A. E. OSBORN.

VALVE MECHANISM FOR INTERNAL COMBUSTION ENGINES.

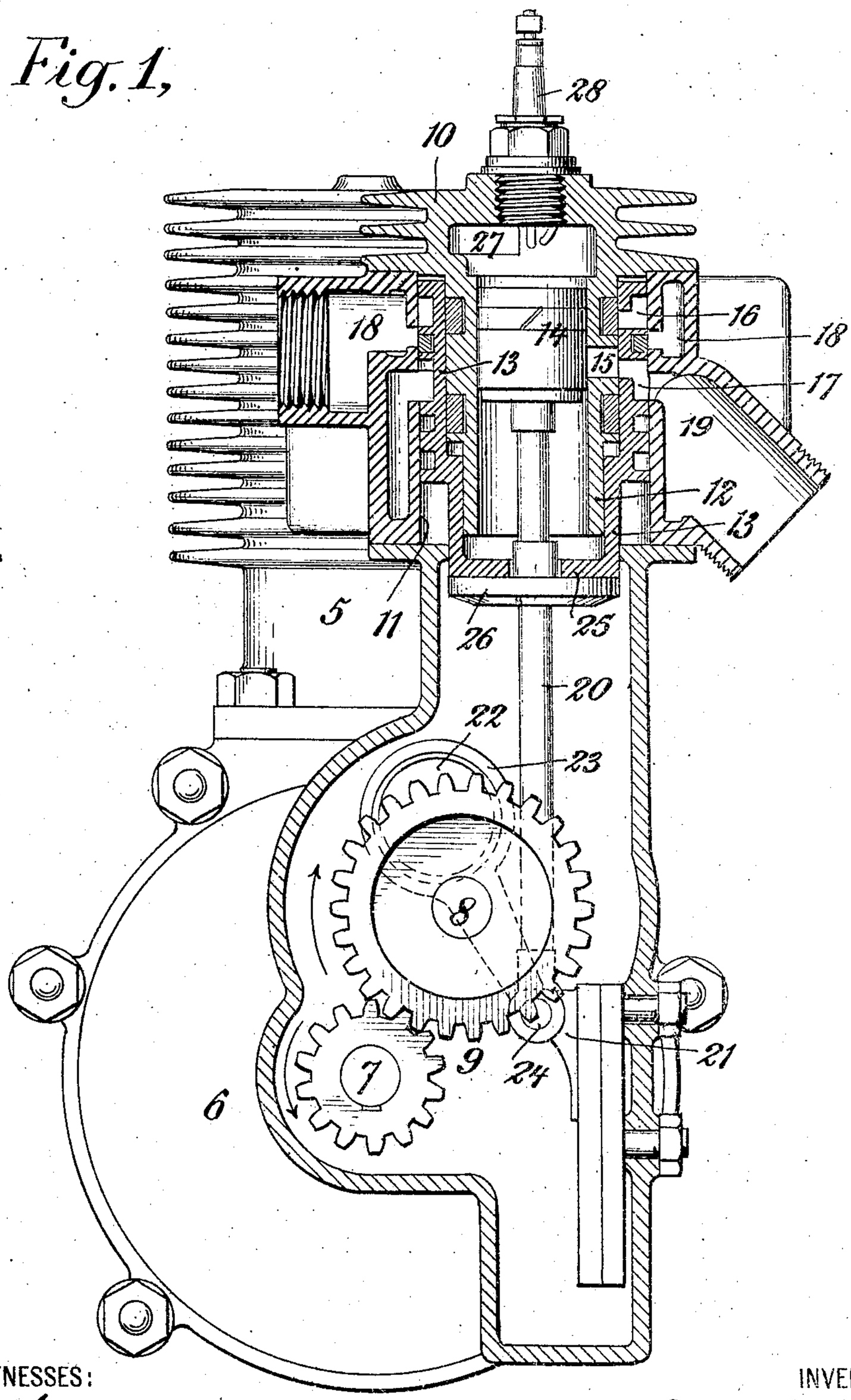
APPLICATION FILED JULY 3, 1909.

987,164.

Patented Mar. 21, 1911.

3 SHEETS—SHEET 1.

Fig. 1,



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3 SHEETS—SHEET 2.

Fig. 2.

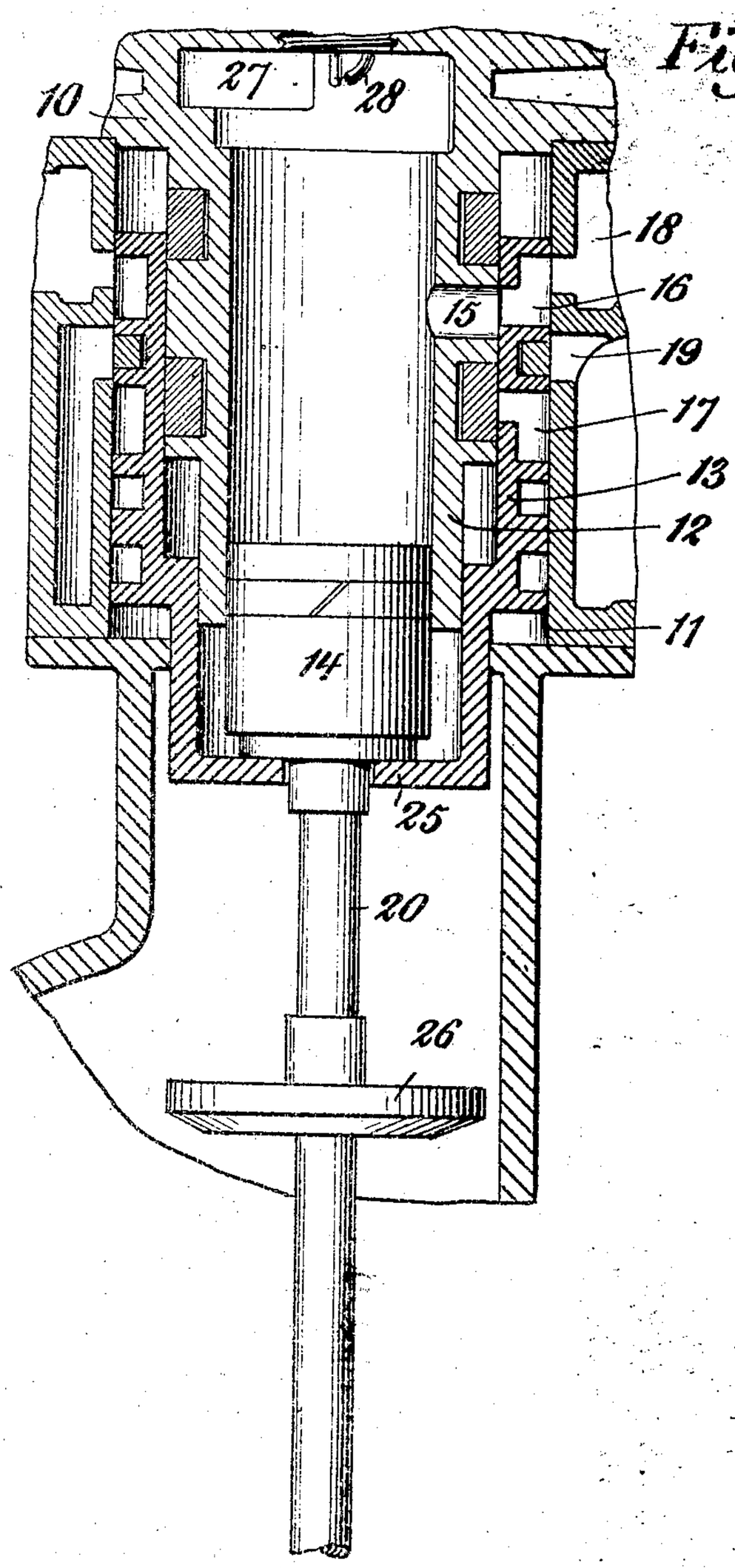
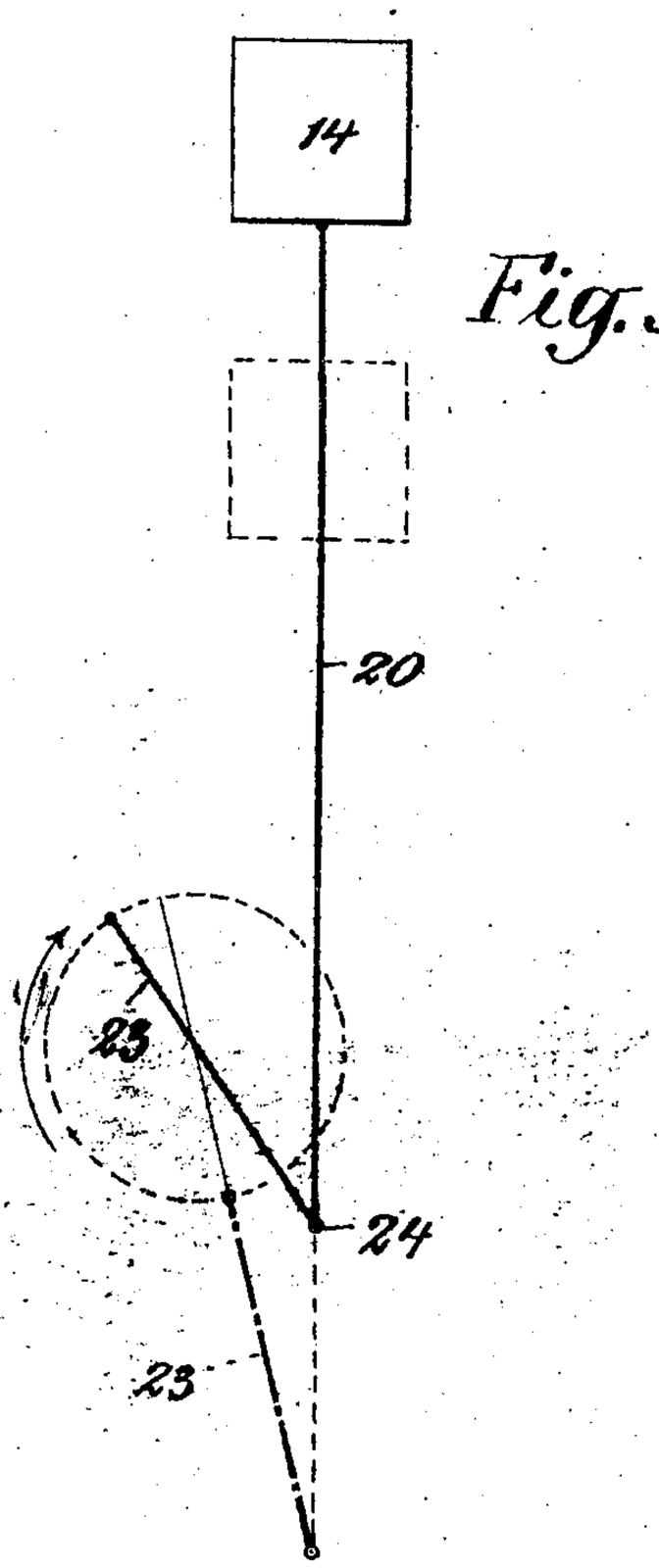


Fig. 3.



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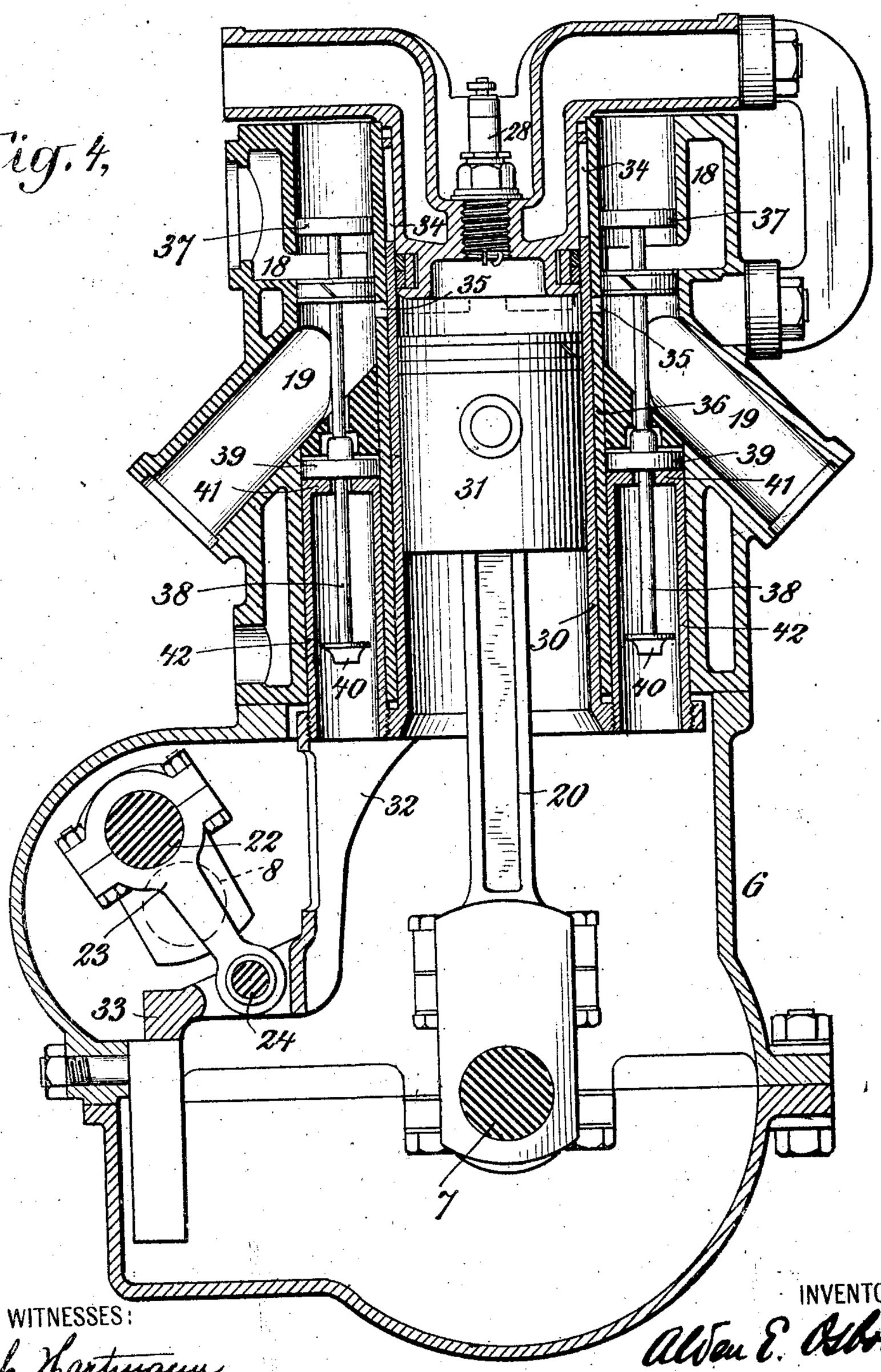
3 SHEETS—SHEET 3.

Fig. 4.



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VALVE MECHANISM FOR INTERNAL-COMBUSTION ENGINES.

987,164. Specification of Letters Patent. Patented Mar. 21, 1911.

Application filed July 3, 1909. Serial No. 505,860.

To all whom it may concern:

Be it known that I, ALDEN E. OSBORN, a citizen of the United States, residing at New York city, in the county and State of New York, have invented a new and useful Improvement in Valve Mechanism for Internal-Combustion Engines, of which the following is a specification.

My invention relates to improvements in valve mechanism for internal combustion engines and particularly to valve mechanism including reciprocating slide valves, and means for positively operating them in either direction.

The valve mechanism commonly employed in connection with four-cycle internal combustion engines of the present day involves the use of cam opened and spring closed puppet valves which, at best, are noisy, unreliable and unsatisfactory in almost every respect. I am aware that attempts have been made to use reciprocating slide valves in connection with this type of engine, but so far as I am at present aware, none of these attempts has been successful, and it is the main object of my present invention to provide an efficient valve mechanism of this character.

To this end, my invention consists in many novel details of construction and combinations of parts, such as will be fully pointed out hereinafter, and in order that my invention may be thoroughly understood, I will now proceed to describe certain embodiments thereof, having reference to the accompanying drawings illustrating the same, and will then point out the novel features in claims.

In the drawings: Figure 1 is a view in partial sectional elevation through a valve mechanism constructed in accordance with my invention, showing the same applied to an internal combustion engine. Fig. 2 is a detail sectional view upon a somewhat larger scale showing the valves in different positions than those in which they are shown in Fig. 1. Fig. 3 is a diagrammatic view showing the relationship of movement between the valve operating shaft, and the valves operated thereby. Fig. 4 is a central vertical transverse sectional view of an internal combustion engine provided with a modified form of valve mechanism constructed in accordance with my invention.

Referring first of all to Figs. 1 and 2, the engine therein shown is the ordinary single cylinder air cooled engine of the four-cycle type. The engine is provided with the usual cylinder 5, crank case 6, and crank shaft 7 journaled therein. A valve operating shaft 8 is connected by gearing 9 with the said crank shaft, the gearing giving a ratio of 2 to 1 so that the operating shaft 8 makes one revolution to every two revolutions of the crank shaft 7. The cylinder 5 is provided with an extension 10 which constitutes a valve casing, the same being in open communication with the engine cylinder by means of a passage 27. This valve casing comprises a cylindrical bore 11 and a tubular member 12, the inner and outer walls of which are cylindrical and are concentric with the cylindrical bore 11. A tubular valve 13 is disposed between the cylindrical bore 11 and the outer walls of the tubular member 12, the same being arranged to act as a distributing valve as will presently be explained, while a piston valve 14 is disposed within the cylindrical bore of the tubular member 12, the same being hereinafter termed the main valve of the engine. The tubular member 12 is provided with one or more transverse passages 15 therethrough, the same being controlled upon one side by the main valve 14, and upon the other side by the distributing valve 13, and the distributing valve is provided with two sets of cross-over ports or passages 16 and 17 which are adapted to alternately connect the said distributing passage 15 with inlet and exhaust chambers 18 and 19 with which the valve casing 10 is provided. The main valve 14 is provided with a valve rod 20 the end of which is secured to a cross-head 21, and the valve operating shaft 8 is provided with an eccentric 22 having an eccentric strap 23 and connecting rod, the end of which is pivotally connected at 24 with the said cross-head. By this means, the rotary movements of the shaft 8 are transmitted in the form of reciprocating movements of the valve 14, and because of the fact that the axis of rotation of the shaft 8 is disposed eccentric with respect to the path of movement of the axis 24, it will follow that the angular movement of the shaft will be greater when moving the valve in one direction than when moving the valve in the other direction. This will readily be understood by reference to the diagrammatic view in Fig. 3, in which it will be seen

that a line passing through the centers of the three parts 24, 8 and 22 when the valve is in its uppermost position, will be oblique to a similar line passing through the parts when the valve is in its lowermost position. The valve moves from its uppermost to its lowermost position while the shaft moves through an angular position from one end of these lines to the other, and in the arrangement of the parts, it will be seen that the valve will move slower when moving downward than it will when being moved upward, for the movement in the former direction will be during the time the shaft moves through the greater arc and hence through more than one-half of a complete movement of rotation of the said shaft. The distributing valve 13 is arranged to be moved by the main valve near the end of its movement in either direction. The distributing valve is provided at its lower end with a flange 25 which is adapted to be engaged by the main valve when near the lower end of its downward movement and by a collar 26 carried by the valve rod 20 when near the upper end of its movement. The movement of the distributing valve is quite small, only such as is necessary to move the ports or passages 16 and 17 into communication with the distributing passage 15, the two extremities of its movement being shown in Figs. 1 and 2, and these movements are required to take place at substantially the end of the reciprocating movements of the main valve, hence the main valve is designed to move the distributing valve from the position in which it is shown in Fig. 1 to the position in which it is shown in Fig. 2 at the extremity of its downward movement, and to return the distributing valve to the position in which it is shown in Fig. 1 at substantially the extremity of its upper movement. The friction of the packing rings between the distributing valve, the inner cylindrical bore 11 and the outer wall of the tubular member 12 employed to prevent leakage, will be sufficient to hold the distributing valve against accidental movement at intermediate times.

The operation of the parts is as follows: When the parts are in the position shown in Fig. 1, the engine piston is at the top of the cylinder and the cylinder contains a charge of compressed gases. Assuming that the combustible charge has been ignited by operation of the spark plug 28 or other suitable means, the engine piston travels downward under the influence of the motive fluid, turning the shaft 7 in the direction indicated by the arrow, and the valve operating shaft in the opposite direction, to the extent of one-half of the angular advance of the crank shaft. When the crank shaft has made nearly one-half a turn and the working stroke of the engine is finished, the main valve 14 will be moved practically one-half its stroke and it will have commenced to uncover the passage 15, thereby affording communication through the valve casing between the engine cylinder and the exhaust chamber 19. This passage is fully uncovered by the time the engine piston has just commenced its return stroke. As the engine piston continues to ascend on the exhaust stroke, the main valve 14 will continue to descend and after the engine piston has reached its uppermost position and just commenced to move downward again, a point in the stroke of the valve 14 is reached wherein the flange 25 is engaged by the main valve, and in the remainder of the downward movement of the valve, the distributing valve 13 is moved therewith so that the parts will finally reach the position shown in Fig. 2. The effect of the latter movement is to close communication between the exhaust chamber 19 and the distributing passage 15 and to open communication between the said passage 15 and the inlet chamber 18, the inlet chamber being in full communication with the passage 15 when the engine piston has moved downward about one-quarter of its suction stroke. As the piston continues to move downward, the main valve will commence to move upward and its speed will now commence to accelerate by means of the eccentric position of the shaft 8 as above described. About the time the suction stroke of the piston has been completed and the piston has commenced its return stroke, the main valve will again cover the distributing passage 15 so as to close the same so that upon the continued compression movement of the piston, the cylinder will be entirely closed. As the engine piston completes its upward movement to compress the charge, the main valve will continue and complete its upward movement, and near the end thereof it will, by reason of the engagement of the collar 26 on the valve rod 20 with the flange 25 of the distributing valve 13, carry the distributing valve up with it in the position in which it is shown in Fig. 1, whereby to disconnect the inlet chamber from the distributing passage, and again connect the exhaust chamber therewith so that when the main valve next uncovers the distributing passage 15, it will open the cylinder to exhaust. The foregoing completes the cycle of operation; the parts are now back in the position in which they are shown in Fig. 1 ready for a new cycle to be commenced.

In the modified form of my invention shown in Fig. 4, the main valve is in the form of a tubular shell 30 which surrounds, and is concentric with, the main piston 31. The said main valve is connected by means of an arm 32 with a cross-head 33, the same being the equivalent of the cross-head

21 of the structure shown in the other figures, the said cross-head being connected to, and operated by, an eccentric 22 upon the valve operating shaft 8. The said valve 30 is provided with slots 34 near the upper end thereof which are engaged to register at the proper time with openings 35 in the cylinder 36 which surrounds the valve 30 and piston 31, the said openings constituting a distributing passage equivalent to the passage 15 in the structure in the other figures. This passage may be connected with either the inlet or exhaust chambers 18, 19 by a suitable valve mechanism such as that shown in Fig. 1. Because of the fact, however, that a valve for this purpose constructed like that shown in the other figures, would be of very large size, I preferably provide one or more distributing valves 37 disposed eccentric with respect to the said main valve 30. Each of the valves 37 shown in Fig. 4 comprises two heads adapted in their movements to connect either the inlet chamber 18 with the said distributing passage 35, or the exhaust chamber 19 therewith. The valves are provided with stems 38 having collars 39, 40 thereon for co-engagement with flanges 41 upon tubes 42 carried by, and with, the said main valve 30. The distributing valves 37 are shown as in their uppermost position, in which position they connect the exhaust chamber with the distributing passage 35. In their lowermost position they will connect the inlet chamber with the said distributing passages, as will be readily understood by an inspection of the drawings. A construction of this kind not only permits the use of very light distributing valves but also distributes the gases to better advantage, preserves a more even distribution of heat, and serves to afford a more direct passage for the gases. The operation of an engine of this construction will be similar to that of the engine shown in the other figures, and further detailed description thereof will be unnecessary herein.

In the construction shown in Fig. 4 the valves 30 and 37 and adjacent parts are shown as surrounded by a suitable jacket within which a cooling medium, such as water, may be circulated for the purpose of keeping down the temperature of the parts. Other cooling means may, of course, be employed, such as the radiating fins in the form of engine shown in Figs. 1 and 2, the gases constituting a fresh charge also tending to cool the parts as they pass through the passages, and it will, of course, be understood that the valve mechanism above described may be applied to a large variety of different forms and constructions of internal combustion engine.

What I claim is:

1. A valve mechanism comprising a casing having inlet and exhaust chambers and a distributing passage, a valve located at one end of the said passage for controlling the same, and means located at the other end of the said passage, and operated by the movement of the said valve, for connecting the said passage with either the said inlet or the said exhaust chamber.

2. A valve mechanism comprising a casing having inlet and exhaust chambers and a distributing passage, a valve located at one end of the said passage for controlling the same, and a second valve located at the other end of the said passage, and operated by the movement of the first said valve, for connecting the said passage with either the said inlet or the said exhaust chamber.

3. A valve mechanism comprising a casing having inlet and exhaust chambers and a distributing passage, a reciprocating valve located at one end of the said passage for controlling the same, and means located at the other end of the said passage, and operated by the movement of the said valve, for connecting the said passage with either the said inlet or the said exhaust chamber.

4. A valve mechanism comprising a casing having inlet and exhaust chambers and a distributing passage, a reciprocating valve located at one end of the said passage for controlling the same, and a second reciprocating valve located at the other end of the said passage, and operated by the movement of the first said valve, for connecting the said passage with either the said inlet or the said exhaust chamber.

5. A valve mechanism comprising a casing having inlet and exhaust chambers and a distributing passage, a reciprocating slide valve located at one end of the said passage for controlling the same, and means located at the other end of the said passage, and operated by the movement of the said valve for connecting the said passage with either the said inlet or the said exhaust chamber.

6. A valve mechanism comprising a casing having inlet and exhaust chambers and a distributing passage, a reciprocating slide valve located at one end of the said passage for controlling the same, and a second reciprocating slide valve located at the other end of the said passage, and operated by the movement of the first said valve for connecting the said passage with either the said inlet or the said exhaust chamber.

7. A valve mechanism comprising a casing having inlet and exhaust chambers and a distributing passage, a valve located at one end of the said passage for controlling the same, and means operated by the movement of the said valve when the valve is near each end of its movement for connecting the other end of the said passage with either the said inlet or the said exhaust chamber.

8. A valve mechanism comprising a cas-

ing having inlet and exhaust chambers, and a distributing passage, a valve located at one end of the said passage for controlling the same, and a second valve operated by the movement of the first said valve when it is near each end of its movement, for connecting the other end of the said passage with either the said inlet or the said exhaust chamber.

9. A valve mechanism comprising a casing having inlet and exhaust chambers and a distributing passage, a reciprocating valve located at one end of the said passage for controlling the same, and means operated by the movement of the said valve, when the valve is near each end of its reciprocating movement, for connecting the other end of the said passage with either the said inlet or the said exhaust chamber.

10. A valve mechanism comprising a casing having inlet and exhaust chambers and a distributing passage, a reciprocating valve located at one end of the said passage for controlling the same, and a second reciprocating valve, operated by the movement of the first said valve when it is near each end of its reciprocating movement, for connecting the other end of the said passage with either the said inlet or the said exhaust chamber.

11. A valve mechanism comprising a casing having inlet and exhaust chambers and a distributing passage, a reciprocating valve located at one end of the said passage for controlling the same, a second valve for connecting the other end of the said passage with either the said inlet or the said exhaust chamber, and means whereby the latter said valve is moved by the first said valve near one end of its movement to connect the said passage with the inlet chamber, and near the other end of its movement to connect the said passage with the exhaust chamber.

12. A valve mechanism comprising a casing having inlet and exhaust chambers, and including a cylindrical element provided with a distributing passage therethrough, a piston valve within the cylindrical element and controlling the inner end of the said distributing passage, and a tubular valve surrounding the said cylindrical element, arranged to connect the outer end of the distributing passage with either the said inlet or the said exhaust chamber.

13. A valve mechanism comprising a casing having inlet and exhaust chambers, and including a cylindrical element provided with a distributing passage therethrough, a piston valve within the cylindrical element and controlling the inner end of the said distributing passage, and a longitudinally reciprocating tubular valve surrounding the said cylindrical element, arranged in one position to connect the outer end of the said distributing passage with the said inlet chamber, and in another position to connect the outer end of the said distributing passage with the said exhaust chamber.

14. A valve mechanism comprising a casing having inlet and exhaust chambers, and including a cylindrical element provided with a distributing passage therethrough, a piston valve within the cylindrical element and controlling the inner end of the said distributing passage, and a tubular valve surrounding the said cylindrical element, arranged to connect the outer end of the distributing passage with either the said inlet or the said exhaust chamber, the said tubular valve being operated by the movement of the first said valve.

15. A valve mechanism comprising a casing having inlet and exhaust chambers, and including a cylindrical element provided with a distributing passage therethrough, a piston valve within the cylindrical element and controlling the inner end of the said distributing passage, and a reciprocating tubular valve surrounding the said cylindrical element, arranged to connect the outer end of the distributing passage with either the said inlet or the said exhaust chamber, the said tubular valve being longitudinally reciprocated by the movement of the first said valve.

16. A valve mechanism comprising a casing having inlet and exhaust chambers, and including a cylindrical element provided with a distributing passage therethrough, a piston valve within the cylindrical element and controlling the inner end of the said distributing passage, and a tubular valve surrounding the said cylindrical element, arranged to connect the outer end of the distributing passage with either the said inlet or the said exhaust chamber, the said tubular valve being connected in operative relation with the first said valve near the limit of its movement in either direction.

17. The combination with a working cylinder and a casing containing a valve chamber, an inlet chamber, an exhaust chamber, a distributing passage, and a passage leading from the interior of the valve chamber to the working cylinder, of a valve located within the said valve casing for controlling communication between the latter said passage and the inner end of the said distributing passage, and another valve concentric with the first said valve and surrounding the same, for controlling the opposite end of the said distributing passage and for connecting it with either the said inlet or the said exhaust chamber.

18. The combination with a working cylinder and a casing containing a valve chamber, an inlet chamber, an exhaust chamber, a distributing passage, and a passage leading from the interior of the valve chamber to the working cylinder, of a valve

located within the said valve casing for controlling communication between the latter said passage and the inner end of the said distributing passage, and another valve concentric with the first said valve and surrounding the same, for controlling the opposite end of the said distributing passage and for connecting it with either the said inlet or the said exhaust chamber, the latter said valve being operated by the movement of the first said valve.

19. The combination with a working cylinder and a casing containing a valve chamber, an inlet chamber, an exhaust chamber, a distributing passage, and a passage leading from the interior of the valve chamber to the working cylinder, of a reciprocating valve located within the said valve casing for controlling communication between the latter said passage and the inner end of the said distributing passage, and another reciprocating valve concentric with the first said valve and surrounding the same, for controlling the opposite end of the said distributing passage and for connecting it with either the said inlet or the said exhaust chamber.

20. The combination with a working cylinder and a valve casing having a cylindrical element containing a distributing passage through the walls thereof, the interior of the said cylindrical casing element being in communication with the said working cylinder, and the said casing having inlet and exhaust chambers, of a piston valve mounted in the said cylindrical casing element, for controlling the inner end of the said distributing passage, and closing it from communication with the said working cylinder, a tubular valve surrounding the said cylindrical casing element, and arranged in one position to connect the said distributing passage with the said exhaust chamber, and means for moving the said tubular valve, by the reciprocation of the said piston valve, to such position.

21. The combination with a working cylinder and a valve casing having a cylindrical element containing a distributing passage through the walls thereof, the interior of the said cylindrical casing element being in communication with the said working cylinder, and the said casing having inlet and exhaust chambers, of a piston valve mounted in the said cylindrical casing element, for controlling the inner end of the said distributing passage, and closing it from communication with the said working cylinder, a tubular valve surrounding the said cylindrical casing element, and arranged in one position to connect the said distributing passage with the said inlet chamber, and means for moving the said tubular valve, by the reciprocation of the said piston valve to such position.

22. The combination with a valve and a reciprocating element connected thereto, of operating means therefor comprising a rotating shaft, an eccentric thereon, and means connecting the eccentric with the said reciprocating element, the axis of the said shaft being so located with respect to the said reciprocating element, as to cause the said reciprocating element to move faster in one direction than in the other.

23. The combination with a valve and a reciprocating element connected thereto, of operating means therefor comprising a rotating shaft, an eccentric thereon, and means connecting the eccentric with the said reciprocating element, the axis of the said shaft being so located with respect to the said reciprocating element, that the said shaft will have a greater angular movement when moving the said element in one direction than when moving it in the other.

24. The combination with a reciprocating slide valve, of operating means therefor comprising a rotating shaft, an eccentric thereon, and means connecting the eccentric with the valve, the axis of the said shaft being so located with respect to the parts reciprocated by the said eccentric as to cause the reciprocating element to move faster in one direction than in the other.

25. The combination with a reciprocating slide valve, of operating means therefor comprising a rotating shaft, an eccentric thereon, and means connecting the eccentric with the valve, the axis of the said shaft being so located with respect to the parts reciprocated by the said eccentric, that the said shaft will have a greater angular movement when moving the said element in one direction than when moving it in the other.

26. The combination with a valve and a reciprocating element connected thereto, of operating means therefor comprising a rotating shaft, an eccentric thereon, and a connecting element mounted upon the eccentric, and pivotally connected to the said reciprocating element, the axis of the said shaft being disposed eccentric to the line of movement of the axis of such pivotal connection, whereby the angular movement of the shaft to move the valve in one direction will be greater than the angular movement thereof to move the valve in the other direction.

27. The combination with a reciprocating slide valve, of operating means therefor comprising a rotating shaft, an eccentric upon the shaft, and a connecting element mounted upon the eccentric and pivotally connected to a part movable with the valve, the axis of the shaft being disposed eccentric to the line of movement of the axis of such pivotal connection, whereby the angular movement of the shaft to move the valve in one direction will be greater than the angu-

lar movement thereof to move the valve in the other direction.

28. The combination with a valve casing having inlet and exhaust chambers and a distributing passage, a valve for controlling the said passage, and means operated by the movement of the said valve for connecting the said passage with either the said inlet or the said exhaust chamber, of a reciprocating element connected to the said valve, operating means for the said valve comprising a rotating shaft, an eccentric thereon, and means connecting the eccentric with the said reciprocating element, the axis of the said shaft being so located with respect to the said reciprocating element, as to cause the said reciprocating element to move faster in one direction than in the other.

29. The combination with a valve casing having inlet and exhaust chambers and a distributing passage, a reciprocating valve for controlling the said passage, and means operated by the movement of the said valve for connecting the said passage with either the said inlet or the said exhaust chamber, of operating means for the said valve comprising a rotating shaft, an eccentric thereon, and means connecting the eccentric with the valve, the axis of the said shaft being so located with respect to the parts reciprocated by the said eccentric as to cause the reciprocating element to move faster in one direction than in the other.

30. The combination with a valve casing having inlet and exhaust chambers and a distributing passage, a reciprocating valve for controlling the said passage, and means operated by the movement of the said valve for connecting the said passage with either the said inlet or the said exhaust chamber, of operating means for the said valve comprising a rotating shaft, an eccentric thereon, and a connecting element mounted upon the eccentric, and pivotally connected to the said reciprocating element, the axis of the said shaft being disposed eccentric to the line of movement of the axis of such pivotal connection, whereby the angular movement of the shaft to move the valve in one direction will be greater than the angular movement thereof to move the valve in the other direction.

31. The combination with a valve casing having inlet and exhaust chambers and a distributing passage, a reciprocating valve for controlling the said passage, and means operated by the movement of the said valve for connecting the said passage with either the said inlet or the said exhaust chamber, of operating means for the said valve comprising a rotating shaft, an eccentric upon the shaft, and a connecting element mounted upon the eccentric and pivotally connected to a part movable with the valve, the axis of the shaft being disposed eccentric to the line of movement of the axis of such pivotal connection, whereby the angular movement of the shaft to move the valve in one direction will be greater than the angular movement thereof to move the valve in the other direction.

32. The combination with a valve casing having a passage therein, and a movable valve for controlling the said passage, of a rotary shaft, a reciprocating member beyond the said shaft, the said shaft being substantially between the said member and the said valve, means connecting the said member with the said valve, an eccentric on said shaft, and means for connecting the said eccentric with the said member.

33. The combination of a main cylinder, a second cylinder, a passage connecting the said cylinders, a piston in the said second cylinder, a passage through the wall of the said second cylinder, a movable sleeve surrounding the said second cylinder, and means for giving the said piston a reciprocating motion to open or close said passage, the said means also serving to move the said sleeve.

34. The combination in an internal combustion engine, of a main cylinder containing the engine piston, a second cylinder having a connecting passage to the said main cylinder, a piston in the said second cylinder, a distributing passage through the wall of the said second cylinder, a movable sleeve surrounding the said second cylinder, an intake chamber surrounding the said sleeve, an exhaust chamber also surrounding the said sleeve, passages through the said sleeve whereby when the said sleeve is moved into one position the said distributing passage is put into communication with the intake chamber and when in another position the said distributing passage is put into communication with the exhaust chamber, means for moving the said valve piston, and means whereby when the said piston has shut off communication between the main engine cylinder and the said distributing passage, the said sleeve is moved to the position in which the said distributing passage communicates with the exhaust chamber, and also means whereby when the said piston has opened the said distributing passage, the said sleeve is moved to open communication between the said distributing passage and the intake chamber.

35. In an internal combustion engine the combination with a valve casing having inlet and exhaust chambers and a distributing passage, and a valve for controlling the said passage, of a means for operating said valve to open or close the said passage, the said means comprising in part a reciprocating member, a connecting rod pivoted on said member, and an eccentric rotating in said

rod and rotating about an axis at one side of the line of reciprocation of said member, and means for throwing said passage into communication with the intake or exhaust chambers, the said means being operated by the reciprocation of said member.

36. In an internal combustion engine the combination of a cylinder, a piston in the said cylinder, a second cylinder constituting a valve casing parallel with the first mentioned cylinder, a passage connecting these two cylinders, a piston valve in the said second cylinder, a passage in the wall of said second cylinder, a crank-shaft, a casing supporting the said crank-shaft and inclosing one end of both of the said cylinders, and means within the said casing to operate the piston in the said second cylinder to open the said passage therein during substantially every other revolution of said crank-shaft.

37. In valve mechanism the combination with a valve casing comprising two concentric cylinders, the inner cylinder having a distributing passage through the wall thereof, and the outer cylinder having inlet and discharge passages therethrough, of a piston valve in the inner cylinder, and a sleeve mounted between the cylinders, for connecting either the inlet or the discharge passage with the distributing passage, the said sleeve being operated by the movement of the said piston valve.

38. In valve mechanism the combination with a valve casing comprising two concentric cylinders, the inner cylinder having a distributing passage through the wall thereof, and the outer cylinder having inlet and discharge passages therethrough, of a piston valve in the inner cylinder, and a sleeve mounted between the cylinders, for connecting either the inlet or the discharge passage with the distributing passage, the said sleeve being operated by the said piston valve near the limit of its movement.

39. In valve mechanism the combination with a valve casing comprising two concentric cylinders, the inner cylinder having a distributing passage through the wall thereof, and the outer cylinder having inlet and discharge passages therethrough, of a piston valve in the inner cylinder, a sleeve mounted between the cylinders, for connecting either the inlet or the discharge passage with the distributing passage, a rotating shaft, an eccentric thereon, and means connecting the eccentric with the piston valve, the rotating shaft being so disposed with relation to the parts reciprocated by the eccentric that it will have a greater angular movement when moving the valve in one direction than when moving it in the other.

40. In valve mechanism the combination with a valve casing comprising two concentric cylinders, the inner cylinder having a distributing passage through the wall thereof, and the outer cylinder having inlet and discharge passages therethrough, of a piston valve in the inner cylinder, a sleeve mounted between the cylinders for connecting either the inlet or the discharge passage with the distributing passage, a rotating shaft, an eccentric thereon, and means connecting the eccentric with the piston valve, the rotating shaft being so disposed with relation to the parts reciprocated by the eccentric that it will have a greater angular movement when moving the valve in one direction than when moving it in the other, the said sleeve being operated by the movement of the said piston valve.

41. In valve mechanism the combination with a valve casing comprising two concentric cylinders, the inner cylinder having a distributing passage through the wall thereof, and the outer cylinder having inlet and discharge passages therethrough, of a piston valve in the inner cylinder, a sleeve mounted between the cylinders, for connecting either the inlet or the discharge passage with the distributing passage, a rotating shaft, an eccentric thereon, and means connecting the eccentric with the piston valve, the rotating shaft being so disposed with relation to the parts reciprocated by the eccentric that it will have a greater angular movement when moving the valve in one direction than when moving it in the other, the said sleeve being operated by the said piston valve near the limit of its movement in either direction.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses, this first day of July, 1909.

ALDEN E. OSBORN.

Witnesses:
JOHN H. GRATACAP,
ADELAIDE E. OSBORN.