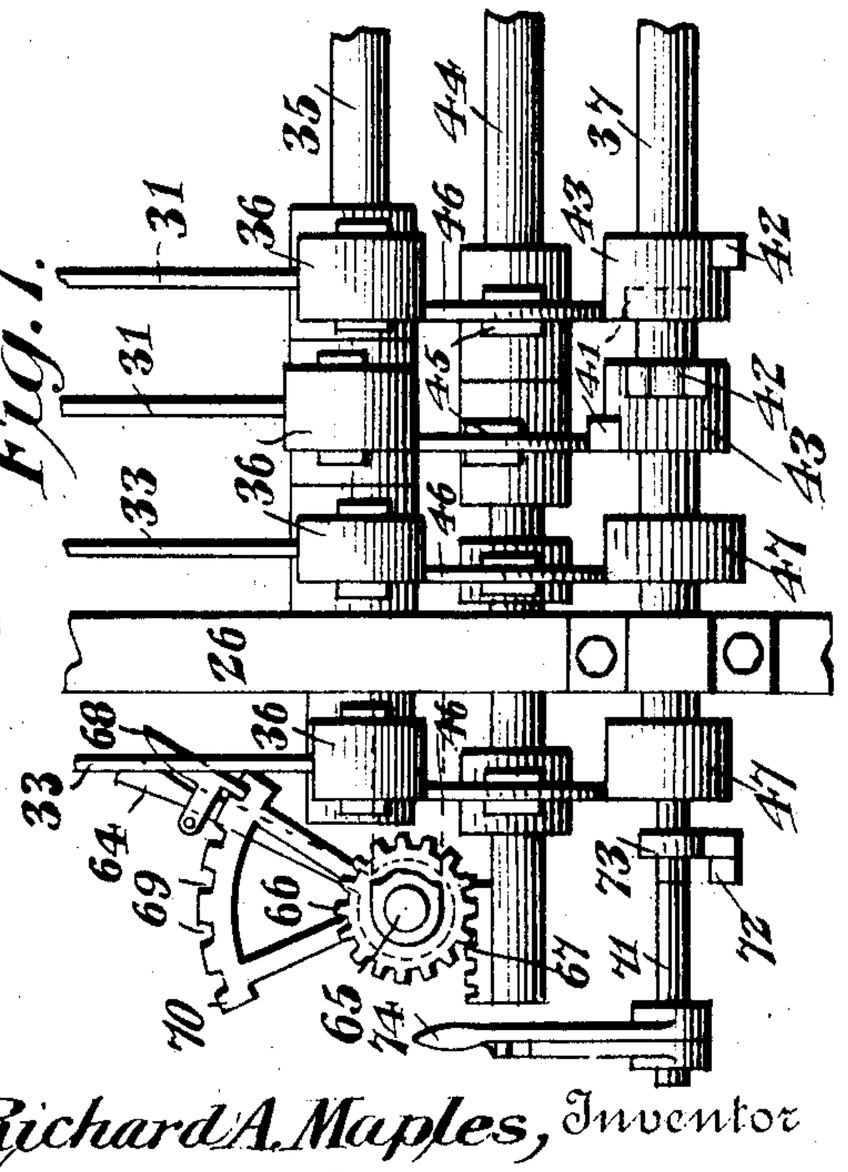


Fig. 7.



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6 SHEETS—SHEET 6.

Fig. 11.

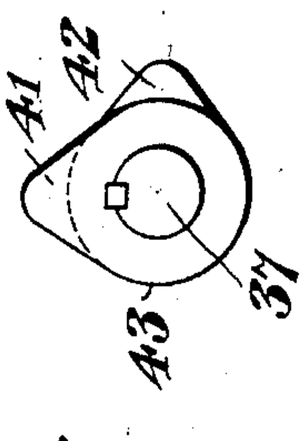


Fig. 13.

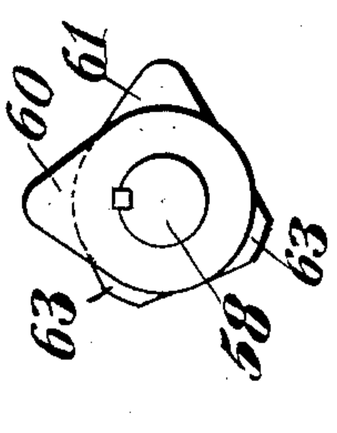


Fig. 15.

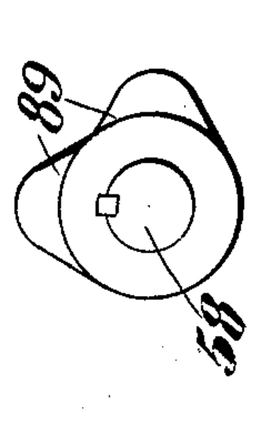


Fig. 10.

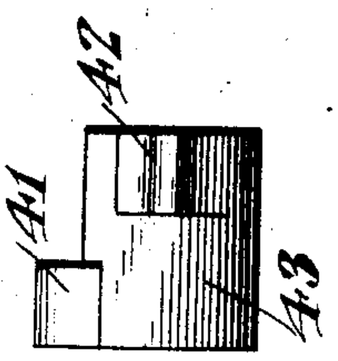


Fig. 12.

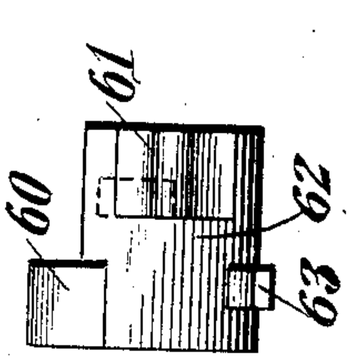


Fig. 14.

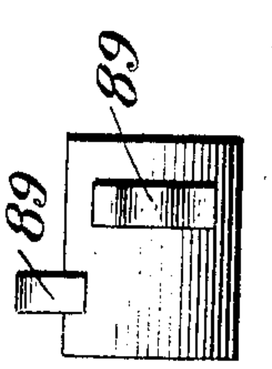


Fig. 9.

Fig. 19.

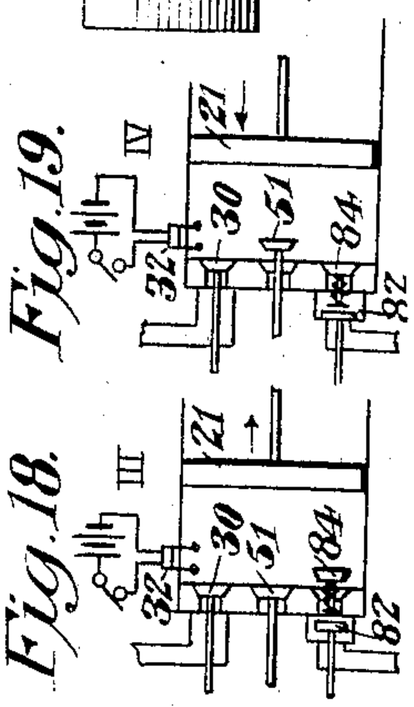


Fig. 18.

Fig. 17.

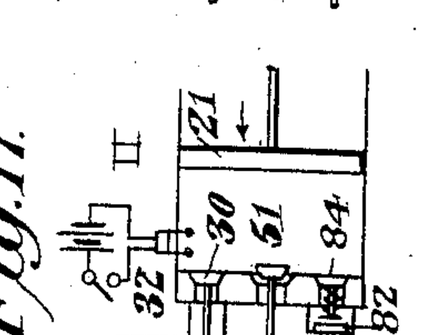
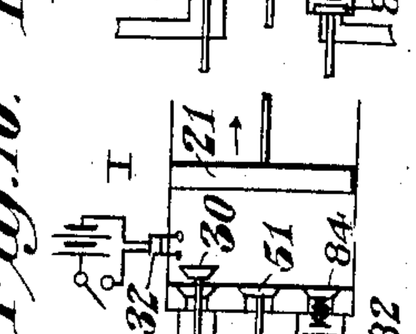


Fig. 16.



Witnesses

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Inventor

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UNITED STATES PATENT OFFICE.

RICHARD ALEXANDER MAPLES, OF CLINTON, IOWA.

EXPLOSIVE-ENGINE.

No. 905,822. Specification of Letters Patent. Patented Dec. 1, 1908.

Original application filed April 29, 1907, Serial No. 370,841. Divided and this application filed July 23, 1907. Serial No. 385,199.

To all whom it may concern:

Be it known that I, RICHARD A. 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.

The present invention relates to explosive engines, and more particularly to the valve gear thereof, and this application is a division of co-pending application Serial No. 370,841, filed April 29, 1907.

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 invention disclosed in the aforesaid application 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.

The principal object of the present invention is to provide novel valve controlling and actuating means, whereby the various changes in the order of succession of the operation of the valve can be readily effected with ease and expedition, and as a result, the engine can be speedily and effectively stopped, started, and reversed. At the same time, the present mechanism is not necessarily limited to the particular structure disclosed in said co-pending application, but is applicable to other types of engines.

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

pitmens 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 the 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 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 mounted on a shaft or axle 35ª 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, the lever 74 is moved to cause the elevation of the various selector rollers and the lever 64 is then moved in one direction or the other one notch of the quadrant 70, after which the lever 74 is returned to its original position, releasing said selector rollers. 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 mechanism of the character described, the combination with an engine, of a controlling valve therefor, an actuated element associated with the valve, actuating means, a movably mounted selector roller interposed between and having a peripheral engagement both with the actuated element and actuating means for transmitting motion from the latter to the former, and means for shifting the selector roller to different positions with respect to the actuating means.

2. In mechanism of the character described, the combination with a valve, of an actuated element associated therewith having a roller, a rotatable actuating cam, a swinging selector arm, and a roller journaled on the arm and peripherally engaged both with the cam and with the roller of the actuated element to transmit motion from the cam to said element.

3. In a four cycle explosive engine, the combination with an engine, of a controlling valve therefor, a valve stem, an actuated element coöperating with the stem, a roller journaled on the actuated element, a selector device including a roller that operates against the roller of the actuated element, actuating devices operating against the roller of the selector device, and means for shifting said selector device and its roller from one actuating device to another.

4. In a four cycle explosive engine, the combination with an engine, of a controlling valve therefor having a stem, a swinging arm that operates against the stem, a roller journaled on the arm, a rotary shaft, means for operating the shaft from the engine, a plurality of cams carried by the shaft, another swinging arm, a roller journaled on said second arm, said roller peripherally engaging against the periphery of the roller of the first arm and being movable into peripheral engagement with the different cams on the shaft, and means for shifting the second arm and its roller to carry it into and out of coaction with the different cams while at the same time retaining it in a position to engage with the first mentioned roller.

5. In a four cycle explosive engine, the combination with a controlling valve, of operating means therefor including actuating elements, an actuated element, an interposed selector for transmitting motion from either of the actuating elements to the actuated element, said selector being movable to different positions with respect to the actuating elements and being movable into and out of coaction with said actuating means, and means for holding the selector out of coactive relation with respect to the actuating elements to permit said selector to be moved to different positions with respect thereto.

6. In a four cycle explosive engine, the combination with an engine, of a controlling valve therefor including a stem, a swinging arm engaging the stem and having a roller, a swinging selector arm having a roller that bears against the roller of the first mentioned arm, said selector arm having a finger, operating cams, means for shifting the selector arm to carry the roller into coaction with the different operating cams, and a cam engaging the finger to hold the selector arm and its roller inactive during its shifting movement.

7. In a four cycle explosive engine, the combination with a cylinder and a piston operating therein, of controlling valves having stems, a plurality of swinging arms against which the stems bear, rollers journaled on the arms, a plurality of sets of cams, each set being associated with one of the rollers, a longitudinally movable shaft, a plurality of independently swinging selector arms loosely journaled on the shaft and movable therewith, rollers journaled on the selector arms and coöperating with the cams and the rollers of the first mentioned arms, means for moving the shaft longitudinally, and means for raising and holding the selector arms elevated during the longitudinal movement of the shaft.

8. The combination with an engine, of intake and exhaust valves associated therewith,

means for operating the valves in different orders of succession, mechanism for effecting the change from one order to another, and means for successively holding the intake and exhaust valves inactive during such changes.

9. In a four cycle explosive engine, the combination with a multiple cylinder engine, of intake and exhaust valves located on opposite sides of the same, shafts having cams located on opposite sides of the engine, selectors coöperating with the cams of the shaft and transmitting motion therefrom to the valves, said selectors being movable to positions on different cams, rock shafts, cams carried by the rock shafts and successively coöperating with the selectors to elevate the same and hold them elevated simultaneously, and means for shifting the selectors when so elevated.

10. In mechanism of the character described, the combination with valve mechanism, of actuating means therefor, a selector interposed between the valve mechanism and actuating means for transmitting motion from one to the other, said selector being movable out of coaction with the actuating means and shiftable with respect to said actuating means when out of coaction therewith, and means for holding the selector out of coaction with the actuating means during the shifting action.

11. In mechanism of the character described, the combination with valve mechanism, of actuating means therefor, a swinging selector interposed between the valve mechanism and the actuating means for transmitting motion from the latter to the former, said selector being movable into and out of coaction with the actuating means, and a cam engaging the selector for holding it out of coaction with the actuating means.

12. In mechanism of the character described, the combination with a valve, of an actuated element associated therewith, actuating means for the valve, a swinging selector arm interposed between the actuating means and actuated element and having a depending finger, and means for swinging the arm independently of the actuating means, said means including a cam that engages the finger.

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,
F. W. ELLIS.