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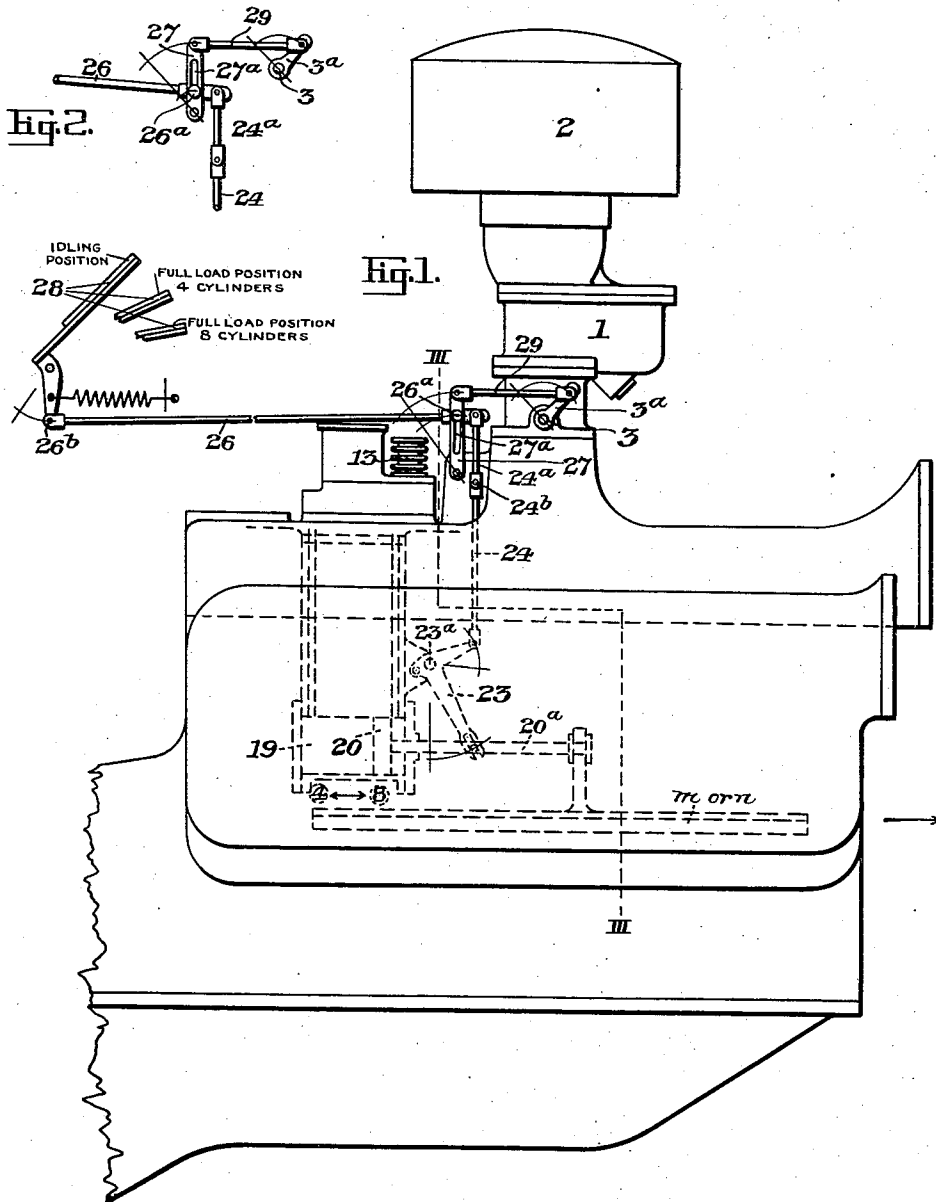
K. W. ROHLIN

2,250,814

INTERNAL COMBUSTION ENGINE OF THE MULTICYLINDER TYPE

Filed Aug. 30, 1937

4 Sheets-Sheet 1



INVENTOR
Karl W. Rohlin,
BY *Murray B. Boyer*
ATTORNEY

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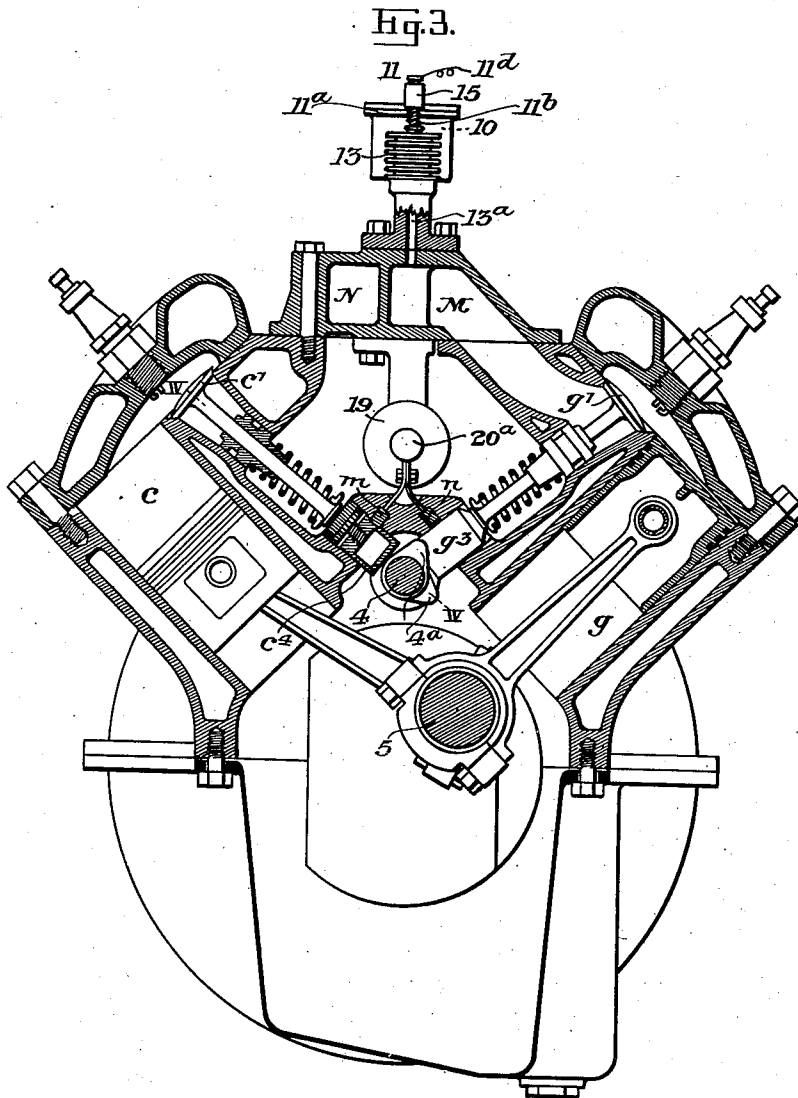
K. W. ROHLIN

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4 Sheets-Sheet 2



INVENTOR
Karl W. Rohlin,
BY Murray B. Boyer
ATTORNEY

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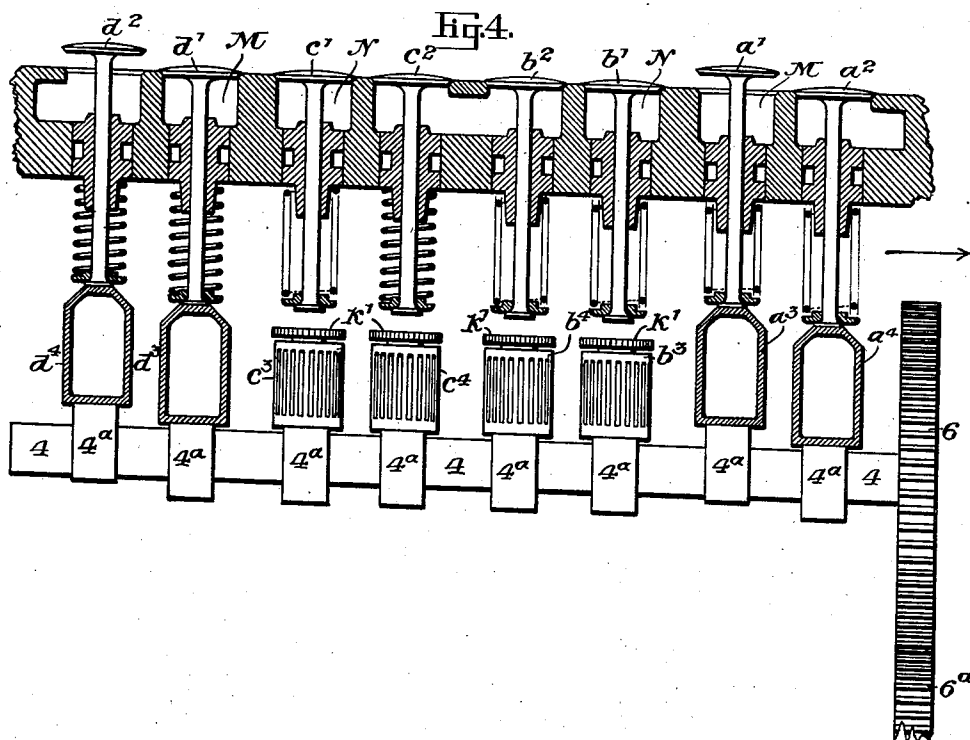
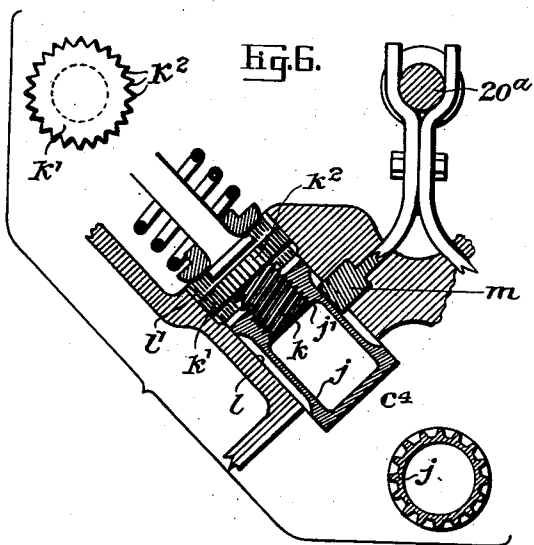
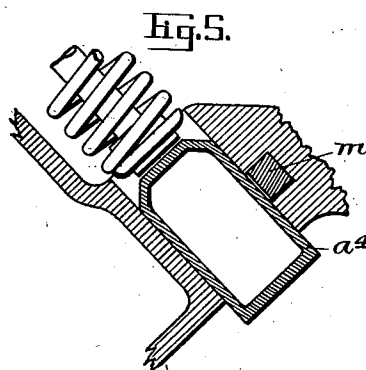
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INTERNAL COMBUSTION ENGINE OF THE MULTICYLINDER TYPE

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4 Sheets-Sheet 3



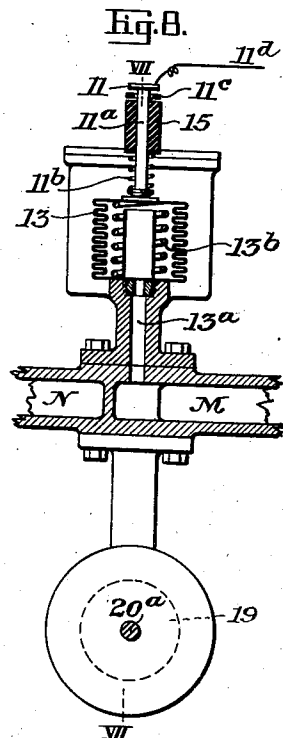
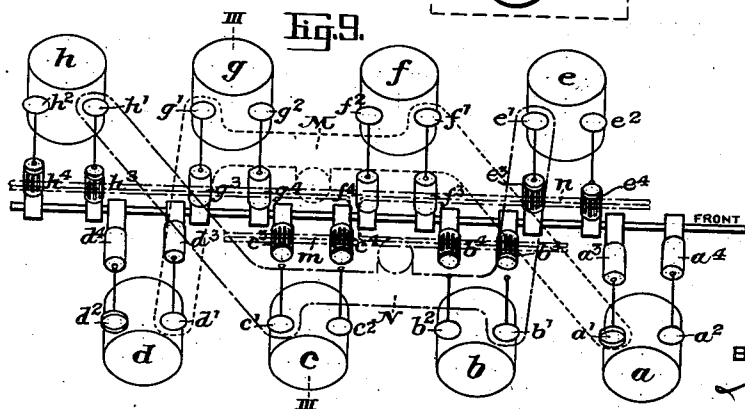
INVENTOR
Karl W. Rohlin,
BY Murray B. Boyer
ATTORNEY

K. W. ROHLIN

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4 Sheets-Sheet 4



INVENTOR
Karl W. Rohlin,
Murray B. Boyer
ATTORNEY

UNITED STATES PATENT OFFICE

2,250,814

INTERNAL COMBUSTION ENGINE OF THE
MULTICYLINDER TYPE

Karl W. Rohlin, Dover, Del.

Application August 30, 1937, Serial No. 161,702

9 Claims. (Cl. 123—52)

My invention relates to means for controlling the operation of multi-cylinder internal combustion engines, more particularly those of the explosion type, and comprises certain improvements upon or a carrying forward of the invention presented in my co-pending application, filed December 18, 1936, Serial No. 116,464 which was issued as Patent No. 2,166,968 on July 25, 1939.

Like the invention set forth in my pending application, the present invention includes means for automatically cutting some of the cylinders of an internal combustion engine into and out of firing service depending upon the speed and load of the engine, but my present invention is an improvement over that of my earlier application in that, when the non-firing cylinders are out of service, the amount of work energy wasted by them is further reduced with the result that further economies in fuel consumption may be realized.

Other advantages of my present invention may be summarized as follows:

(1) No air is drawn into and through the non-firing cylinders and no additional silencers, air-cleaners or pre-heaters, over those employed in conventional internal combustion engine equipment, are required.

(2) Means are provided to prevent the automatic mechanism of the present invention from cutting cylinders out of service while shifting gears.

(3) The automatic mechanism is controlled by electrical means involving only the low amperage circuits; the high amperage circuit from the generator not being involved.

(4) Improved resetting means of a mechanical type insure non-chatter and non-flutter.

While my present invention, as set forth in the following specification and exemplified by the structure illustrated in the accompanying drawings, involves mechanism especially applicable to a Ford V-8 engine, the invention is equally adapted to engines having more or less than eight cylinders, and to engines designed for other purposes than propelling an automobile. My invention is also applicable to engines having all of its cylinders in one plane, including the so-called "straight eights."

In carrying out the invention forming the subject of my earlier application, fuel flow to the non-firing cylinders is interrupted in the carburetor, or at a point between the carburetor and the engine suction valves, by means of a special needle valve arranged in the liquid fuel line, or by special sleeve or poppet-type valves

in the fuel charge channels of the intake manifold; the opening of another valve permitting air to flow freely to the cylinders not firing, to reduce drag. In the mechanism forming the subject of my present invention, no separate fuel, fuel charge, or air valves are required; the automatic mechanism serving instead to close the poppet valves for each of the intermittently firing cylinders during non-firing periods when such cylinders neither draw in air nor fuel, nor discharge to the exhaust. The suction and exhaust valves associated with these cylinders remain tightly closed during the entire non-firing periods and no work is absorbed by the non-firing cylinders except that necessary for overcoming friction therein plus the work done on the relatively insignificant quantity of air that leaks past the piston rings or the seated poppet valves.

As in the mechanism of my earlier application, the exact arrangement of the firing and non-firing cylinders with respect to each other is of little importance so long as the working cylinders fire rhythmically and produce smooth operation. Various groupings of the cylinders of a V-8 engine to be cut out of firing service may be employed, for example, two may be cut of each side of the V. In a "straight eight" or similar structure, the first half of the cylinders or the last half of the cylinders may be cut out, or every other cylinder may be cut out or, cylinders may be cut out in pairs, provided that the working cylinders fire at even intervals.

The accompanying drawings show a cylinder arrangement similar to that illustrated in my earlier application; two cylinders on each side of the V firing continuously, and two cylinders firing intermittently. In like manner manifolds indicated herein at M and N, feed groups of continuously firing and intermittently firing cylinders, respectively. The firing order of the cylinders may be any of several used with V-8 motors, so long as the intermittently firing cylinders fire at 180° intervals intermediate the firing of the continuously firing cylinders, which also fire at 180° intervals so that, when eight cylinders fire, they do so at 90° intervals. In these drawings, which are more or less diagrammatic in character,

Figure 1 is a view in elevation of part of a Ford V-8 motor, showing the location and arrangement of the parts of the mechanism constituting one form of my present invention.

Fig. 2 shows part of the operating linkage in the position required when some cylinders are not firing.

Fig. 3 is a cross sectional elevation of the motor showing the arrangement of the mechanism of my present invention within the valve alley, and its relation to the intake manifold.

Fig. 4 is a sectional elevation on the line IV—IV, Fig. 3, showing the inlet and exhaust valves and operating mechanism for the cylinders on the right-hand side of a V motor (viewed from the driver's seat).

Fig. 5 is a fragmentary sectional view, slightly enlarged, of part of the structure illustrated in Figs. 3 and 4; showing in detail one of the push rod elements for operating the valves associated with the continuously firing cylinders.

Fig. 6 is a view similar to Fig. 5, showing one of the special push rod elements for operating the valves associated with the intermittently firing cylinders and constructed in accordance with my present invention.

Fig. 7 is a sectional elevation on the line VII—VII, Fig. 8, showing in detail one form of automatic control mechanism within the scope of my invention, and also illustrating diagrammatically an arrangement of wiring for use therewith.

Fig. 8 is a sectional elevation on the line VIII—VIII, Fig. 7, and

Fig. 9 is a diagrammatic view of the cylinders, their valves, operating mechanism therefor, and the manifolds associated therewith.

As hereinabove set forth, the object of my present invention is to provide means whereby I can cut certain cylinders into and out of firing service through mechanism which may be controlled by the pedals, or may be automatically operated under certain running conditions.

I have found, from tests carried out in developing my method of control, that it is desirable to keep the inlet and exhaust valves of the non-firing cylinders closed during the non-firing periods thereof so as to avoid the energy losses that would result from pumping air through the non-firing cylinders if the inlet and exhaust valves associated therewith were permitted to open and close in the conventional manner.

Figure 1 of the drawings illustrates diagrammatically the mechanism controlled by the pedals for putting certain of the valves into and out of operation, and indicates by dotted lines the mechanism controlled thereby; while Fig. 7 shows the electrical circuits associated with the mechanical means for automatically operating the control mechanism under certain running conditions.

In Fig. 4 I have illustrated one bank of valves of a motor of the V-8 type; for instance, they may be the valves indicated at the left side of the cross-sectional elevation, Fig. 3. In the present arrangement, and as indicated in diagrammatic view, Fig. 9, the cylinders of a V-8 motor are indicated at *a, b, c, d, e, f, g* and *h*. In the operative arrangement herein described, cylinders *a, d, f* and *g* fire continuously, while cylinders *b, c, e* and *h*, are arranged to fire intermittently.

Each cylinder is provided with inlet and exhaust valves and in Fig. 4, which is a sectional elevation on the line IV—IV, Fig. 3, the inlet valves are indicated at *a', b', c'* and *d'*, while the exhaust valves are indicated at *a'', b'', c''* and *d''*. The operation of opening and closing these valves is controlled by push-rod elements and the usual springs reacting upon the valve stems; said push-rod elements being actuated by cams carried by the cam shaft. In Fig. 4, only the

cams for operating push-rod elements to open the valves of the bank of cylinders at the left of Fig. 3, are shown; each valve stem being engaged by a separate push rod element. Those for the inlet valves are indicated at *a', b', c'* and *d'*, while those for the exhaust valves are indicated at *a'', b'', c''* and *d''*.

It will be understood, of course, that the bank of cylinders at the right of Fig. 3, will be equipped with inlet and exhaust valves of a similar character and in the diagrammatic view, Fig. 9, all of the cylinders are represented, with the several valves associated therewith.

The push rod elements indicated at *a', a'', b', b'', c', c'', d', d'', e', e'', f', f'', g', g'', h', h'', i', i'', j', j'', k', k'', l', l'', m', m'', n', n'', o', o'', p', p'', q', q'', r', r'', s', s'', t', t'', u', u'', v', v'', w', w'', x', x'', y', y'', z', z''* are in operative engagement with the respective valve stems at all times. The push rod elements *b', b'', c', c'', e', e'', h', h'', i', i'', j', j'', k', k'', l', l'', m', m'', n', n'', o', o'', p', p'', q', q'', r', r'', s', s'', t', t'', u', u'', v', v'', w', w'', x', x'', y', y'', z', z''*, however, are of another type, and although they may be continuously operated by the cams in the same manner as the other push rod elements, they are adjustable as to length so that they may be held in an inoperative position with respect to the valves which they otherwise operate when the cylinders associated therewith do not fire. In the position indicated in Fig. 4, the cylinders with which the valves *b', b'', c', c''* and *e', e''* are associated, are not firing.

The push rod elements *a', a'', d', d'', e', e'', f', f'', g', g'', h', h'', i', i'', j', j'', k', k'', l', l'', m', m'', n', n'', o', o'', p', p'', q', q'', r', r'', s', s'', t', t'', u', u'', v', v'', w', w'', x', x'', y', y'', z', z''* are of fixed length and transmit the lift of the cams to the valves *a', a'', d', d'', e', e'', f', f'', g', g'', h', h'', i', i'', j', j'', k', k'', l', l'', m', m'', n', n'', o', o'', p', p'', q', q'', r', r'', s', s'', t', t'', u', u'', v', v'', w', w'', x', x'', y', y'', z', z''*, and always operate as they would in a conventional engine. But the push rod elements *b', b'', c', c'', e', e'', h', h'', i', i'', j', j'', k', k'', l', l'', m', m'', n', n'', o', o'', p', p'', q', q'', r', r'', s', s'', t', t'', u', u'', v', v'', w', w'', x', x'', y', y'', z', z''* are so constructed that their length may be automatically increased to that of the other push rod elements when eight cylinders fire under control of the automatic mechanism, and automatically shortened to the length indicated in Fig. 4, whenever only four cylinders are firing. It is this feature, and the mechanism for effecting such result, that constitutes an important part of my present invention, and the operation of this mechanism will now be described.

Each of the push rod elements indicated at *b', b'', c', c'', e', e'', h', h'', i', i'', j', j'', k', k'', l', l'', m', m'', n', n'', o', o'', p', p'', q', q'', r', r'', s', s'', t', t'', u', u'', v', v'', w', w'', x', x'', y', y'', z', z''*, comprises a toothed sleeve *j* with a threaded socket *j'* receiving a threaded stem *k* with a head *k'*; said sleeves being arranged for movement within openings *l* in the crank case wall. The heads *k'* have notched rims *k''* to fit teeth *l'* formed in the openings *l* so that while longitudinal movement of said heads with respect to the sleeves *j* may be imparted by rotation of said sleeves acting as nuts, such heads and their threaded stem are held against rotation. When the stems *k* are extended to provide for operative engagement of their heads *k'* with the valve stems of the valves *b', b'', c', c'', e', e'', h', h'', i', i'', j', j'', k', k'', l', l'', m', m'', n', n'', o', o'', p', p'', q', q'', r', r'', s', s'', t', t'', u', u'', v', v'', w', w'', x', x'', y', y'', z', z''*, movement of the latter will be effected by the cams in the same manner as the other valves are operated by the other push rod elements.

The sleeves *j* are externally provided with teeth for engagement by rack rods *m* and *n*, and rotation of said sleeves upon moving said rack rods imparts movement to the stems *k* threaded in the sockets *j'* of said sleeves—in and out of said sockets depending upon the direction of movement of said rack rods. Right hand threads are cut on the stems *k* of the push rod elements *b', b'', c', c'', e', e'', h', h'', i', i'', j', j'', k', k'', l', l'', m', m'', n', n'', o', o'', p', p'', q', q'', r', r'', s', s'', t', t'', u', u'', v', v'', w', w'', x', x'', y', y'', z', z''*, and left hand threads are cut on the stems *k* of the push rod elements *e', e'', h', h'', i', i'', j', j'', k', k'', l', l'', m', m'', n', n'', o', o'', p', p'', q', q'', r', r'', s', s'', t', t'', u', u'', v', v'', w', w'', x', x'', y', y'', z', z''*. In order to rotate the sleeves of the several push rod elements, the rack rods *m* and *n* are operatively connected with the piston rod 20 and the teeth *m'* and *n'* of said rack rods

mesh with the teeth of the sleeves *j* of the several adjustable push rod elements.

Movement of the rack rods *m* and *n* to the left (Fig. 9) will cause the threaded stems *k* to more deeply enter the sockets *j'* and reduce the overall length of the associated parts sufficiently to avoid engagement with the stems of valves *b'*, *b²*, *c'*, *c²*, *e'*, *e²*, *h'* and *h²*, when the cams *4^a* lift the several push rod elements, so that these several valves remain seated under the action of their springs. Movement of the rack rods in the opposite direction (to the right, Fig. 9) reverses this action and elongates said adjustable push rod elements.

The sleeve portions *j* of the push rod elements associated with the valves *b'*, *b²*, *c'*, *c²*, of the intermittently firing cylinders of the right half of the V-block are rotated counter-clockwise when the rack rods are moved to the left, while those associated with the valves *f'*, *f²*, *g'*, *g²*, of the intermittently firing cylinders of the left half of the V-block are rotated clockwise (as viewed from the driver's seat). Movement of said rack rods to the right reverses the direction of movement of said sleeves. The threaded stems are free to move longitudinally with respect to the sleeves *j*, but are prevented from rotation by the teeth *j²* of the sockets *j'* receiving the same, which register with the notches *k²* of the heads *k'*. In an engine with cylinders in one plane, all of the stems *k* will have threads of the same character. Movement of the rack rods *m* and *n* to cause rotation of the sleeves *j* of the adjustable push rod elements is effected in a manner hereinafter described.

The operation of a Ford V-8 engine fitted with one form of controlling mechanism within the scope of my present invention, may be described as follows:

Air for mixture with the fuel for delivery into the cylinders *a*, *b*, *c* enters carburetor 1 (via air cleaner 2) where it is mixed with the fuel in the usual manner and passes thence to the manifolds M and N; its flow being controlled by a pair of conventional butterfly valves (not shown) fixed to shaft 3. The fuel charges are then drawn into the cylinders during their respective suction strokes, when valves *a¹*, *b¹*, *c¹*, *d¹* are opened. During eight-cylinder operation, all suction valves operate in turn to permit fuel and air to enter the cylinders so that they all fire in the usual order and the engine operates like any conventional motor. The exhaust valves *a²*, *b²*, *c²*, *d²* likewise operate normally, all valves being operated by means of a cam shaft 4 carrying cams *4^a*, which shaft is rotated synchronously with the crank shaft 5 of the engine through timing gears 6 and 6^a.

In Fig. 7 I have shown a form of control mechanism for automatically effecting changes in engine operation from eight-cylinder firing to four-cylinder firing, and vice versa. This control mechanism is electrically and hydraulically operated and includes a generator, a solenoid-operated switch, a plurality of cut-out switches, one of which is under the control of the clutch pedal, and a fluid-actuated piston.

Assuming, considering an automobile, that the car is running at a moderate speed (above, perhaps, fifteen miles per hour) on a level road; operation of the generator 7, indicated in Fig. 7, will energize coil 8^a of a cutout C, so as to attract armature 8^b and complete a circuit through contacts 8^c. The current produced by the generator charges a battery 9; such current flowing via

wires 9^a and 9^b, and an ammeter 9^c. Contacts 8^d, which are mechanically but not electrically connected to contacts 8^c, are closed at the same time and an electric circuit, which includes a solenoid coil indicated at 10, and a vacuum switch indicated at 11, will be completed, provided the clutch pedal 12 is actuated to close switch 12^a associated therewith. The manifold M is in communication with a bellows-folded diaphragm 13, and the solenoid coil 10 will not be energized unless the vacuum in said diaphragm chamber 13, which communicates therewith via channel 13^a, is sufficient to draw down the head of diaphragm 13, against the force of the internally disposed spring 13^b; thereby permitting stem 11^a to lower under the action of spring 11^b until the head of said stem engages contact plate 11^c, and an electric circuit is completed. Stem 11^a and contact plate 11^c are electrically insulated from the bellows-folded diaphragm 13 and other mechanical parts of the device.

In the present arrangement, the vacuum present in manifold channel M and diaphragm 13 will be relatively high, because the accelerator pedal, hereinafter described, will then be near its fully raised position and the butterfly valves on shaft 3 will be nearly closed, in which case switch 11 will have made the desired contact.

Closing switch 11 completes the following circuit: battery 9, ammeter 9^c, wires 9^b and 9^d, an ignition switch indicated at 14, wire 14^a, clutch pedal switch 12^a, wire 12^b, solenoid coil 10, wire 10^a, contact plate 11^c, stem 11^a, wire 11^d, contacts 8^d, wire 8^c, and ground, back to the battery. Solenoid plunger 10^p then rises, lifting lever 15 so that the head of stem 11^a presses more tightly against contact plate 11^c; thereby establishing a positive contact and preventing chatter of the solenoid armature 10^p.

Upward movement of the solenoid plunger 10^p relocates its valve portions 10^b and 10^c so that flow of oil under pressure from the lubricating oil pump, common to internal combustion engines, (not shown) can take place via tube 16, and channel 16^a, annular space 17 surrounding the valve portions of the solenoid plunger, and channel 18, to cylinder 19 for the purpose of moving piston 20 therein to the left; carrying piston rod 20^a with it. Under such condition, oil from the left side of piston 20, leaves the cylinder 19 via channels 18^a and 18^b, and passes thence by gravity to the crank case and the suction opening of the lubricating pump.

The engine now operates with four cylinders, *a*, *d*, *f* and *g*, firing rhythmically at 180° intervals, and four cylinders, *b*, *c*, *e* and *h*, not firing, as no fuel charge is admitted thereto, but operating at 180° intervals, intermediate the operation of the firing cylinders. A minimum amount of work is subtracted by the non-firing cylinders from that produced in the firing cylinders by reason of the fact that each upward stroke of the pistons in the non-firing cylinders compresses the gas in the cylinders and each downward stroke permits expansion of the gas an equal amount; the energy used in compressing the gas on the up-stroke of the pistons equalling the work delivered back to the pistons on their down strokes by the expanding gas. Of course, the firing cylinders must do the work necessary to overcome friction of the pistons operating in the non-firing cylinders and to make up for work lost with gas leaking past the pistons and valves in the non-firing cylinders.

All of the savings effected by the use of the structure forming the subject of my co-pending

application are retained. In this present example, during four-cylinder firing, only one-half of the pistons are operating under the handicap of high vacuum in the intake manifold, and only one-half of the cylinders lose heat to the cooling water.

Simultaneously with the movement of the rack rods *m* and *n*, and the adjustable push rod elements operated thereby, whereby cylinders *e*, *b*, *c* and *h* are cut out of firing service, additional mechanism is operated to reset the throttle valves of the carburetor to such position that the power output from one-half the number of cylinders will approximate that previously delivered by all of the cylinders, or vice versa, and lever 15 will be automatically moved to reset the degree of vacuum at which diaphragm 13 will operate switch 11 so as to avoid "flutter" of the entire control mechanism.

The operation of these features will now be described.

As piston 20 moves to the left, its rod 20^a actuates a lever 23, fulcrumed at 23^a. This lever has arms 23^b and 23^c to which links 15^a and 24 are pivotally connected and in such movement of the piston rod, link 15^a is raised and link 24 is simultaneously lowered; the movement of link 15^a operating the lever 15 of the non-flutter mechanism. Link 24, which may be loosely guided through an aperture in the manifold casing, is attached by means of a second link 24^a, pivotally connected thereto at 24^b, to one end of a link 26 operatively connecting the carburetor butterfly valve lever, etc., with the accelerator pedal 28. Link 26 engages a slotted lever 27, by means of a pin 26^a which is moved in said slot, indicated at 27^a, by means of the jointed link 24—24^a. The throttle valve shaft 3 of the carburetor carries a crank arm 3^a which is operatively connected to the upper end of the lever 27 by a link 29 so that movement of said lever 27 will be imparted to said shaft 3. The slot 27^a may be arcuate and is struck from the point 26^b so that vertical movement of pin 26^a will not change (or will only slightly change) the relative position of throttle valve shaft 3 with respect to that of the accelerator pedal 28, when they are in the positions shown in Figs. 1 and 2, that is, during the idling or minimum load position.

In resetting the mechanism for four-cylinder firing, movement of piston 20 to the left, will effect movement of pin 26^a from its upper position, shown in Fig. 1, to its lower position, shown in Fig. 2, and any given movement of pedal 28 transmitted by link 26 will cause a greater angular movement of lever 27 and a correspondingly greater movement of throttle valve shaft 3; thereby delivering more fuel and air to the cylinders of the motor then firing. If the accelerator pedal 28 is already depressed when the mechanism is shifted from eight- to four-cylinder firing position, downward movement of pin 26^a will result in moving lever 27 further to the left, actuating shaft 3 and further opening the throttle valve (or valves) carried thereby to increase the amount of fuel and air flowing to the firing cylinders. Conversely, upward movement of the jointed link 24—24^a resulting from movement of the control mechanism from four- to eight-cylinder firing position will cause lever 27 to move to the right and actuate shaft 3, partially closing the throttle valves thereon. The effect of these operations is to readjust the throttle valves so as to maintain a reasonably constant output of power when the mechanism shifts

from four-cylinder firing to eight-cylinder firing, or vice-versa, unless, of course, such a shift results from changing the position of the accelerator pedal 28, which will be described more in detail later.

The "load-compensating mechanism," as it may be called, which includes links 24 and 24^a, pin 26^a, lever 27, etc., is of particular importance if carburetor 1 is of the dual or multiple jet type and from which fuel and air flow through separate passages to separate channels in the intake manifold: to the suction valves for the firing cylinders in one case, and to the suction valves for the non-firing cylinders in the other case. With such arrangement there is no inherent adjustment of fuel and air delivery to the cylinders of the engine when the controls shift from four- to eight-cylinder firing, or vice versa, and the above-described "load compensating mechanism" is quite desirable.

However, if a single jet carburetor is used or if two firing and two non-firing cylinders are fed from each jet of a dual jet carburetor, the load-compensating mechanism may be designed or adjusted for a much smaller movement of the throttle valves when the controls shift from the four- to the eight-cylinder firing position, or vice versa or, in some cases the load compensating mechanism may be dispensed with entirely. If, for instance, all of the suction valves *a'*, *b'*, *c'* and *d'* on the right half of the V block are fed from one jet of a dual jet carburetor, then, on operation of the control mechanism to keep valves *b'* and *c'* shut for a period of four-cylinder operation, valves *a'* and *d'* will automatically deliver more fuel and air to their cylinders because the pressure in the manifold channels *M* and *N* (joined together in this instance) will rise (and the vacuum will fall), even though no load-compensating mechanism is included and throttle valve shaft 3 remains stationary. When the valves *b'* and *c'* are again in operation, cylinders *b* and *c* will draw in air and fuel and increase the vacuum in the manifold channels so that less air and fuel will be delivered to cylinders *a* and *d*. Some degree of load compensation is inherent in this arrangement; so that special mechanism having that function may not be necessary for some engines.

The "non-flutter" mechanism will now be described. I have already described how movement of the piston 20 to the left to bring about four-cylinder firing will effect movement of links 24 and 15^a; link 24 operating the load-compensating mechanism which has been described, and link 15^a operating "non-flutter" mechanism, including lever 15.

Shifting of the mechanism from eight- to four-cylinder firing occurs when the vacuum in manifold *M* is sufficient to draw down diaphragm 13 and close switch 11, as described earlier, and operates the load compensating mechanism to increase the opening of the throttle valves and reduces the vacuum in manifold *M* and diaphragm 13, with the result that switch 11 would then be opened, the control mechanism would operate to fire eight cylinders, and "flutter" of the entire mechanism would have started. To avoid such undesirable operation, switch 11 and its associated parts are initially set to operate at a relatively high vacuum whenever the control mechanism is in the eight-cylinder firing position. When the mechanism moves to the position for firing only four cylinders, switch 11, etc., are automatically reset for successively lower

vacua. This insures that movement of the control mechanism to either position, once it has started, will be completed without interruption through such movement affecting the vacuum to reverse switch 11. Of course, the mechanism may be reversed from either position by operating switch 12^a or by changing the position of the accelerator pedal. Otherwise, switch 11 will not operate to reverse the mechanism until the vacuum has been still further reduced by a change in throttle position or engine speed, and "flutter" is thereby avoided.

Suppose now that the automobile speed is reduced below the point at which the electrical output from generator 7 is sufficient to energize coil 8^a of cutout C so as to hold down armature 8^b and close contacts 8^c and 8^d. Under such condition, current flow between the generator and battery, and current flow through solenoid coil 10, will both be interrupted. Solenoid plunger 10^p then falls by gravity and its valve portions 10^b and 10^c are brought to the position shown in Fig. 7, so as to permit oil under pressure from the lubricating pump to flow via tube 16, channel 16^a, annular space 17, channel 18^a into cylinder 19 where it effects movement of the piston 20 and rod 20^a to the right, to the position shown in said figure. The rack rods *m* and *n*, also moving to the right (Fig. 9), will rotate the sleeves *j* of the adjustable push rod elements and the threaded stems *k* thereof will be moved outward with respect to said sleeves until their effective length equals that of the other push rod elements for engagement with the several valve stems. In such relation all valves of both V-blocks will rise and fall under the action of the cams 4^a, and all cylinders will fire and function like those in any conventional engine. The engine now operates with the smoothness resulting from power impulses from all the cylinders and the objectionable vibration that would occur if only half of the cylinders fired at low speed is avoided.

Suppose, while running under light load on one-half of the cylinders, that the driver desires to accelerate the car. Accelerator pedal 28 is then depressed, moving link 26, lever 27, the upper end of link 24^a, link 29 and lever 3^a to the left, rotating shaft 3 counter-clockwise to increase the opening of the throttle valves and produce more power and therefore greater speed in the engine. Opening the throttle valves will reduce the vacuum in manifold channel M and diaphragm 13, and, if the accelerator pedal is depressed sufficiently, the head of diaphragm 13 will rise and open switch 11; breaking the circuit through solenoid coil 10 and dropping solenoid plunger 10^p with the result that the oil flow will be reversed to move piston 20 to the position shown in Fig. 7, and all cylinders will again fire and produce power, as described earlier, for the case of low engine speeds.

Or suppose that, while the car is running on one-half of the cylinders, a hill is encountered and the driver does not press down the accelerator pedal. The engine slows down under the increased burden and either operates switch 11 to fire all cylinders, because of the gradually reducing vacuum in manifold M, or, if the speed falls low enough, generator 7 will cause cutout C to open switch 8^d and drop solenoid plunger 10^p to fire all cylinders.

Economy of fuel consumption while idling, whether the car is standing or coasting, may be provided by operating the engine on one-half of its cylinders whenever the accelerator pedal 28

is raised to its upper position. Current from battery 9 flows, through ignition switch 14, clutch pedal switch 12^a, solenoid coil 10, wire 30^a, accelerator pedal switch 30 (while the engine is idling only, wire 30^b to ground, and back to the battery. This "idling" circuit energizes solenoid coil 10 regardless of the position assumed by switch 11, raises solenoid plunger 10^p, and operates piston 20 to reset the mechanism to fire one-half of the cylinders.

Too frequent operation of the control mechanism as a result of changes in engine speed or load while in gear, or shifting gears, and from raising the accelerator pedal while shifting gears, are avoided through operation of switch 12^a on the clutch pedal. This switch is held closed by the clutch pedal whenever the latter is substantially all the way up, and delivers current from the ignition switch 14 to solenoid coil 10 whenever current is required by the operation of switches 11, 30 and 8^d. But when the clutch pedal is depressed to shift gears, or even if it is depressed slightly while in gear, switch 12^a will be opened, solenoid coil 10 will be deenergized, solenoid plunger 10^p will fall to or remain in its lower position and piston 20 will be positioned to reset the mechanism to fire all cylinders. As a rule, all cylinders fire from the time the clutch pedal is depressed to put the gears in "low" upon starting the car, until after the shift into "high" gear.

It should be mentioned in connection with the means for preventing "flutter" that shifting of the control mechanism from eight- to four-cylinder firing position, raises link 15^a in the manner described, which in turn raises the right hand end of lever 15; moving switch 11 with it. Switch 11 maintains contact with plate 11^c holding armature 10^p in its raised position and, through the means described, keeps piston 20 in the four-cylinder firing position, despite the reduction in vacuum in manifold M caused by the concurrent operation of the "load compensating mechanism." Bellows-folded diaphragm 13 will not operate to open switch 11 until a further reduction in vacuum has taken place, thereby permitting such diaphragm to expand under the action of spring 13^b and raise stem 11^a to open switch 11. Conversely, on movement to the eight-cylinder position, link 15^a, lever 15, and switch 11, lower so that switch 11, already opened by a reduction in vacuum in manifold M, will remain open until a further reduction has drawn down the head of bellows-folded diaphragm 13, such action permitting stem 11^a to lower and close switch 11; thereby energizing solenoid 10 to raise armature 10^p to position the mechanism for four-cylinder firing. This manner of resetting switch 11 avoids the "flutter" that would occur if switch 11 always opened or closed with the same degree of vacuum controlling bellows-folded diaphragm 13.

It will be understood that various modifications may be made in the foregoing embodiments of my invention without departing from the spirit and scope of the same as set forth in the appended claims.

I claim:

1. The combination, in an engine of the explosion type, of a plurality of cylinders, pistons therein, valves controlling the inlet of fuel-air charges to and the exhaust from said cylinders, and means for rendering certain inlet valves inactive whereby certain cylinders may be out of firing operation, including an hydraulic cylinder, a piston therein, solenoid controlled means for

directing fluid to opposite sides of said piston; all of said cylinders firing in normal sequence when said last-named piston is in one position and certain cylinders being rendered inactive when said piston is in the opposite position, and means coordinated with certain phases of engine operation for energizing and deenergizing said solenoid.

2. In a control for explosion type engines, means responsive to suction of some of the cylinders, a switch actuated by said means, a solenoid armature affected by current flow controlled by said switch, and means responsive to movement of said armature and the parts affected thereby for resetting the degree of vacuum at which said switch operates.

3. The combination, in means for controlling the operation of multi-cylinder internal combustion engines, of means for controlling the admission of fuel charges into and exhaust from the several cylinders, an automatic control for interrupting the flow of said fuel charges to some of said cylinders coordinated with a change in the load on said engine, and means for resetting said control to admit fuel charges to all of said cylinders at a greater load.

4. The combination, in means for controlling the operation of multi-cylinder internal combustion engines, of means for controlling the admission of fuel charges into and exhaust from said cylinders, an automatic control for interrupting the flow of fuel charges to some of said cylinders in response to a reduced load on said engine, and means for resetting said control to admit fuel charges to all of said cylinders at a greater load.

5. The combination, in means for controlling the operation of multi-cylinder internal combustion engines, of carburetting means, an intake manifold delivering fuel charges therefrom to at least one of said cylinders, means for controlling the admission of fuel into and exhaust from the cylinders, an automatic control for interrupting the flow of fuel charges to at least one other cylinder in response to increased vacuum in said intake manifold, and means for resetting said control to admit fuel charges to all of said cylinders at a lower vacuum.

6. The combination, in means for controlling the operation of multi-cylinder internal combustion engines, of means for delivering fuel charges to at least one of said cylinders, means for controlling the admission of fuel into and exhaust from the cylinders, an automatic control for interrupting the flow of fuel to at least one other

cylinder in response to reduced load and increased speed, and means for resetting said control to admit fuel to all of said cylinders at a greater load.

7. The combination, in means for controlling the operation of multi-cylinder engines of the explosion type, of a plurality of cylinders, a pair of valves for each cylinder; one of said valves controlling the inlet of fuel charges and the other valve controlling the exhaust, means for actuating said valves including cam-actuated push rod elements, means for rendering certain of said push rod elements inactive whereby two or more cylinders may be cut out of operation during certain conditions of engine operation including rotatable portions associated with the push rod elements, teeth on said rotatable portions, and fluid-actuated rack rods in engagement with said toothed push rod portions for adjusting them into and out of operative position.

8. The combination, in means for controlling the operation of multi-cylinder engines of the explosion type, of a plurality of cylinders, a pair of valves for each cylinder; one of said valves controlling the inlet of fuel charges and the other valve controlling the exhaust, means for actuating said valves including cam-actuated push rod elements, means for rendering certain of said push rod elements inactive whereby two or more cylinders may be cut out of operation during certain conditions of engine operation including rotatable toothed portions associated with the push rod elements, fluid-actuated rack rods operatively engaged with said toothed members to render them operative and inoperative, and electrically controlled means for rendering the fluid-actuated means operative.

9. The combination, in an engine of the explosion type, of a plurality of cylinders, pistons therein, valves controlling the inlet of fuel-air charges to said cylinders and exhaust therefrom, means for rendering certain inlet valves inoperative whereby certain cylinders may be cut out of firing operation including a hydraulic cylinder, a piston therein, means for directing motive fluid to opposite sides of said piston; all of said cylinders firing in normal sequence when said last-named piston is in one position and certain cylinders being rendered inactive when said piston is in the opposite position, and means coordinated with certain phases of engine operation for controlling the delivery of motive fluid to the hydraulic cylinder.

KARL W. ROHLIN.