No. 670,871. Patented Mar. 26, 1901.

A. J. FRITH.

VALVE GEAR FOR EXPLOSIVE ENGINES.

(Application filed July 17, 1899.)

(No Model.) 2 Sheets—Sheet 1.

FIG. 1.

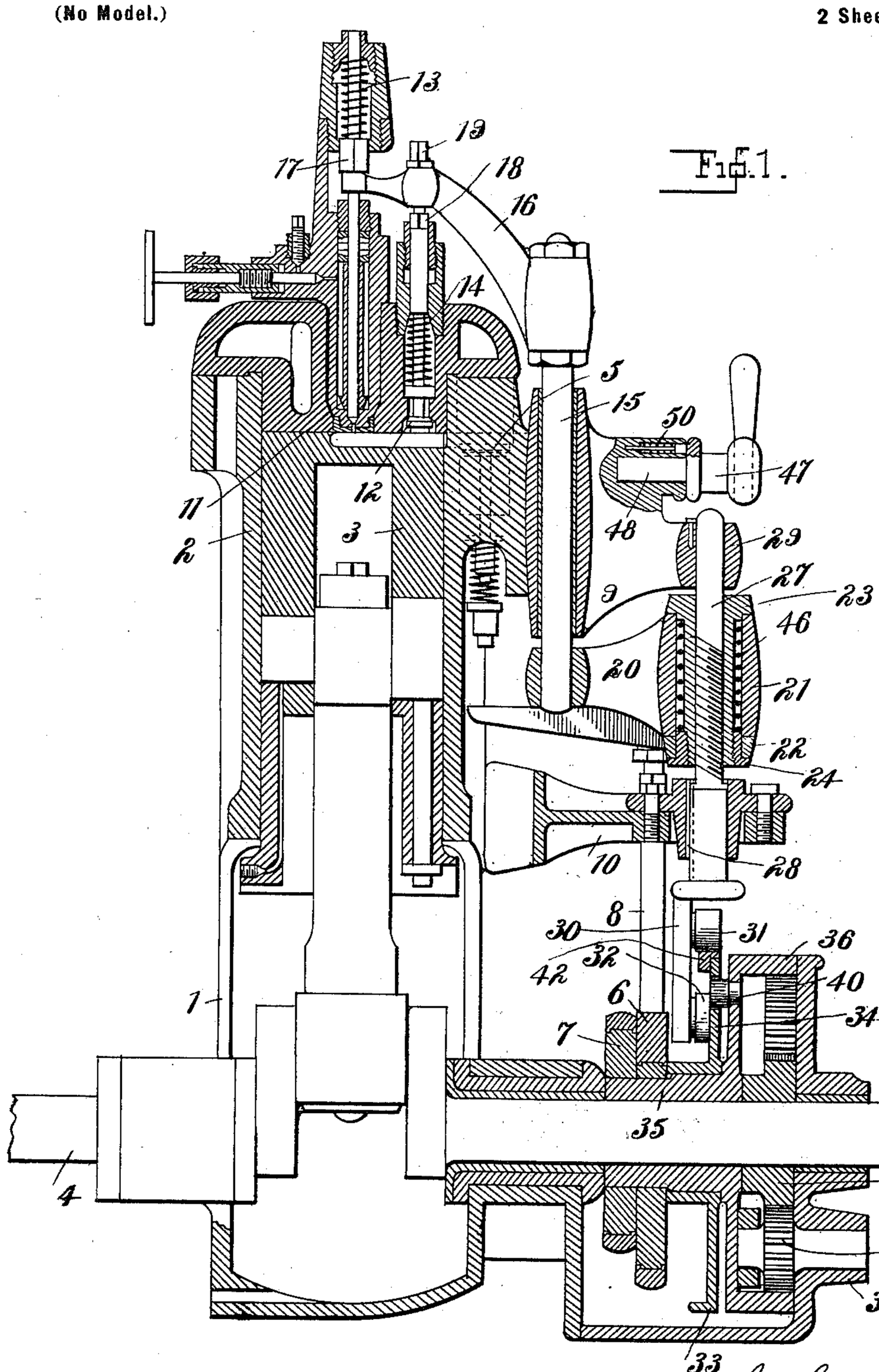

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Fig. 2.

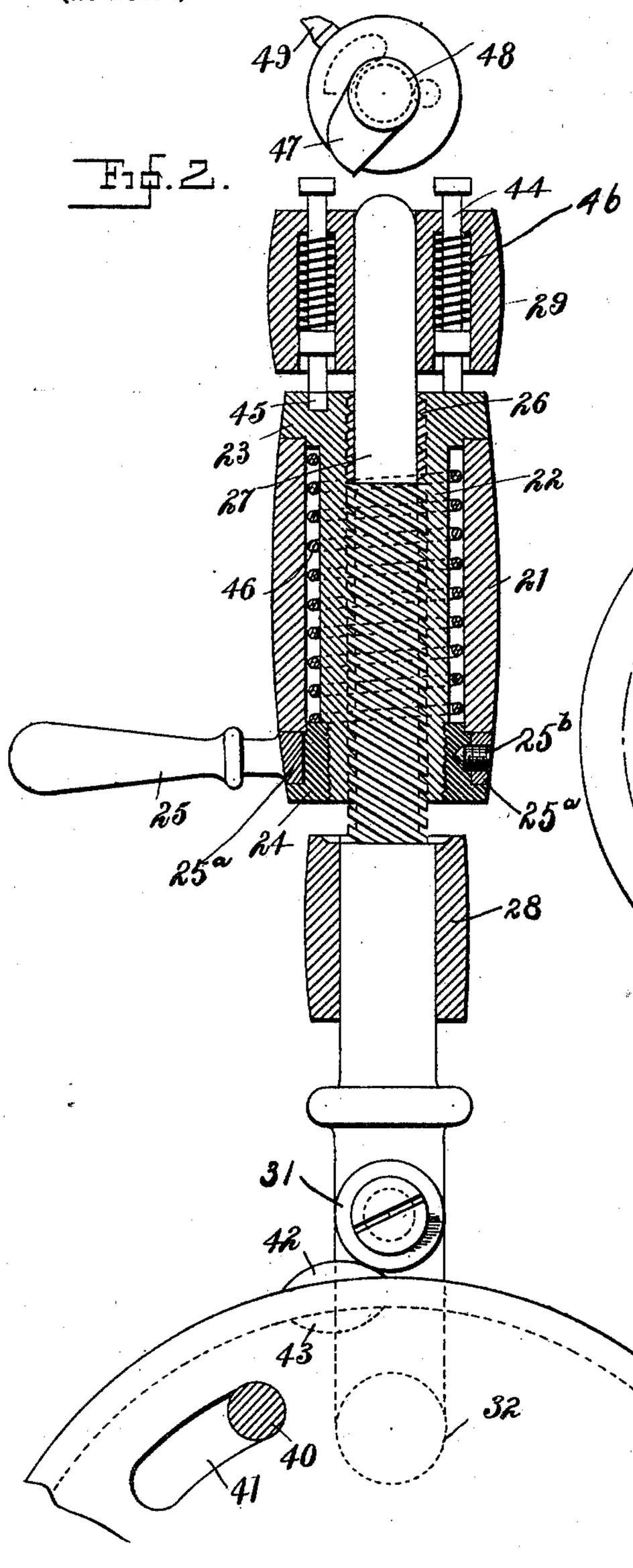


Fig. 3.

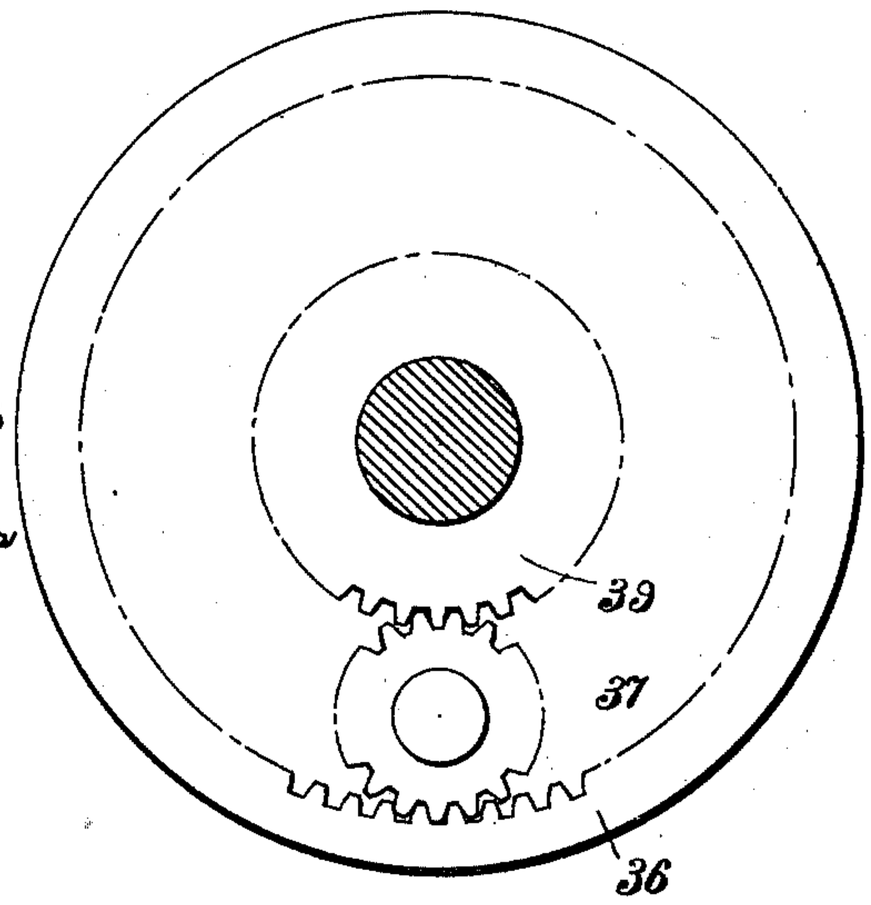
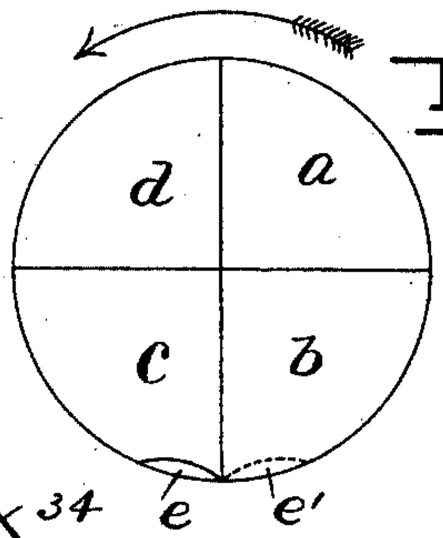


Fig. 4.



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UNITED STATES PATENT OFFICE.

ARTHUR J. FRITH, OF NEW YORK, N. Y., ASSIGNOR TO DIESEL MOTOR COMPANY OF AMERICA, OF SAME PLACE.

VALVE-GEAR FOR EXPLOSIVE-ENGINES.

SPECIFICATION forming part of Letters Patent No. 670,871, dated March 26, 1901.

Application filed July 17, 1899. Serial No. 724,053. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR J. FRITH, a citizen of the United States, residing in the borough of Manhattan, in the city, county, and State of New York, have invented certain new and useful Improvements in Valve-Gear, of which the following is a specification.

This invention relates to valve-gear for Diesel motors or generally for internal-combustion motors working on a four-stroke cycle; and its object is to facilitate the reversing and starting of such motors.

The invention comprises means whereby the operation of the fuel-valves is automatically controlled so as to introduce the fuel at the proper time in either direction of rotation of the motor, and it also comprises special means for controlling the admission of compressed air for starting the motor.

In the accompanying drawings, Figure 1 is a longitudinal vertical section of an internal-combustion engine embodying my invention. Fig. 2 is a sectional detached view of the fuel-valve-controlling mechanism, transverse to Fig. 1. Fig 3 is a detail view of the operating-gear for such mechanism, and Fig. 4 is a diagram illustrating the cycle of operations of the engine.

The engine-frame 1, cylinder 2, piston 3, and main shaft 4 are of any construction usual or suitable in a four-stroke-cycle internal-combustion engine—for example, a Diesel motor—such engine being provided with means for injecting fuel during the combustion-stroke, means for supplying compressed air in starting, and admission and exhaust-valves for admitting atmospheric air during the first stroke of the cycle and exhausting the products of combustion during the last stroke of the cycle. In the present case these admission and exhaust valves, one of which is indicated in dotted lines at 5 in Fig. 1, are assumed to be identical in operation and construction and are operated alternately by cams 6 7, arranged to rotate once during each cycle of the engine, the valve-gear rod for valve 5 being indicated at 8 and being supported in brackets 9 10 on the frame of the engine.

11 represents the fuel-valve, and 12 the compressed-air-supply valve, both of which are held normally in closed position by their respective springs 13 14. A valve-gear 15, mounted to slide vertically in the fixed bracket 9, carries at its upper end an arm 16, which is adapted to engage in the upward movement of rod 15 with a collar 17 on the spindle of fuel-valve 11 and in the downward movement of rod 15 with a shoulder 18 on the spindle of compressed-air valve 12, the spindle of valve 12 having also a terminal head or nut 19 above the arm 16. On the lower end of valve-gear rod 15 is mounted an arm 20, having a vertical cylindrical portion 21, in which is mounted a sleeve 22, having a flange 23 at its upper end and a screw collar or nut 24 at its lower end, engaging with and embracing the bearing 21, so as to prevent relative vertical movement of the sleeve and bearing. A handle 25 is fastened to nut 24, as by means of the ring 25^a and set-screw 25^b, so as to enable the sleeve 22 to be turned, and said sleeve engages by an internal-screw-thread connection 26 with a screw-threaded spindle 27, passing vertically through same. Said spindle being held from rotation by passing through a spindled bearing 28 in bracket 10, this turning of sleeve 22 causes vertical movement of the spindle 27 relatively to the sleeve 22. The upper end of this spindle is guided on a bearing 29 in the bracket 9, and at its lower end said spindle terminates in a hanger 30, carrying rolls 31 32, arranged, respectively, above and below the rim of circumferential flange 33 on a disk 34. This disk is mounted to rotate with a sleeve 35, which is loosely mounted on main shaft 4, said sleeve also carrying the eccentrics 6 7, and means being provided for rotating the sleeve 35 at one-half the speed of the main shaft. As shown, such means may consist of an internal gear 36, fast on the sleeve, meshing with an intermediate pinion 37, journaled in a fixed frame extension 38 and driven by a pinion 39 on the main shaft, the latter pinion being one-half the diameter of gear 36. While the disk 34 rotates with the sleeve 35, it is not fast thereon, but is connected thereto by a shifting connection with a limited amount of play—that is, permitting a limited amount of free relative rotative movement of the said disk and sleeve—so that while the rotation of the sleeve carries the

disk with it there is a limited amount of circumferential slip of the disk when the movement of the sleeve is reversed. Such connection may consist of any suitable lost-motion connection—as, for example, a pin 40 on the side of gear 36, engaging loosely in a slot 41 in the disk 34, so that this disk is drawn around by the sleeve 35 in either direction of movement, but in either such direction of movement falls back a certain angular distance for a purpose hereinafter explained. The rim 33 of disk 34 has an outside projection or cam 42 and an inside projection or cam 43, the cam 42 being adapted to engage with the roll 31 on spindle 27 when said spindle is depressed relatively to sleeve 22 by the rotation of the handle of such sleeve to one side and the cam 43 being adapted to engage with the roll 32 on such spindle when the latter is elevated by turning the sleeve-handle to the other side. Spring-pins 44 may be arranged in upper bracket 9, adapted to engage with a hole 45 in the sleeve 22 to hold same in either extreme position, and a helical spring 46 is shown connected at opposite ends, respectively, to sleeve 22 and to the non-rotating bearing 21, so as to tend to move the sleeve to the position in which the spindle 27 is depressed and therefore in engaging relation with the top cam 42. Under these circumstances the operation of the disk 34 causes elevation of the spindle 27, with consequent operation, through valve-gear rod 15, of the fuel-valve 11; but when the handle is turned to the other side and the spindle 27 is elevated the roller 31 is removed from engaging relation with cam 42, while the roller 32 is brought into engaging relation with cam 43, so that operation of the disk 34 causes depression of spindle 27 and valve-gear rod 15, thereby opening the compressed-air valve. A cam 47 on a pivot-pin 48, rotatable in bracket 9, is adapted to be turned by a handle 49 to depress the spindle 27 directly when it is desired to admit a single charge of compressed air to the engine, as hereinafter explained, the cam being normally locked out of engagement with the spindle by a spring-pin 50.

As an aid to the explanation of the operation of the engine I have shown by diagram in Fig. 4 the sequence of operation in a cycle, the circle in that figure representing a complete four-stroke cycle, while the several quadrants *a b c d* thereof represent successive strokes of the cycle when the engine is moving in, say, the direction of the arrow, these strokes occurring in the order in which the quadrants pass the top of the circle—thus: stroke *a*, admission of atmospheric air; stroke *b*, compression of air; stroke *c*, admission of fuel and combustion; stroke *d*, exhaust. The period of fuel injection is represented by full line *e* in the beginning of the quadrant *c*.

If now the engine be assumed to move in the opposite direction, the sequence will be as follows: stroke *d*, admission of atmospheric air; stroke *c*, compression of air; stroke *b*, admission of fuel and combustion; stroke *a*, exhaust. The fuel admission is now in the beginning of stroke *b*, as indicated by dotted line *e*. To change the period of fuel admission over from the beginning of stroke *c* for one direction of movement to the beginning of stroke *b* for the other direction requires only that it shall lag or fall back angularly in the rotation of the engine in either direction to an extent represented by the length of the fuel-admission period *e* relatively to the whole cycle of operations *a b c d* or *d c b a*. This angular displacement or lag of the fuel admission is effected by the loose pin-and-slot connection between the end disk 34 and its driving-sleeve. The changes in reversal are then that the period of fuel introduction, which equals, say, ten per cent. of piston movement, is shifted from stroke *c* to stroke *b* and lags back of the direction of rotation. The air-admission period changes from stroke *a* to stroke *d*. The exhaust period changes from stroke *d* to stroke *a*. It is thus seen that in reversing the engine the air-admission and exhaust valves interchange their periods of being open. Hence if provision be made so that one is always opened only during stroke *a*, while the other is only opened during stroke *c*, they will simply interchange their functions without any change of operation. Thus when the engine is running in one direction valve 5 may be supposed to be open during stroke *a* and admits air, while in the opposite direction of motion the valve is open during the stroke *a*, but inasmuch as there is then pressure in the cylinder it acts as an exhaust-valve.

In starting, the engine is placed slightly over the top center on stroke *c*, proper connection being made to the compressed-air tank. By turning the cam 47 to engage with spindle 27 the compressed-air valve may be opened to give the cylinder a single charge of air, which starts it in the direction it has been set, the valve-gear being either thrown up by the action of cam 42 during this same stroke or in the stroke *c* of next cycle, so as to open the fuel-valve and admit a charge of fuel, the engine then running with fuel in obvious manner. If it is desired to give more than one charge of compressed air in starting, the compressed air may be introduced automatically by the engine by turning the handle of sleeve 22 to raise the spindle 27 in place of operating the cam 47. In this case the cam 43 during stroke *c* opens the compressed-air valve, and compressed air will be introduced in this manner at each cycle if the handle is held in that position. On releasing the handle, however, the next succeeding depression of the valve-gear during the fuel-admission stroke will, while opening the compressed-air valve, release the sleeve 22 from its locking-pin 44 and allow the spring 46 to throw this sleeve to fuel-admitting position.

To reverse the engine, the handle of sleeve

22 is turned so as to put the spindle 27 in an intermediate position, engaging with neither of its operating cams. As a consequence the engine runs without fuel and finally stops on a compression-stroke—say stroke *c*, this stroke being that of the greatest resistance. Having stopped, the engine is started in reverse direction by the air thus compressed in the cylinder; but as enough power would not thus be given to drive it through the cycle the operator opens the compressed-air valve during stroke *b* by hand, either by cam 47 or by throwing the handle 25 to bring the cam 43 into operation, thus giving the cylinder ample high-pressure air, which drives it through the reverse cycle, the fuel-cam automatically shifting its position by its pin-and-slot connection and the air-admission valve and the exhaust-valve interchanging their functions.

While in the above description it has been assumed that the engine is of the vertical type and that the motions of the parts are vertical, this is merely for convenience of description, as the principles of the invention are equally applicable whatever be the position or the direction of movement of the parts.

The valve-gear rod 15, the spindle 27, and the connecting parts constitute a valve-gear medium having two parts, of which one part engages with the fuel and compressed-air valve, while the other part is operated by the cam mechanism, and the sleeve and screw-spindle connection between these parts enables them to be relatively adjusted, so as to control the operation of the valve-gear, by bringing one or other of the cam portions 42 43 on the disk 34 into operation, and thus controlling the operation of one or other of the valves.

I claim—

1. In an internal-combustion engine, the combination with a fuel-valve, a compressed-air valve, an air-supply valve and an exhaust-valve, of manual means for throwing the fuel-valve out of operation to stop the engine, manual means for admitting one or more charges of compressed air while said fuel-valve is out of operation to start the engine in a reverse direction, and a cam mechanism constructed and arranged to automatically shift the time of operation of the fuel-valve and to interchange the functions of the air-supply and exhaust valves after the engine has been started by the operation of the said compressed-air valve, as set forth.

2. An internal-combustion engine, the combination with a fuel-valve, a compressed-air valve, an air-supply valve, and exhaust-valve, of valve mechanisms adapted to operate the air-supply and exhaust valves, a double-acting valve mechanism adapted to operate the fuel-valve when moving in one direction, and the compressed-air valve when moving in the opposite direction, a cam mechanism, adapted to operate said double-acting mechanism, and comprising a cam and an operating part connected to be driven by the engine and connected to the cam by a connection with a limited amount of free relative motion; all constructed and arranged to automatically shift the time of operation of the fuel-valve, and to interchange the functions of the air-supply and exhaust valves after the engine has been started by the operation of the said compressed-air valve, substantially as set forth.

3. In an internal-combustion engine, the combination with a fuel-valve, a compressed-air valve, an air-supply valve and an exhaust-valve, of a double-acting valve mechanism, adapted to operate the fuel-supply valve when moving in one direction, and the compressed-air valve when moving in the opposite direction, a cam mechanism, adapted to operate said double-acting mechanism, comprising two parts, viz: a gear system and a disk with a limited amount of free motion relatively to one another, a slot in said disk, a pin on said gear system, adapted to engage the said slot and arranged to operate at one-half the speed of the main shaft of the engine, all constructed and arranged to automatically shift the time of operation of the fuel-valve and to interchange the functions of the air-supply and exhaust valves after the engine has been started by the operation of the said compressed-air valve as set forth.

4. In an internal-combustion engine, the combination with the cylinder, the fuel-valve and a compressed-air valve, of valve-gear mechanism arranged to engage one of said valves when moving in one direction, and to engage the other of said valves when moving in the reverse direction, cam mechanism operated by the engine and having portions respectively arranged to operate the valve-gear mechanism in opposite directions, and controlling means for the valve-gear mechanism constructed and arranged to bring it into engaging relation with one or the other of such cam portions.

5. In an internal-combustion engine, the combination with the cylinder, the fuel-valve and a compressed-air valve, of valve-gear mechanism arranged to engage one of said valves when moving in one direction and to engage the other of said valves when moving in the other direction, cam mechanism comprising two cam portions respectively arranged to engage with the valve-gear to produce motion in one or the other direction, and means for controlling the valve-gear mechanism constructed and arranged to bring it into engaging relation with either of such cam portions or to remove it from engaging relation with both of such cam portions.

6. In an internal-combustion engine, the combination of the cylinder, the fuel-valve and a compressed-air valve, of valve-gear mechanism comprising two parts, relatively adjustable, one of such parts being arranged to engage with either the fuel-valve or the compressed-air valve, according to the direction of movement of the valve-gear mechanism, means connected to the engine for oper-

ating the other valve-gear part in either direction, and means constructed and arranged to control the relative adjustment of said valve-gear parts to bring one or the other valve into operation.

7. In an internal-combustion engine, the combination with the cylinder, the fuel-valve and a compressed-air valve, of valve-gear mechanism having two parts, one of which is arranged to engage one or the other of said valves in its movement in one or the other direction, and means connected to the engine for actuating the other of said valve-gear parts in either of such directions, one of such valve-gear parts having a rotatable screw-sleeve adapted to be manually operated and the other of such valve-gear parts having a screw-spindle engaging with such sleeve.

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