May 21, 1946. C. L. WALKER 2,400,581

INTERNAL-COMBUSTION ENGINE

Filed June 18, 1942 3 Sheets-Sheet 1

Fig. 1.

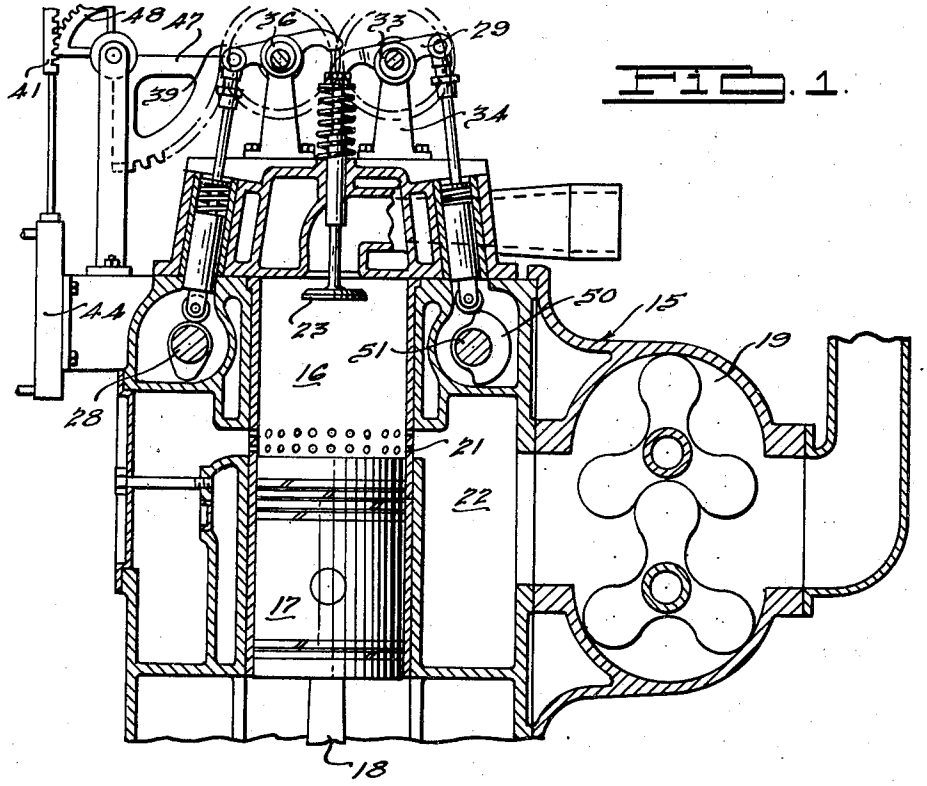


Fig. 3.

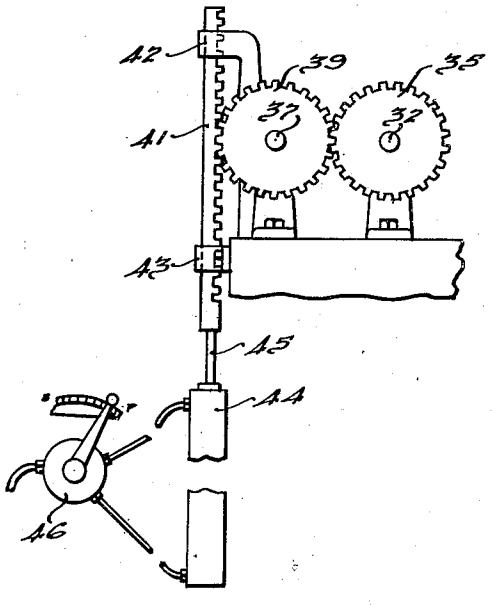
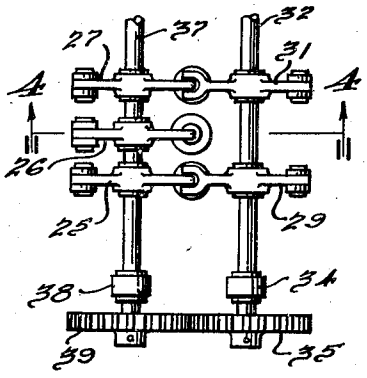


Fig. 2.



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Filed June 18, 1942 3 Sheets-Sheet 2

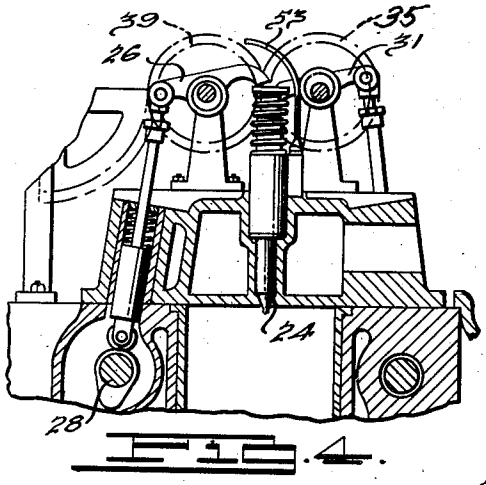

FIG. 4.

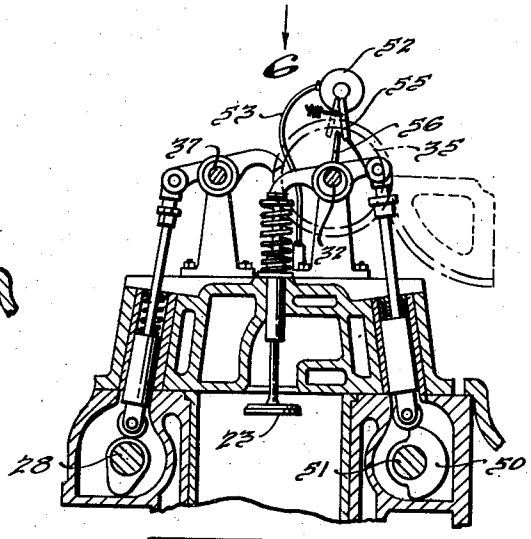

FIG. 5.

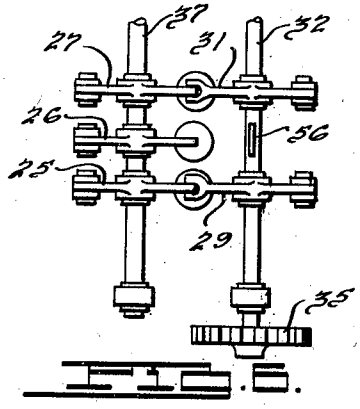

FIG. 6.

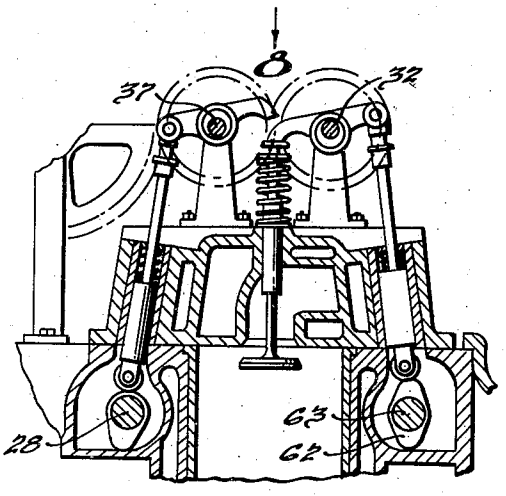

FIG. 7.

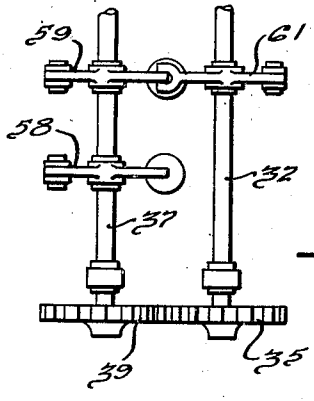

FIG. 8.

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Filed June 18, 1942 3 Sheets-Sheet 3

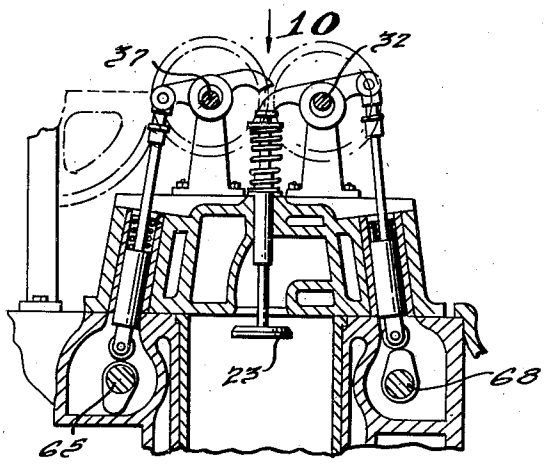

FIG. 9.

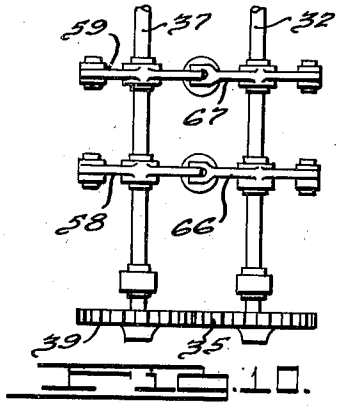

FIG. 10.

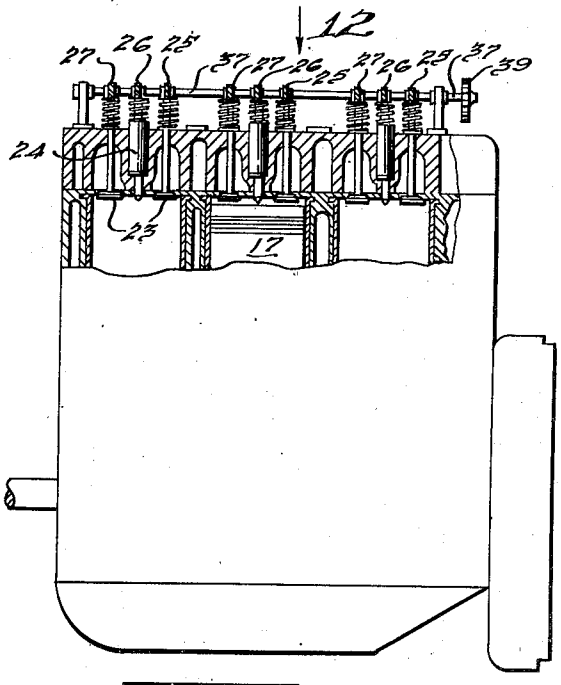

FIG. 11.

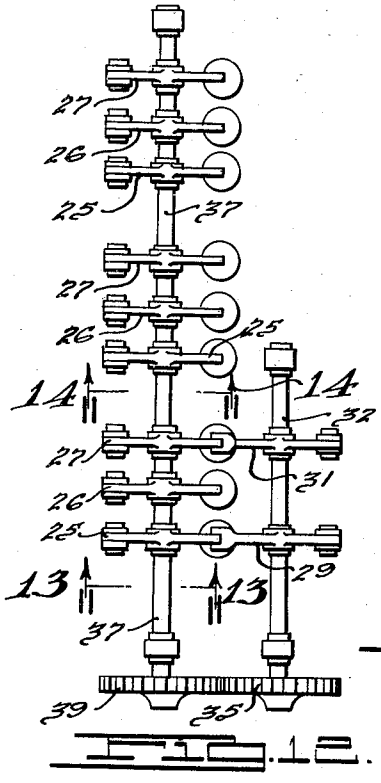

FIG. 12.

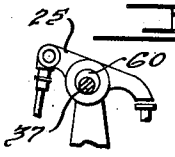

FIG. 13.

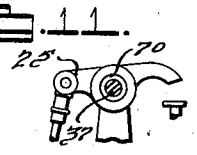

FIG. 14.

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Patented May 21, 1946

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UNITED STATES PATENT OFFICE

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INTERNAL-COMBUSTION ENGINE

Clinton L. Walker, Piedmont, Calif.

Application June 18, 1942, Serial No. 447,560

12 Claims. (Cl. 230—41)

This invention relates to internal combustion engines, and particularly to an internal combustion engine having two sets of cam shafts and means for selectively rendering the cam shafts effective for operating the valves to change from normal engine operation.

The engine, which may be of the Otto or Diesel type, has a set of rocker arms operated from one cam shaft for moving the valves of the engine in a predetermined sequence for normal engine operation and a second set of rocker arms operated by a second camshaft for operating the valves when the first rocker arms are rendered ineffective for operating the engine as a compressor or otherwise. Means are provided for changing the valve operation from one set of rocker arms to the other. When an injector nozzle is operated directly by the rocker arm the movement of some of the arms out of contact with the valve moves the arms out of contact with the nozzle and cuts off the supply of fuel when operating the engine as a compressor.

It is within the purview of the invention to operate a valve by the sequence of shifting from one set of rocker arms to the other to interrupt or initiate the flow of the fuel, as the case may be, when changing from normal engine operation to operation as a compressor in the first instance, and changing from compressor operation to normal motor operation in the second instance.

The same method may be utilized for shifting the valve sequence and spark timing to operate the engine with clockwise or counter-clockwise rotation. A multi-cylinder engine may have one or more of the cylinders operate as a compressor through the shifting of the valve operating means from one sequence to another while the remainder of the cylinders continue to operate as an engine which drives the piston in the first-mentioned cylinders as a compressor. The change-over from an engine to a compressor operation is effected by moving one set of rocker arms out of operating position with the valves while moving another set into operation position therewith. This may be effected manually or by automatic means, and through the manipulation of a lever the engine may be changed to a compressor or from a compressor to an engine.

Accordingly, the main objects of my invention are; to provide two sets of valve operating elements for an engine along with means for rendering one or the other sets of elements effective for producing valve actuation in different series; to move the arm from the injector nozzle of a Diesel engine when changing to a compressor to thereby interrupt the injection of the fuel into the cylinders; to provide two sets of rocker arms for the valves of an engine for changing the sequence of operation of the valves for driving the engine in a clockwise direction when employing one series and in a counter-clockwise direction when employing the other; to operate one or more cylinders of a multi-cylinder engine as a compressor while the remaining cylinders operate as an engine by changing the valve actuating arms on the cylinder or cylinders which function as a compressor; and in general, to change the operating characteristics of an engine by shifting one or the other set of rocker arms for shifting the valves into and out of operating position.

Other objects and features of novelty of the invention will be either specifically pointed out or will become apparent when referring, for a better understanding of my invention, to the following description taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a broken sectional view of a Diesel type engine having valve operating means which embodies features of my invention;

Fig. 2 is a broken view of structure similar to that illustrated in Fig. 1, showing a further form which my invention may assume;

Fig. 3 is a broken plan view of the valve arm and operating mechanism of the engine illustrated in Fig. 1;

Fig. 4 is a sectional view of structure illustrated in Fig. 3, taken on the line 4—4 thereof;

Fig. 5 is a view of structure similar to that illustrated in Figs. 1 to 4, with the exception that the rocker arms, employed for controlling the position of the valves during normal operation, are maintained in operating position while the fuel delivered to the injector nozzle is cut off;

Fig. 6 is a plan view of the valve control mechanism illustrated in Fig. 5, as viewed from line 6—6 thereof;

Fig. 7 illustrates the application of the valve control mechanism of Figs. 1 to 5 inclusive applied to an autocycle engine for changing from engine to compressor operation;

Fig. 8 is a view of the operating mechanism employed on the structure of Fig. 7, as viewed from line 8—8 thereof;

Fig. 9 illustrates the valve operating mechanisms which are shiftable into and out of operating position to time the valves for either clockwise or counter-clockwise rotation of the engine crankshaft;

Fig. 10 is a plan view of the valve operating mechanism of the engine illustrated in Fig. 9;

Fig. 11 is a broken sectional view in side elevation of a three-cylinder Diesel engine, in which one cylinder may be changed over to operate as a compressor driven by the remaining cylinders.

Fig. 12 is a plan view of the valve operating mechanism of the engine illustrated in Fig. 11, as viewed from the line 12 thereof;

Fig. 13 is a sectional view of the structure illustrated in Fig. 12, taken on the line 13—13 thereof; and

Fig. 14 is a sectional view of the structure illustrated in Fig. 12, taken on the line 14—14 thereof.

Referring to Figs. 1 to 4 inclusive, I have illustrated a two-cycle Diesel engine 15, having a cylinder 16 in which a piston 17 operates a connecting rod 18 which joins the piston to a crankshaft. A blower 19 is employed for scavenging the gas in the crankcase which escapes through apertures 21 into an annular chamber 22 at the end of the stroke of the piston. Each cylinder has a pair of valves 23 between which an injector nozzle 24 is mounted. A set of three rocker arms 25, 26, and 27 is employed for operating the two valves and the injector nozzle in a predetermined sequence controlled by the cam shaft 28 which is operated in timed relation to the rotation of the crankshaft in the conventional manner. This portion of the engine just described is of conventional form and will not be described further.

A second set of crankarms 29 and 31 is mounted on a shaft 32 on eccentrics 33 provided on the shaft. The shaft 33 is supported on spaced brackets 34 and has provided on the end thereof a gear 35. Similarly, the sets of arms 25, 26, and 27 are supported on eccentrics 36 on the shaft 37 which is supported on brackets 38 and which has on the forward end thereof a gear 39 in mesh with the gear 35 on the shaft 32. The eccentrics 36 are disposed 180 degrees from the position of the eccentrics 33 which raises the set of arms 25, 26, and 27 while the other set 29 and 31 are lowered into operating position with the valves 23.

The gear 39 is in mesh with the rack 41 which is supported on brackets 42 and 43. The rack rotates the gear 39 which in turn rotates the gear 35 and is of sufficient length to produce 180 degree rotation to the gears which reverses the positions of the cams 33 and 36. While the rack 41 may be manually operated I have illustrated, in Fig. 2, a cylinder 44 having a piston rod 45 connected to the rack and operated by a fluid from a reversing valve 46 to have one or the other sets of rocker arms effective for controlling the sequential operation of the valves.

In Fig. 1, I have illustrated a sector 47 which is in mesh with the gear 39 and which has connected therewith a smaller sector 48 which is operated by the rack 41 from the cylinder 44. The length of the stroke of the rack 41 is reduced when the sector 48 is made smaller than the sector 47.

It will be noted in Fig. 4 that the rocker arm 26 is in engagement with the injector 24 and that the two arms 25 and 27 are in engagement with the intake valves 23. The arm 26 operates the injector nozzle 24 in timed relation to the operation of the valves by the arms 25 and 27. During normal operation the gears 35 and 39 are so positioned as to have the cams 36 reversed from the position illustrated in Fig. 1 so that the arms 25, 26, and 27 are lowered for operating the valves 23 and the injector nozzle 24. The arms 29 and 31 are moved upward in position by the eccentrics 33 out of contact with the valves 23. When it is desired to have the engine operate as a compressor such as for braking the wheels of a truck or bus when on a long grade, the valve 46 is shifted to rotate the gears 39 and 35 to move the eccentrics to the position illustrated in Fig. 1 to raise the sets of rocker arms 25, 26 and 27 out of engagement with the valves 23 and injector nozzle 24.

At the same time the arms 29 and 31 are lowered into engagement with the valves 23 to operate them at a predetermined point in the cycle of operation, controlled by the cams 50 on a second cam shaft 51. No fuel will be delivered to the cylinder and the valves 23 will be closed during the greater part of the upstroke of the piston, as in a compressor, which will load the piston and produce a brake load on the wheels of the vehicle. Before topping center the valves 23 are opened by the cam 50 to relieve the pressure in the cylinder. After the vehicle has reached the bottom of the grade the operation of the piston within the cylinder 44 will lower the crankarms 25, 26, and 27 and raise the crankarms 29 and 31 to cause the valves 23 and the injector nozzle 24 to function on the Diesel cycle in the conventional manner.

In Fig. 5, I have illustrated similar structure to that illustrated in Fig. 1, with the exception that the shaft 37 on which the arms 25, 26, and 27 operate in a normal manner, is not provided with the eccentrics and the arms are not shifted. The arms 29 and 30 are operated in the same manner as the arms provided on the structure of Fig. 1, to be raised and lowered relative to the valves. The piston in the cylinder 44 operates a rack 41 to directly rotate the gear 35 to move the arms 29 and 31 into and out of engagement with the tappets of the valves 23. To render the engine cycle of the device inoperative, I have provided a valve 52 disposed in the circuit 53 of the ejector nozzle 24. The valve 52 is operated by an arm 55 which is actuated by a finger 56 carried by the shaft 32 which engages the arm 55 when the shaft is rotated through 180 degrees. Power is entirely cut off from the engine when the shaft 32 is rotated to move the arms 29 and 31 into contact with the valves by cutting off the flow of fluid to the injector nozzle. The engine will then operate as a compressor.

In Figs. 7 and 8, I have shown similar structure applied to a four-stroke otto cycle engine. In this arrangement the shaft 37 carries a pair of arms 58 and 59, the former of which operates the intake valve while the latter operates the exhaust valve. A rocker arm 61 is mounted on a shaft 32 for operating the exhaust valve when the shaft 37 is rotated with the shaft 32 for moving the arms 58 and 59 out of engagement with the valves. The four-stroke cycle engine will require a double cam 62 on the cam shafts 63 for operating the arm 61 for each cycle of reciprocation of the piston. Fuel will not be drawn into the cylinder as the intake valve is not operated when the arm 58 is moved out of engagement therewith.

Referring to Figs. 9 and 10, I have illustrated a still further form of my invention as applied to otto-cycle engines. In this arrangement the cam shaft 65 functions to operate the crankarms 58 and 59 in the normal manner for operating both the intake and exhaust valves in a timed relation. The valves are also actuatable by crankarms 66 and 67 which are mounted on a shaft 32 to be

moved into engagement with the valve when the arms 58 and 59 are raised out of engagement therewith. The cam 68 has the cams thereof so positioned as to operate the crankarms 66 and 67 in a sequence to produce operation of the engine in a reverse direction. By manipulating the valve 46 the gears 39 and 35 are rotated to have on or the other sets of arms 58 and 59 or 66 and 67 moved into position to operate the valves. The electric distributing mechanism (not illustrated) is also changed to have the firing sequence follow the sequence of operation of the piston and valves in either direction. By having one set of crankarms to operate the valves with the proper distribution of the electric current, the engine will be driven in a clockwise direction. When the other set of crankarms operate the valves, with the change of the electric distributing mechanism, the engine will be run in a counterclockwise direction. Accordingly, by merely shifting valve 46 and the distributing mechanism the engine may be operated in one or the other directions.

Referring to Figs. 11 to 14 inclusive, I have illustrated a three-cylinder Diesel type engine having a shaft 37 on which a single set of arms 25, 26, and 27 are mounted in the same manner as that illustrated in Fig. 3 for operating the two valves and the injector nozzle of the one cylinder of the engine.

Two additional sets of arms 25, 26, and 27 are mounted on the shaft 37 to rock thereon. The two sets of arms are employed for operating the valves and injector nozzle of the remaining two cylinders. The shaft 32 carries arms 29 and 31 which operate the valves of the first cylinder when moved into engagement therewith in the same manner as the arms operate on the valves illustrated in Fig. 3.

In this particular arrangement the engine will normally operate as a Diesel engine when the shaft 37 is positioned to have all of the sets of arms 25, 26, and 27 engage and operate the valves and the injector nozzles. When the valve 46 is operated to shift the gears 35 and 39, the shaft 37 will be rotated to raise the one set of arms 25, 26, and 27 while the shaft 32 will lower arms 29 and 31 into position to engage and operate the one set of valves 23. The two cylinders of the engine will continue to operate in the normal manner to drive the piston in the first cylinder. The first cylinder will have the valves actuated by the arms 29 and 31 and will then operate as a compressor. This may be employed for applying a braking load to the vehicle or for producing compressed air for operating air hammers or similar devices. By moving the valve 46 to its original position the arms 29 and 31 are moved out of engagement with the valves 23 while the one set of arms 25, 26, and 27 will be moved into operating position so that all three cylinders will then operate on the Diesel cycle for driving the engine.

It will therefore be seen that I am able to change the driving and driven characteristics of an engine or compressor by manipulating the rocker arms which control movement of the valves for timing the intake and exhaust of the gases in accordance with the position of the piston. The engine may be operated in a clockwise or counterclockwise direction, or may be changed to a compressor to be driven by other means such as by a vehicle which is travelling down grade. The change over may be made on one of a plurality of cylinders of an engine, the remaining cylinders functioning as an engine for driving the piston in the changed over cylinder. A simple mechanism is employed for producing the change in position of the rocker arms so that the operating characteristic of an engine may be quickly changed. This embodies a piston for operating a pair of meshing gears which rotate the shaft on which the sets of arms are mounted. The shafts are mounted in eccentric bearings which raise one set of arms while lowering another to render one set inoperative while moving another set into operating position.

I claim as my invention:

1. In an internal combustion engine, a cylinder, a piston in said cylinder, a valve, a rocker arm for operating said valve, means for operating said rocker arm and valve as in an internal combustion engine, a shaft having an eccentric upon which said rocker arm operates, a second rocker arm, means for operating said second rocker arm and said valve as in a compressor, a second shaft, an eccentric on said shaft on which the rocker arm operates, and means for rotating said shafts to have the eccentric on one shaft move the rocker arm out of engagement with said valve as the eccentric on the second shaft moves the other rocker arm into engagement therewith to have the arms operate the valve at one time while the cylinder is functioning as an engine and operate it at another time while the cylinder is operating as a compressor.

2. In an internal combustion engine operating on a Diesel cycle, a cylinder, a piston in said cylinder, a valve, an injector nozzle, a pair of rocker arms for operating said valve and said injector nozzle respectively, means for operating said rocker arm, nozzle and valve as in a Diesel engine, and an additional rocker arm movable into engagement with said valve, means for operating said additional rocker arm to operate said valve as in a compressor, means for moving the rocker arms out of engagement with said valve and nozzle when said additional rocker arm is moved into engagement with said valve, and means for simultaneously operating said shafts to have the arms operate the valve at one time while the cylinder is functioning as an engine and operate it at another time while the cylinder is operating as a compressor.

3. In an internal combustion engine, a cylinder, a piston in said cylinder, a valve, a rocker arm for operating said valve, means for operating said rocker arm and valve as in an internal combustion engine, a shaft having an eccentric upon which said rocker arm operates and which raises and lowers said arm when rotated, a second rocker arm, means for operating said second rocker arm to operate said second rocker arm to operate said valve as in a compressor, a second shaft having an eccentric by which said second rocker arm is moved into and out of engagement with said valve, a pair of meshing gears connected to said shafts, toothed elements in engagement with one of said gears, and means for operating said toothed elements for operating said gears and shafts through 180 degrees to have the arms operate the valve at one time while the cylinder is functioning as an engine and operate it at another time while the cylinder is operating as a compressor.

4. In an internal combustion engine having a cylinder, a piston, and intake and exhaust valves, rocker arms for operating said valves, means for moving said rocker arms and valves as in an internal combustion engine, a shaft having eccentrics upon which said rocker arms operate, an additional rocker arm movable into en-

gagement with said exhaust valve, means for operating said additional rocker arm to operate said exhaust valve as in a compressor, a shaft having an eccentric upon which said arm rocks, and means for rotating said shafts for moving the first said rocker arms out of engagement with both of the valves when the additional rocker arm is moved into engagement with the exhaust valve to have the arms operate the valve at one time while the cylinder is functioning as an engine and operate it at another time while the cylinder is operating as a compressor.

5. In an internal combustion engine having a cylinder, a piston, and intake and exhaust valves, rocker arms for operating said valves, means for operating said rocker arms and valves as in an internal combustion engine, a shaft having eccentrics upon which said rocker arms operate, an additional rocker arm movable into engagement with said exhaust valve, means for operating said additional rocker arm and the exhaust valve as in a compressor, a shaft having an eccentric upon which said additional arm rocks, a pair of meshing gears secured to said shafts, and means for rotating said gears through 180 degrees for moving the first said rocker arms out of engagement with both valves as the additional rocker arm is moved into engagement with the exhaust valve to have the arms operate the valve at one time while the cylinder is functioning as an engine and operate it at another time while the cylinder is operating as a compressor.

6. In an internal combustion engine of the Diesel type having a piston movable in a cylinder, a pair of exhaust valves and an injector nozzle, a rocker arm shaft containing eccentrics, rocker arms mounted on said eccentrics in engagement with said two exhaust valves and said nozzle, means for operating said rocker arms, exhaust valves and nozzle as in a Diesel engine, a second shaft having eccentrics, additional rocker arms mounted on the eccentrics of said second shaft movable into engagement with said valves, means for operating said additional rocker arms and the exhaust valves as in a compressor, and means for rotating said shafts for moving said first rocker arms out of engagement with the valves and nozzle and moving the additional rocker arms into engagement with the valves to have the arms operate the valve at one time while the cylinder is functioning as an engine and operate it at another time while the cylinder is operating as a compressor.

7. In an internal combustion engine of the Diesel type having a piston movable in a cylinder, a pair of exhaust valves and an injector nozzle, a rocker arm shaft containing eccentrics, rocker arms mounted on said eccentrics in engagement with said two exhaust valves and said nozzle, means for operating said rocker arms to actuate said valves and nozzle as in a Diesel engine cylinder, a second shaft having eccentrics, rocker arms mounted on said eccentrics movable into engagement with said valves, means for rotating said shafts for moving the first said rocker arms out of engagement with the valves and nozzle and moving the rocker arms on the second said shaft into engagement with the valves, and means for operating said last-named rocker arms in the sequence to have the cylinder operate as a compressor when the valves are operated thereby and as an engine when the valves are operated by said other rocker arms.

8. In an internal combustion engine of the Diesel type having a cylinder in which a piston operates, a pair of exhaust valves and injector nozzle, a rocker arm shaft, a plurality of rocker arms on said shaft in engagement with said valves and injector nozzle, means for operating said rocker arms to actuate said valves and nozzle as in a Diesel engine cylinder, a second shaft having eccentrics thereon, rocker arms on said eccentrics, means for actuating the rocker arm on said second shaft to operate the exhaust valves as in a cylinder of a compressor, means for rotating said last shaft for moving the rocker arms thereon into and out of engagement with said valves, a fuel supply line to said injector nozzle, a valve in said line, and means for closing said valve when said arms are moved by the eccentrics into engagement with said valves for cutting off the supply of fuel to said cylinder whereby the arms operate the valves at one time while the cylinder is functioning as an engine and operate them at another time while the cylinder is operating as a compressor.

9. In an internal combustion engine, having a piston operating in a cylinder and an intake and exhaust valve, a pair of rocker arms for operating said valves, a shaft having eccentrics on which said arms rock, a second set of arms movable into engagement with said valves, a shaft having eccentrics on which said second set of arms rock, cam shafts for operating said arms in different sequences for operating the engine in either direction of rotation when one or the other set of arms engages said valves, and means for moving one set of rocker arms into operating position when the other set of arms is moved into inoperative position for reversing the direction of rotation of the engine.

10. In an internal combustion engine, having a piston operating in a cylinder and an intake and exhaust valve, a pair of rocker arms for operating said valves, a shaft having eccentrics on which said arms rock, a second set of arms movable into engagement with said valves, a shaft having eccentrics on which said second set of arms rock, cam shafts for operating said arms in different sequences for operating the engine in either direction of rotation when one or the other set of arms engages said valves, a pair of meshing gears mounted on said shaft, and means for operating said gears through 180 degrees to move one set of rocker arms into engagement with said valves while moving the other set out of engagement therewith to have the arms operate the valves at one time while the engine is functioning in the normal operation and operate them at another time while operating as a compressor.

11. In an internal combustion engine having a plurality of cylinders in which pistons are movable and which are provided with valves, a rocker arm shaft, a rocker arm for operating some of the valves mounted on said shaft, an eccentric on said shaft, additional rocker arms on said eccentric for operating other of said valves, means for operating all of said rocker arms and valves as in an internal combustion engine, an additional shaft having eccentrics, a rocker arm mounted on said eccentrics engageable with one of the valves with which the arms on the eccentrics of the other shaft engage, means for operating said last rocker arm and valve with which it engages as in a compressor, means for moving certain of said rocker arms out of engagement with said valves while said last rocker arm is moved into engagement with said valve, whereby the arms operate the valves at one time

while certain of the cylinders are functioning as an internal combustion engine and another cylinder is operating as a compressor and operate the valves at another time while all of the cylinders are functioning as an internal combustion engine.

12. In an internal combustion engine having a plurality of cylinders in which pistons are movable and which are provided with valves, a rocker arm shaft, a rocker arm for operating some of the valves mounted on said shaft, an eccentric on said shaft, additional rocker arms on said eccentric for operating other of said valves, means for operating all of said rocker arms and valves as in an internal combustion engine, an additional shaft having eccentrics, a rocker arm mounted on said eccentrics engageable with one of the valves with which the additional arms on the eccentrics of the other shaft engage, means for operating said last rocker arm and said valve as in a compressor, means for rotating said shafts and eccentrics to move said additional rocker arms out of engagement with the valves of one cylinder and moving said last rocker arm into engagement with said one valve while the rocker arms on the other cylinders continue to function in the normal manner to have the pistons operate as an internal combustion engine driving the piston in the other cylinder as a compressor in one position of operation of the valves by the arms while in the other position of operation of the valves by the arms all of the cylinders functioning as an internal combustion engine.

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