W. R. McKEEN, Jr.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JAN. 17, 1907.

1,065,262.

Patented June 17, 1913.

6 SHEETS—SHEET 1.

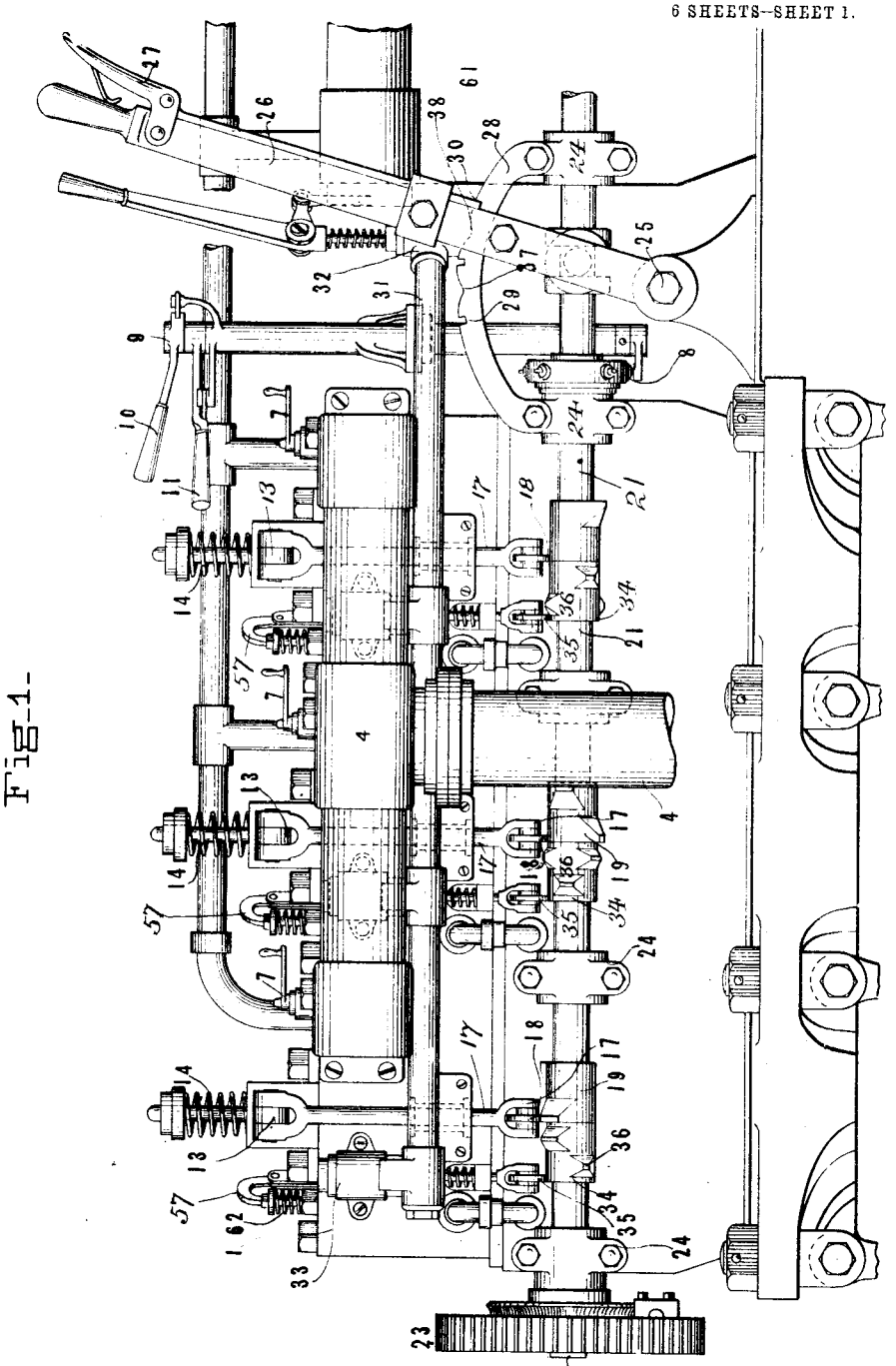

Fig-1-

WITNESSES

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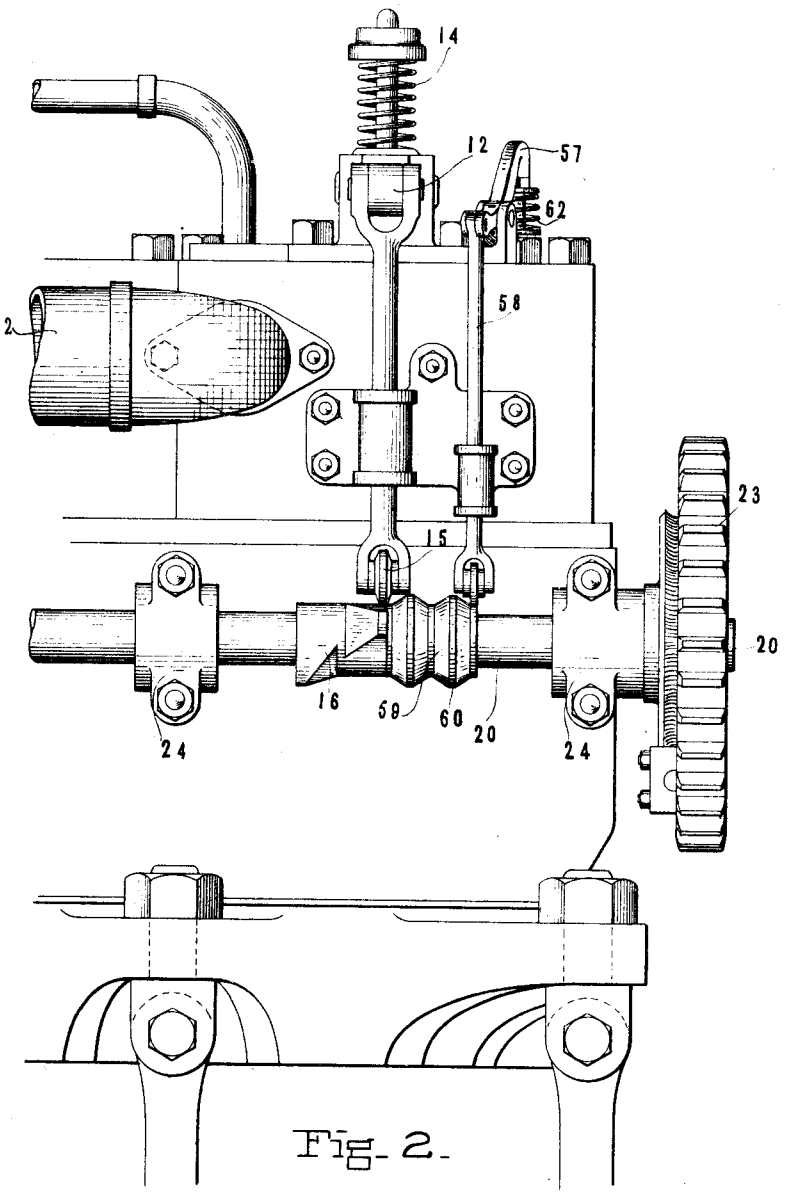

Fig. 2.

WITNESSES
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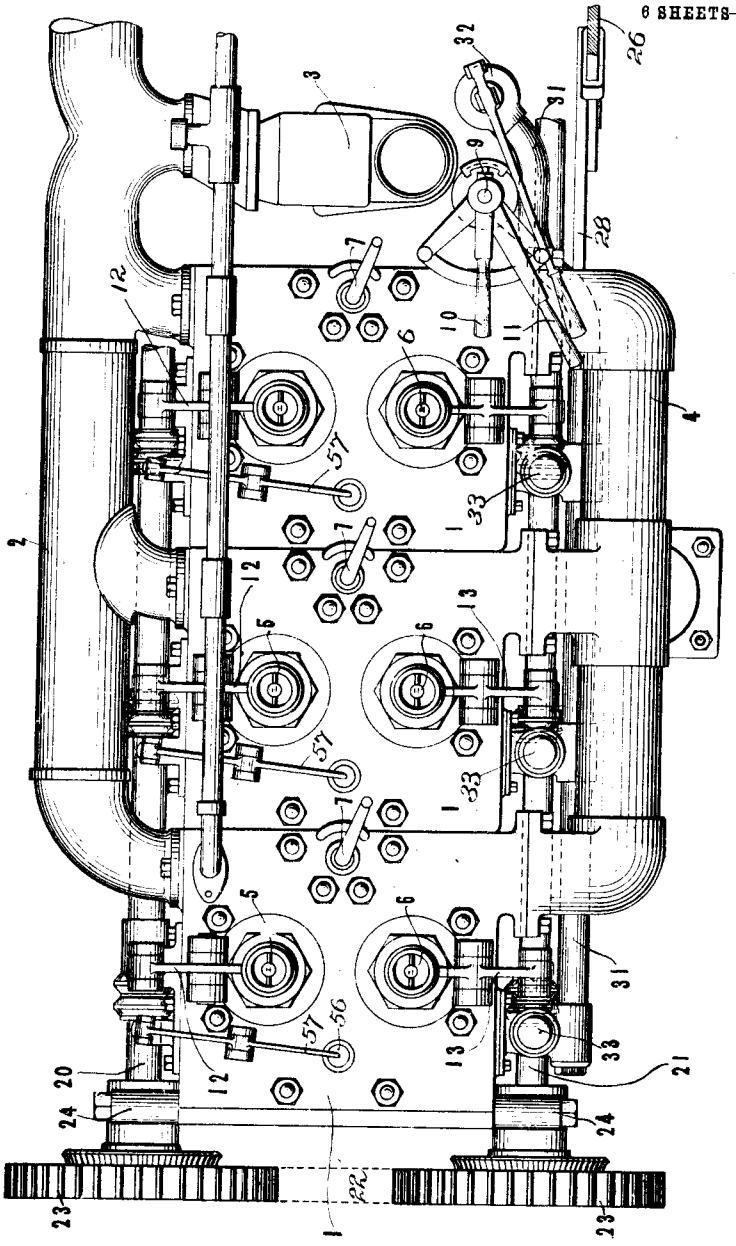

Fig. 3.

WITNESSES

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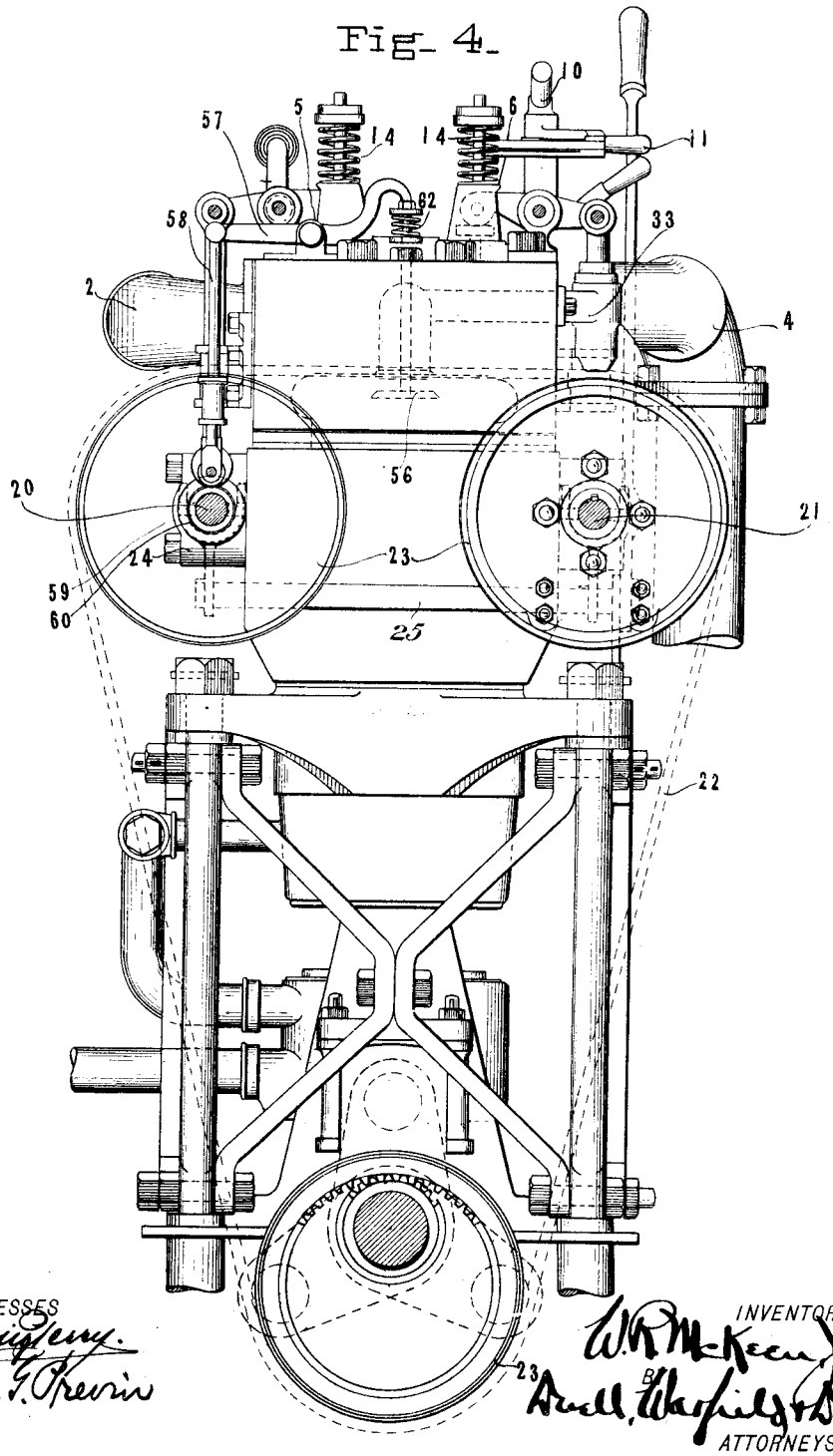
6 SHEETS—SHEET 4.

Fig. 4.



WITNESSES
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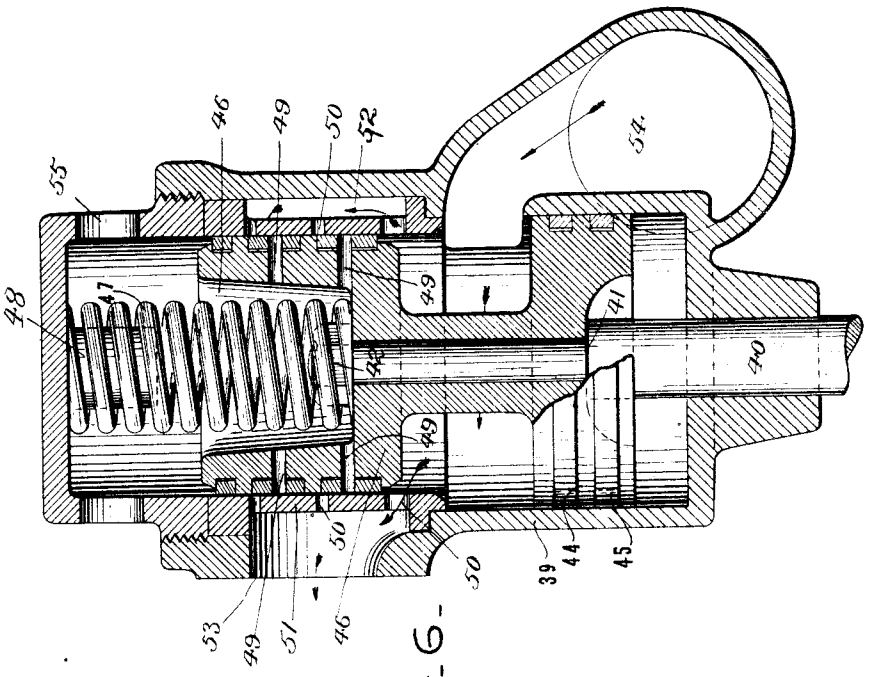

Fig. 6.

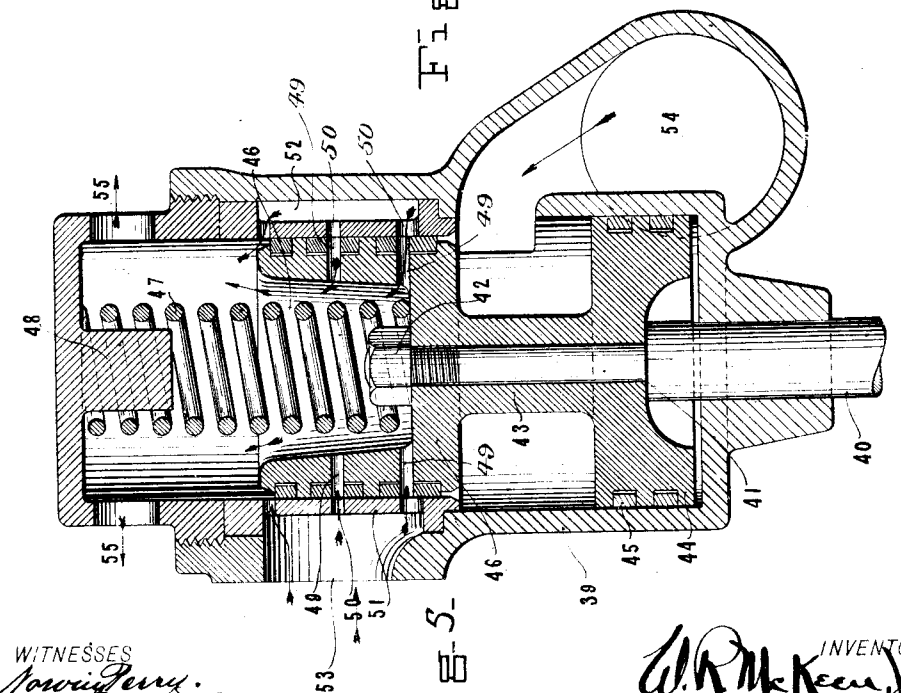

Fig. 5.

WITNESSES

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6 SHEETS—SHEET 6.

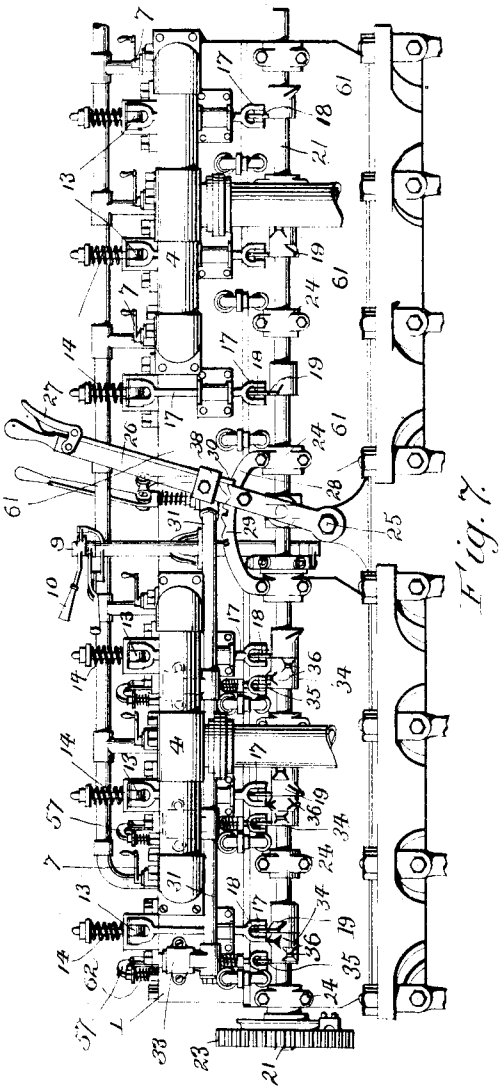

Fig. 7.

WITNESSES

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INVENTOR:

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by Dodge & Sons, Attorneys.

UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE.

1,065,262. Specification of Letters Patent. Patented June 17, 1913.

Application filed January 17, 1907. Serial No. 352,726.

To all whom it may concern:

Be it known that I, WILLIAM R. McKEEN, Jr., residing at Omaha, in the county of Douglas and State of Nebraska, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to engines, and more particularly to those of the internal combustion type.

One of the objects thereof is to provide an efficient engine of the above type, of non-complicated construction, which can be readily set in motion.

Another object is to provide an internal combustion engine of the self-starting type in which the starting apparatus is of efficient action and is readily thrown into or out of operative condition.

Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, wherein is shown one of various possible embodiments of my invention, Figure 1 is a side elevation thereof; Fig. 2 is a partial side elevation taken from the opposite side; Fig. 3 is a plan; Fig. 4 is an end elevation; Fig. 5 is a detail sectional elevation of an air valve, showing the same in exhaust position; Fig. 6 is a similar view showing the same parts at admission; Fig. 7 is a front elevation of the complete engine showing, in addition to the cylinders adapted to receive compressed air for starting, a second group of cylinders designed to be operated only by explosive or combustible mixture.

Similar reference characters refer to similar parts throughout the several views of the drawings.

As tending to a more complete understanding of certain aims of this invention, it may here be noted that the efficient starting of internal combustion engines is a problem of such a high degree of importance that the difficulty found in its solution has seriously retarded the development of this art. Of the many types of starting apparatus which have been used, it is generally conceded that those utilizing compressed air are preferable, but in order to render mechanism of this type of practical value it is desirable that means be provided whereby the compressed air is economically employed, thus doing away with the necessity for extensive compressing and starting apparatus. It may also be noted that for the efficient and reliable running of an internal combustion engine, it is of prime importance that the valve gear be peculiarly adapted for such running, as any attempt to adapt the same in whole or in part for operation under a different principle results in a marked decrease in the efficiency of its action. It may also be noted at this point that, if the charge of carbureted gas be merely drawn into the cylinder through a spring-retracted valve, there is a lack of uniformity in the charge dependent upon the variation in the strength of the spring, in the tightness of the piston packing and in other factors, which tend to impair the running qualities of the engine. Another factor which has tended to retard the extensive commercial advent of internal combustion engines is the complication and inaccessibility of the mechanism whereby the reliability of its action is decreased and its supervision and inspection interfered with. The above and other defects are eliminated and many advantageous features attained in constructions of the nature of that hereinafter described.

Referring now to Fig. 1 of the accompanying drawings, there is shown an engine comprising cylinders 1 the pistons of which may be connected in any desired manner to the crank shaft, the cranks being angularly spaced so as to avoid a dead center in the well known manner. Mounted adjacent these cylinders, as best shown in Fig. 3 of the drawings, are a gas supply conduit 2 leading from a carbureter 3 and an exhaust pipe 4, each of these being connected to the respective cylinders through suitable inlet and exhaust valves 5 and 6. Spark plugs 7 are also provided in these cylinders, the same being suitably connected with a dis-

tributer or timer 8, best shown in Fig. 1, the spark being controlled through a shaft 9 rocked by a lever 10. The details of this mechanism are not set forth, inasmuch as the same in itself forms no part of the present invention. As likewise tending to render clearer the general construction of the illustrative embodiment shown, it may be noted that the gas supply is throttled by a lever 11 connected adjacent the carbureter 3. Valves 5 and 6 are actuated through levers 12 and 13 and are spring pressed, as by the springs 14, in such manner as to tend to depress the outer ends of these levers. Levers 12 are provided at their free ends with links which terminate in rollers 15 co-acting with cams 16, the construction of which will hereinafter be set forth more fully. Levers 13 are in a similar manner connected with links 17, the rollers 18 of which co-act with cams 19. Cams 16 and 19 are respectively mounted upon cam shafts 20 and 21 which are driven as by the chain 22 passing over sprockets or gears 23. It may here be noted that this feature of my invention as well as certain other features herein shown, are shown described and claimed in my co-pending applications, Serial No. 352,727, filed January 17, 1907, and Serial No. 378,574, filed June 12, 1907, and accordingly are not claimed herein. Shafts 20 and 21 are mounted in guides 24 so as to permit of a longitudinal sliding movement being imparted thereto by a rock shaft 25 swung by a lever 26. This rock shaft is connected in any desired manner as by forked cranks and grooved collars with the shafts 20 and 21 to slide the same longitudinally as the lever 26 is swung. The latter member is provided with a hand latch 27 co-acting with a locking segment 28 in such manner as to admit of five predetermined positions of the cam shafts. Each of the cams 16 above referred to is provided with a pair of projections angularly spaced one from another at 90° and so formed and related as to become operative with relation to the corresponding rollers 15 only upon the corresponding cam shaft 20 occupying one of its extreme positions, that is, corresponding to either notch 29 or notch 30 of the segment 28. In any of the three intermediate notches the latch will hold the shaft in such position as to render this cam inoperative. Similarly, cam 19 upon shaft 21 is provided with two projections angularly spaced one from another and adapted to be operative only upon this shaft being set in one of the above two extreme positions. Inasmuch as the admission valve is thus opened for each revolution of the shaft 20, the latter being appropriately geared with reference to the crank shaft to admit of -cycle operation only upon the projections of cam 16 becoming alined with roller 15, it will be seen that the engine cannot operate as an internal combustion motor unless the cam shafts are swung to their extreme positions. It will also be noted that the exhaust valves 6 remain closed during intermediate positions of the shaft in like manner. Another feature to be noted at this point is that by means of the above-described mechanism the gas inlet valves are positively opened and held open throughout precisely the desired length of time, a uniformity of charge being thus insured and all tendency of the valves to chatter upon the valve seats done away with. The object of using angularly spaced projections upon the cams 16 and 19, as above described, is to admit of a reversal of the engine as the cam shafts are swung from one extreme position to the other by a change of phase of the valves with respect to the crank shaft in the well known manner.

For the purpose of starting the engine above described, it is proposed to employ air or other gas in compressed form and utilize its expansive properties without combustion. The air is led through a supply pipe 31, controlled by a throttle 32, to valves 33, one of which is or may be positioned adjacent each cylinder 1 of the engine. The stems of these valves are controlled by cams 34 co-acting with anti-friction rollers 35 journaled within the valve stems. Each of the cams 34 is provided with two pairs of projections 36, the projections of each pair being angularly spaced midway between those of the other pair. These projections are so formed and disposed as to remain inoperative with the cam shaft 21 either in mid position or at one of its extremes. When placed in the intermediate notches 37 or 38, however, these cams alternately raise and permit to fall the corresponding valve stems twice each revolution of the shaft and thus actuate the valves 33, the construction of which will be hereinafter described more fully. It may be noted at this point that in mid position all of the cams 16, 19 and 34 are inoperative, at extreme positions the gas inlet and exhaust cams 16 and 19 are operative while the cams 34 are inoperative, and in the positions corresponding to the notches 37 and 38 the cams 34 will operate the air valves 33 and the valves 5 and 6 will remain unactuated, with the cylinders which are designed to receive and operate with compressed air. The cams 16 and 19 of the remaining cylinders, that is, of those which operate upon the internal combustion principle only, are made of such measurement in the direction of the axis of their supporting shafts that they shall be in operative position both when the lever 26 is set for air starting and for operating upon the internal combustion principle alone.

Referring now to Figs. 5 and 6 of the drawings, in which are disclosed the compo-

nent parts of the valve 33, there is shown at 39 an outer casing or cylinder within which the valve stem 40 passes and is secured, as by the shoulder 41 and nut 42, to a double piston 43. The lower portion 44 of this piston is adapted to reciprocate within the cylinder 39, suitable packing rings 45 being provided, and serves merely to aid in balancing or over-balancing the upward pressure occasioned by the incoming air against the upper valve portion 46. This downward tendency, moreover, is intensified and the action quickened by a spring 47 interposed between the upper surface of the piston and a cap 48 applied to the upper portion of the cylinder. Portion 46 of the piston is provided with a cup-shaped depression in which the spring 47 is seated, and has formed therein ports 49 co-acting with ports 50 in a sleeve 51 which serves as a valve seat for this portion of the valve. About the sleeve 51 is formed an annular passage 52 leading to the main cylinder 1 through a port 53. The inlet to the valve is positioned at 54 and the exhaust passes through suitable ports 55 in the cap 48. As shown in Fig. 6 of the drawings, the air passes through the lowermost inner port 50 directly to the cylinder through port 53 and also enters the cylinder by means of the outer port 50 and the annular passage 52. The valve is in this position only while the stem is raised by one of the projections of the cam 34. Upon the stem snapping downwardly to the cylindrical surface of the cam, the valve assumes a position, shown in Fig. 5, in which the admission is cut off and the exhaust occurs through the several ports 50 and 49 in the sleeve 51 and upper portion 46 of the piston. The ports 53 of the air valves lead to check valves 56, which control communication between the compressed air supply and the respective cylinders of the engine designed to receive the compressed air for starting, as shown in Fig. 4. These check valves cut off such communication except at such time as the lever 26 has its locking latch in one of the notches 37 or 38, at which time the cams 34 serve to actuate the compressed air admission valves 33. Each of these check valves is opened upon shifting the shaft 20 longitudinally in one or the other direction, and arresting said shaft with the lever 26 locked in either of the notches 37 or 38, by a sleeve or collar 59 secured upon said shaft, and having two circular portions or members 60, the sides of which are beveled or inclined so as to make two double truncated cones, the beveled sides or faces serving to lift or force upward the links or stems 58 through contact with their lower ends, or with rollers carried by said lower ends. When the lever 26 is set with its locking bolt in either notch 37 or 38, the lower end of the stem 58 or its roller rides upon the periphery of one or the other of the disks or circular members 60, and is thereby held in elevated position. This elevation of the stem lifts the outer end and depresses the inner end of the lever 57, and consequently depresses and opens the check valve 56, thus permitting compressed air to enter the cylinders under the control of the several valves 33 actuated by the cams 34. In this way the check valves are kept open so long as the engine is being operated by compressed air. When the shafts 20 and 21 are moved to either extreme position, or to medial position, the check valves 33 are permitted to close, the stems 58, or their rollers, moving down the inclined faces of the disks or members 60, and traveling upon or standing over the reduced hub portion of the sleeve 59 at either end or at the midlength of said sleeve. A spring 62 serves to close and hold closed each check valve 56, except at such time as they are held open by the circular disks or members 60. At 61 are indicated additional cylinders connected to the crank shaft of the engine, these cylinders being operative solely under the internal combustion principle, and serving chiefly to aid in carrying the load on the engine during the shifting of the same from compressed air to internal combustion operation. Any desired number of these cylinders may be employed, and the same may be, on the other hand, entirely dispensed with without the loss of all of the advantageous features of this invention.

The operation of the above-described embodiment of my invention is substantially as follows: Assuming that it is desired to start the engine, the reverse lever 26 is thrown from mid position into either notch 37 or 38 according to the direction which it is desired that the crank shaft be driven. This action will so shift the shafts 20 and 21 as to bring one of the pairs of projections of each of the cams 34 opposite the corresponding valve stems and to bring one of the circular projections of each of the cams 59 under the stems 58 and thus open the check valves as above described. The throttle 32 is then opened, admitting compressed air to the several air valves 33, and, on account of the spaced relation of the pistons of the several cylinders, air will immediately enter the head and of one or more of the same and force downwardly the corresponding pistons. The engine is thus started, as upon the stroke of one of the pistons being completed another of the cylinders has become operative and each of the same acts under the pressure of the incoming fluid as a single-acting steam engine, the extra movement of the valve necessary for an impulse at every stroke in contradistinction from an impulse at every other stroke, as in 4-cycle running, being gained from the doubling of the number of the projec-

tions on the cams 34 with reference to those on the cams 16 and 19. After the engine has gained sufficient momentum and after other cylinders run solely as internal combustion cylinders, as those diagrammatically indicated at 61, have taken up their regular cycle, the shafts 20 and 21 may be shifted to their extreme positions, whereupon the valves 33 snap down into their exhaust position and are not raised to admission, thus cutting off the air supply, which may be also turned off at the throttle 32. This movement of the shafts, moreover, releases the stems 58 controlling the check valves 56 and permits the latter to be snapped upwardly under the impulse of springs 62 into closed position. Cams 16 and 19 are, however, shifted into operative position by this movement of the cam shafts and the regular inlet and exhaust valves 5 and 6 are actuated, the compression being furnished either by additional cylinders 61 acting under the internal combustion principle or by the momentum of the parts. The engine is then running under its regular 4-cycle mode of operation and may be stopped or reversed by the lever 26 as above described.

It will of course be understood that in order that the valves of cylinders 61 may be properly actuated at all times, with said cylinders acting upon the internal combustion principle, the cams which actuate the valves thereof must be of measurement sufficient in the direction of the axes of the shafts 20 and 21 to permit the shifting of the shafts without taking the appropriate cams from beneath the rollers with which they co-act. In other words, each of said cams will be of a length sufficient to permit a longitudinal movement of its shaft equal to that required to shift the cams 16 and 19 from the mid or neutral position, which they occupy when the lever 26 is locked in the middle notch, to the position they occupy when the lever is thrown to either extreme, the cams for the cylinders 61 being of course in two sections, and set in such angular relation as necessary to enable them to operate with the engine running in either direction.

It will thus be seen that there is provided apparatus in which the several objects of my invention are attained and the above enumerated advantages are present in a high degree. By the distribution of the valve-driving means upon opposite sides of the engine, all crowding of this mechanism is avoided and the parts are so spaced as to act most efficiently and to be susceptible of ready access, as for purposes of inspection, lubrication or adjustment. The complete segregation of the air valve mechanism from the gas valve mechanism without the loss of the adaptation of either for use in connection with the other is a feature of marked utility, and the individual construction of these mechanisms whereby their functions are accurately and reliably performed is of a high degree of practical value.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense. It is also to be understood that the language used in the following claims is intended to cover all of the novel generic and specific features of the invention herein described and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

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

1. In engine construction, in combination, a cylinder; valves and valve gearing adapted to run said cylinder under the internal combustion principle; a source of fluid pressure; a passage connecting said source with the cylinder; means adapted to render operative or inoperative the valve gearing; and means controlled from said valve gearing, adapted to open the pressure fluid passage in the act of rendering inoperative the valve gearing, and to close said passage in the act of rendering said gearing operative.

2. In engine construction, in combination, a cylinder, valve mechanism adapted to run said cylinder from a source of compressed fluid supply, valve mechanism independent of the same adapted to run said cylinder as an internal combustion engine, cams adapted respectively to actuate said valve mechanisms, and means adapted alternatively to throw said cams into operative position.

3. In engine construction, in combination, a cylinder, valve gearing adapted to run said cylinder under the internal combustion principle, means comprising a valve controlling a passage to said cylinder independent of said valve gearing, means comprising cam surfaces adapted to operate said valve gearing and said valve, and means adapted to shift said last mentioned means alternatively to open said valve and render inoperative said valve gearing, and to close said valve and render operative said valve gearing.

4. In engine construction, in combination, a cylinder, valve mechanism adapted to run said cylinder from a source of compressed fluid supply, means comprising a valve controlling a passage leading from said valve mechanism to said cylinder, valve mechanism independent of said first valve mechanism adapted to run said cylinder as an in-

ternal combustion engine, and means adapted substantially simultaneously to render inoperative said first valve mechanism and close said valve, and to render operative said second valve mechanism, said last mentioned means comprising a plurality of cam surfaces and operative connections leading therefrom.

5. In engine construction, in combination, a cylinder, valve mechanism adapted to run said cylinder from a source of compressed fluid supply, means comprising a valve controlling a passage leading from said valve mechanism to said cylinder, valve mechanism adapted to run said cylinder as an internal combustion engine, and means adapted substantially simultaneously to render inoperative said first valve mechanism and close said valve, and to render operative said second valve mechanism, said last mentioned means comprising a plurality of cam surfaces and operative connections leading therefrom.

6. In engine construction, in combination, a cylinder, valve mechanism adapted to run said cylinder from a source of compressed fluid supply, valve mechanism independent of the same adapted to run said cylinder as an internal combustion engine, a plurality of longitudinally shiftable cams respectively coacting with said valve mechanisms, and means adapted to shift said cams to render said valve mechanisms alternatively operative.

7. In engine construction, in combination, a cylinder and piston; means adapted to run said engine upon the two-cycle principle; means independent of said first means, adapted to run said engine upon the four-cycle principle; mechanism adapted to shift said two first mentioned means alternatively one into and the other out of operative condition; and a second cylinder and piston connected in said engine construction, and adapted to run solely on the four-cycle principle.

8. In engine construction, in combination, a cylinder, valve mechanism adapted to run said cylinder as an internal combustion engine, a source of compressed fluid supply, means comprising a passage leading from said source of compressed fluid supply to said cylinder, a piston valve disposed within said passage exposed to pressure upon one side and to the exhaust upon the other, means tending normally to force said piston valve in a predetermined direction, a cam adapted to force the same in the opposite direction, a cam adapted to actuate said first valve mechanism, and means adapted to shift said cams to render said first valve mechanism and said piston valve alternatively operative.

9. In engine construction, a cylinder and piston; valve mechanism adapted to run said cylinder as an internal combustion engine; a source of compressed fluid supply; means comprising a passage leading from said source of supply to said cylinder; a valve disposed within said passage, and adapted to open said cylinder to said source of supply and to the exhaust alternately; means adapted to actuate said valve; and mechanism common to and adapted alternatively to actuate the internal combustion valve mechanism, or the compressed fluid valve mechanism, according to adjustment.

10. In engine construction, in combination, a cylinder, valve mechanism adapted to run said cylinder as an internal combustion engine, a source of compressed fluid supply, means comprising a passage leading from said source of supply to said cylinder, a valve disposed within said passage adapted alternatively to open said cylinder to said source of supply and to the exhaust, a check valve disposed within said passage, and means adapted in a given condition to open said check valve, render operative said first valve, and render inoperative said valve mechanism, and in another condition to close said check valve, render inoperative said first valve, and render operative said valve mechanism.

11. In engine construction, in combination, a cylinder, valve mechanism adapted to run said cylinder as an internal combustion engine, a source of compressed fluid supply, means comprising a passage leading from said source of supply to said cylinder, a valve disposed within said passage adapted alternatively to open said cylinder to said source of supply and to the exhaust, a check valve disposed within said passage, means adapted in a given condition to open said check valve, render operative said first valve, and render inoperative said valve mechanism, and in another condition to close said check valve, render inoperative said first valve, and render operative said valve mechanism, and means adapted substantially simultaneously to shift said last mentioned means from one of said conditions to the other.

12. In engine construction, in combination, a cylinder, valve mechanism adapted to run said cylinder from a source of compressed fluid supply, valve mechanism independent of the same adapted to run said cylinder as an internal combustion engine, and cams respectively coacting with said valve mechanisms adapted in a predetermined position to maintain both of the same inoperative, and upon being moved in a given direction from said position successively to render one of the said mechanisms operative and the other inoperative, and the first mechanism inoperative and the second mechanism operative.

13. In engine construction, in combina-

tion, a cylinder, valve mechanism adapted to run said cylinder from a source of compressed fluid supply, valve mechanism independent of the same adapted to run said cylinder as an internal combustion engine, and cams respectively coacting with said valve mechanisms, said cams being adapted in a predetermined position to maintain both of the said mechanisms inoperative, and upon being moved in a predetermined direction from said position successively to render operative said valve mechanisms.

14. In engine construction, in combination, a cylinder, valve mechanism adapted to run said cylinder from a source of compressed fluid supply, valve mechanism independent of the same adapted to run said cylinder as an internal combustion engine, and cams respectively coacting with said valve mechanisms, said cams being adapted in a predetermined position to maintain both of the said mechanisms inoperative, and upon being moved in a predetermined direction from said position successively to render operative said valve mechanisms, and upon being moved in the opposite direction to render said mechanisms successively operative with the engine driven in the reverse direction.

15. In engine construction, in combination, a cylinder, a gas inlet valve leading to said cylinder, a gas outlet valve leading from said cylinder, a valve controlling the admission to and exhaust from a passage leading to said cylinder of a compressed fluid, a check valve positioned within said passage, means positioned upon one side of said cylinder controlling said check valve and one of said two first-mentioned valves, and means positioned upon the opposite side of said cylinder controlling said third valve and the other of said two first-mentioned valves.

16. In engine construction, in combination, a cylinder, a gas inlet valve leading to said cylinder, a gas outlet valve leading from said cylinder, a valve controlling the admission to and exhaust from a passage leading to said cylinder of a compressed fluid, a check valve positioned within said passage, a pair of cam shafts, cams upon one of said shafts controlling one of said first-mentioned valves and said check valve, and cams upon the other of said shafts controlling the other of said first-mentioned valves and said third-mentioned valve.

17. In engine construction, in combination, a cylinder, a gas inlet valve leading to said cylinder, a gas outlet valve leading from said cylinder, a valve controlling the admission to and exhaust from a passage leading to said cylinder of a compressed fluid, a check valve positioned within said passage, a pair of cam shafts, cams upon one of said shafts controlling one of said first-mentioned valves and said check valve, and cams upon the other of said shafts controlling the other of said first-mentioned valves and said third-mentioned valve, said cam shafts being positioned upon opposite sides of said cylinder.

In testimony whereof I affix my signature, in the presence of two witnesses.

WILLIAM R. McKEEN, Jr.

Witnesses:
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C. W. Loucks.