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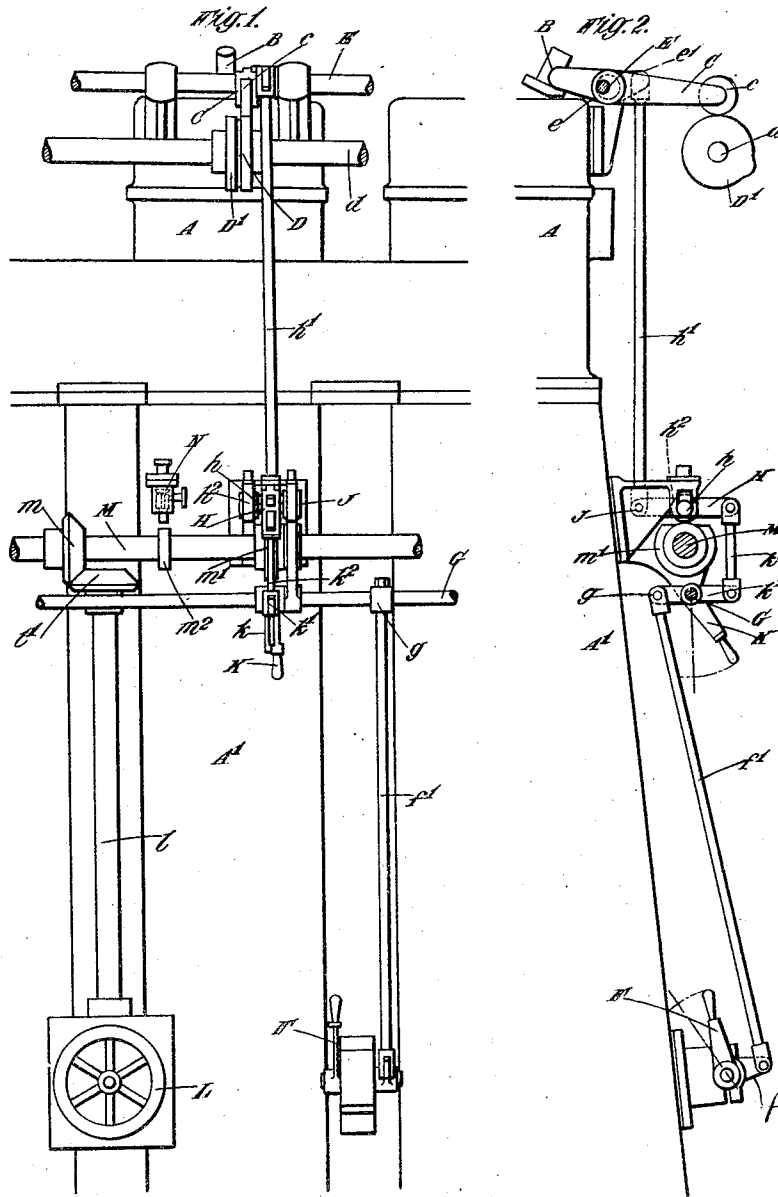
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J. McKECHNIE

MECHANISM FOR INJECTING FUEL IN INTERNAL COMBUSTION ENGINES

Filed Dec. 31, 1919

4 Sheets-Sheet 1



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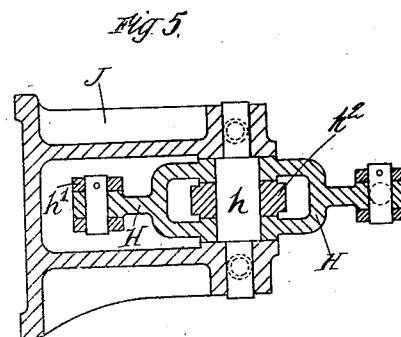
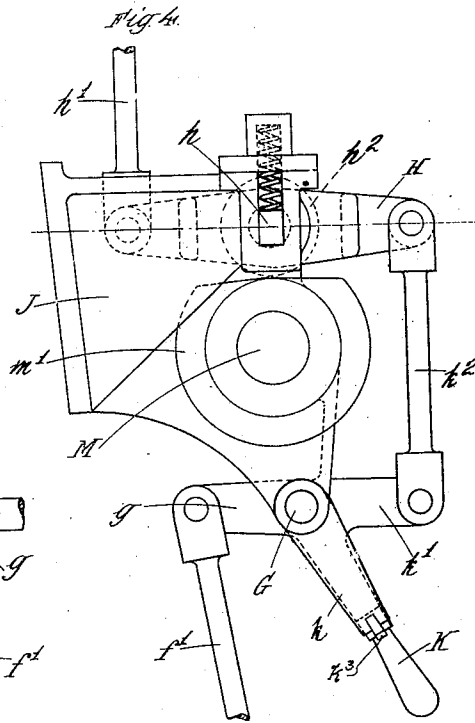
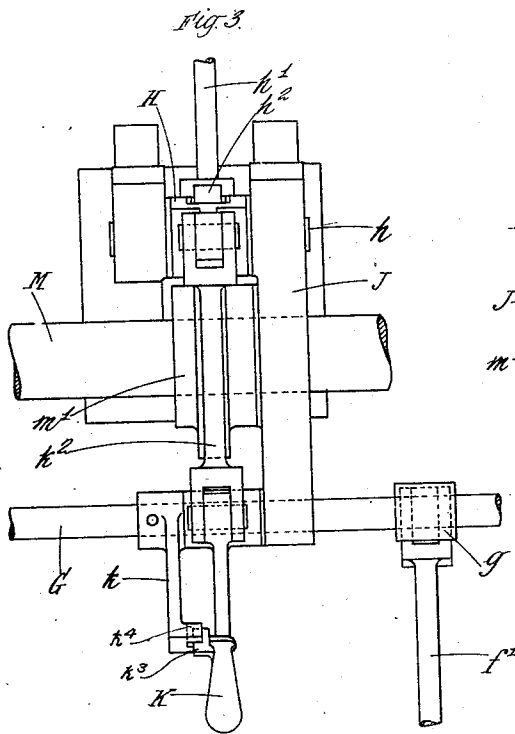
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4 Sheets-Sheet 2



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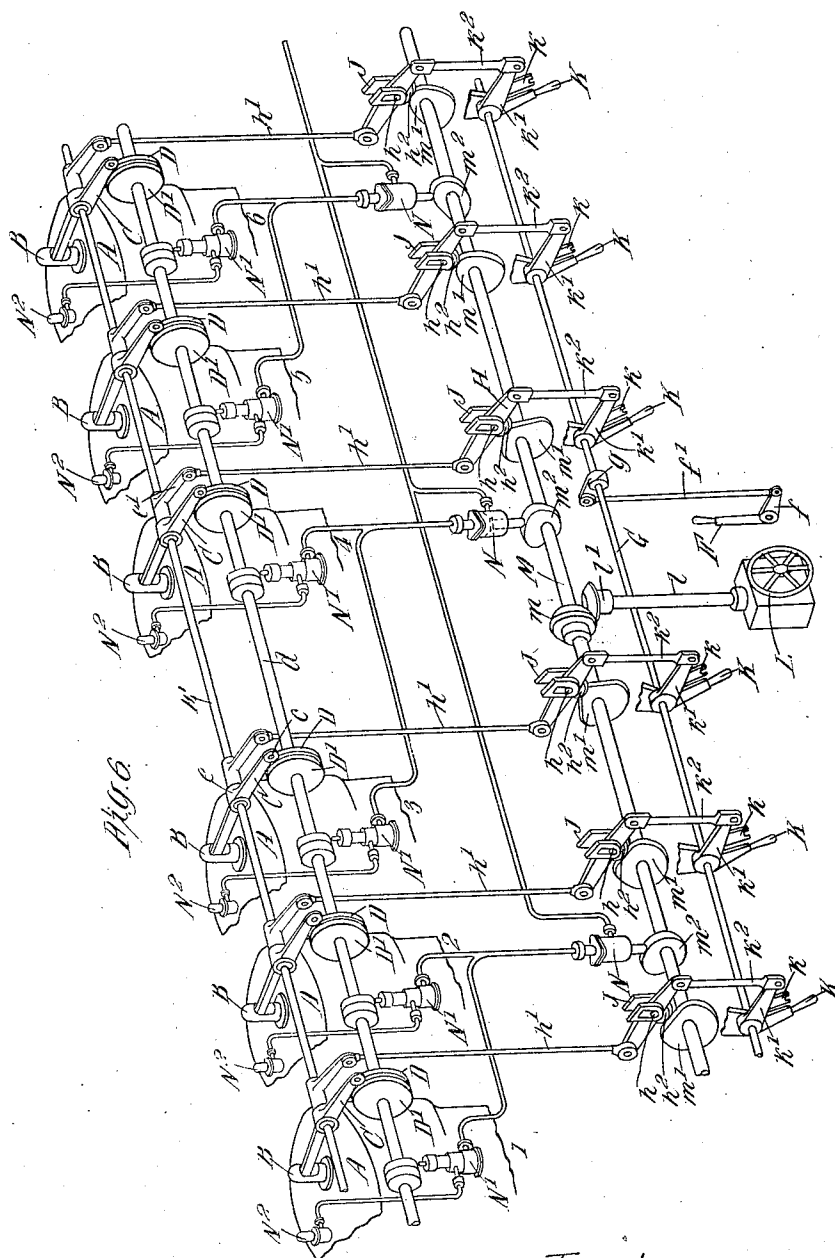
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4 Sheets-Sheet 3



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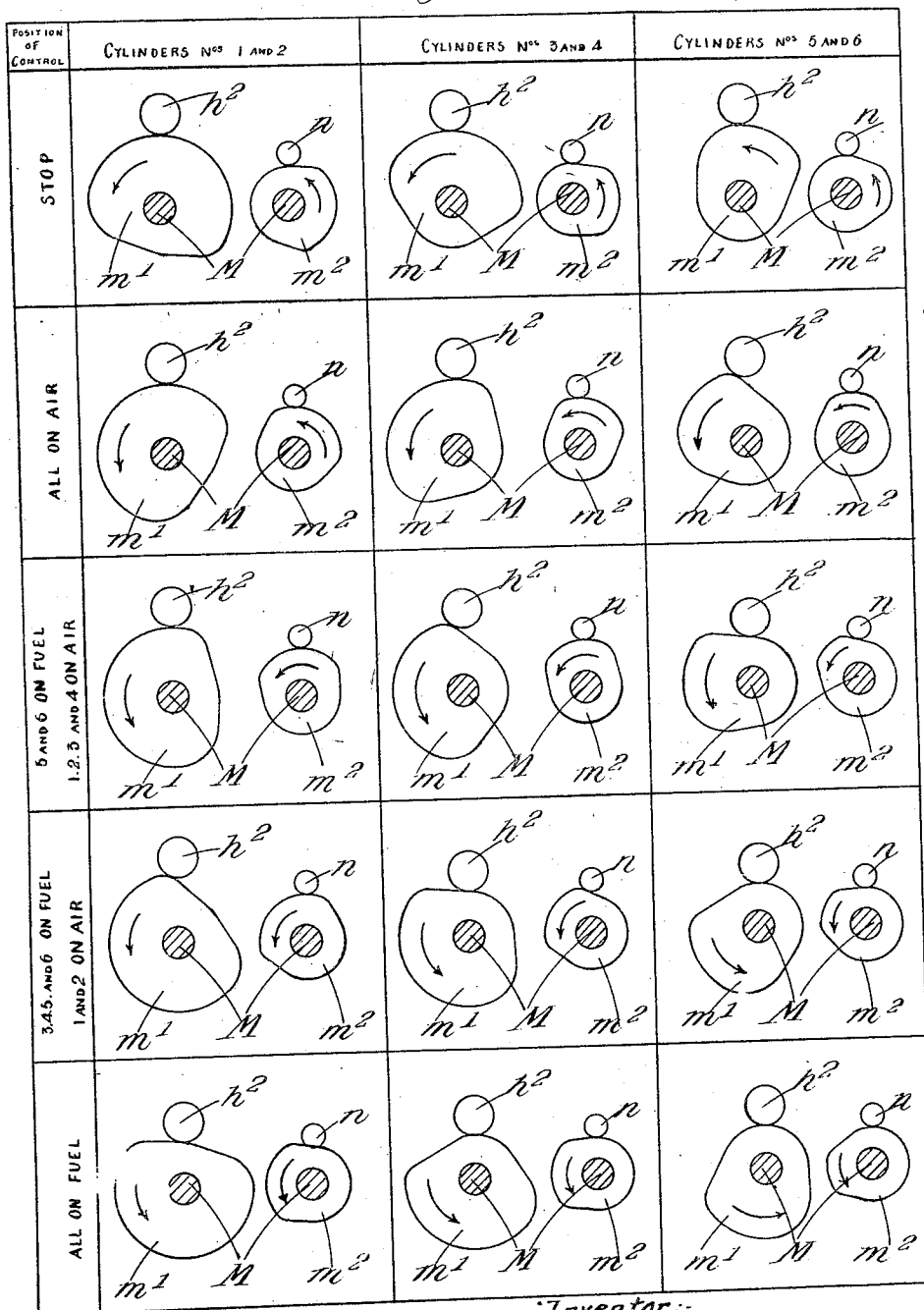
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Fig. 7.



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UNITED STATES PATENT OFFICE.

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MECHANISM FOR INJECTING FUEL IN INTERNAL-COMBUSTION ENGINES.

Application filed December 31, 1919, Serial No. 348,702, and in Great Britain January 16, 1919.

This invention relates to mechanism for injecting fuel in multi-cylinder internal combustion engines of the type in which liquid fuel is injected into the working cylinder by means of an injection valve, which also regulates the supply and consequently the power of the engine.

According to this invention the fuel injection valves are controlled by associated gears comprising a starting gear for placing the injection valve levers of the working cylinders into operative condition in the required order and number and a gear for giving common control of all the said levers.

The common control of the opening of the injection valves (which control can vary the power from "full" to "stop") may be effected by means of a hand lever or wheel operating through a suitable arrangement of rods and levers upon eccentric fulcrums of the injection valve levers, which eccentric fulcrums enable the levers to be raised from the operating or fuel cams to any required extent up to entire clearance. The hand lever operates upon a shaft which is common to all the cylinder and the mechanism interposed between this common shaft and each of the injection valve levers may be so constructed that the lifting of any fulcrum can be effected independently by a handle to allow the independent cut out for each valve to be effected by hand. The gear for putting the injection valves into action in the desired order and number on starting the engine may comprise a manœuvring wheel operating through bevel gearing upon a shaft which is common to all the cylinders and which carries a number of suitably formed cams, one appertaining to each cylinder and operating the eccentric fulcrum of the corresponding injection valve levers so that, for starting, fuel can be admitted to the cylinders in the order and number required, the starting air admitted at the initial stage being, as in the usual practice, cut off when fuel is admitted.

In order that the said invention may be clearly understood and readily carried into effect the same will now be described more fully with reference to the accompanying drawings, in which:—

Figures 1 and 2 are elevations at right angles to each other of gear embodying this in-

vention, the gear belonging to one cylinder only being shown.

Figures 3, 4 and 5 are respectively front and side elevations and a sectional plan of part of the gear showing it more fully than in Figures 1 and 2.

Figure 6 indicates in perspective a general view of a six cylinder engine provided with the improved gear,

Figure 7 shows the relative positions of the control cams of the fuel and starting air mechanism for different stages in the starting of the engines, the cylinders to which the cams belong and the stages of starting being indicated in the diagram.

A is the cylinder casting and A' the engine casing. B is the fuel injection valve. C is the injection valve lever provided with the cam roller *c* which when the lever is in operative position meets one or other of the cams D, D' mounted on the sliding cam shaft *d* which is adapted to bring either the forward or the reverse cam D or D' under the roller *c*. The lever is mounted on an eccentric fulcrum *e* on the fulcrum shaft E, this shaft, as well as the cam shaft *d*, extending across all the cylinders as shown in the general view Figure 6.

The simultaneous regulation of all the fuel valves of the engine is effected by means of the hand lever F, the arm *f* of which is connected through the rod *f'* to the arm *g* on the shaft G, to which shaft is fixed a lever *h* at each cylinder the lever *h* being normally clutched to the handle K which is loose on the shaft G and is provided with an arm *h'* connected through the rod *h''* to the end of the lever H fulcrumed at *h* in a vertically sliding bearing in the bracket J on the engine casing A' the other end of the lever being provided with a connecting rod *h'* connected to an arm *e'* on the eccentric fulcrum *e* of the lever C. The shaft G extends across all the cylinders so that operation of the lever F effects simultaneous regulation of the fuel valves of all the cylinders and allows them to be cut out simultaneously. Independent cutting out on any individual injection valve is provided for by the handle K which is adapted to be disengaged from the lever arm *h* for operation of the individual valve, so that on turning the handle K (after its disen-

gagement) in the desired direction the levers h' , H and e' belonging to the cylinder are operated and the eccentric fulcrum e turns so as to lift the valve lever C from the cam D or D', thus rendering the cylinder inoperative. The handle K is connected to the arm h as shown in Figure 3 by the engagement of the tongue h^3 on the handle in the fork h^4 on the end of the lever h . The handle has sufficient freedom in its mounting to allow it to be moved into and out of engagement with the lever. Each cylinder is provided with this hand cutting out mechanism which may be operated independently of the common control through the lever F.

Associated with the regulating and cutting out gear is the special gear employed for starting, by means of which when the injection valves are permitted to be in action by the levers F and K the valves of the cylinders can be brought into operation in the required order. This gear comprises, in the construction illustrated, a manoeuvring wheel L operating through bevel gearing the shaft l which gears through the bevel wheel l' with the bevel wheel m on the shaft M, which shaft extends across the cylinders of the engine and is provided at each of the cylinders with a cam m' adapted to operate upon the fulcrum h of the lever H through a cam roller h^2 . The fulcrum h is slidable in the bracket J and is spring pressed so as to keep its roller on the cam m' , the position of each roller when the manoeuvring gear is in "stop" position being at the top of its range of movement. With the gear in this position to cut out the injection valves of the cylinders the valve levers C are all raised off the cams D, D'.

The manoeuvring shaft M also carries at each cylinder an air valve cam m^2 adapted to operate an air starting valve N, when the manoeuvring wheel is turned to starting position the valves N communicate with cam operated air valves N' and cylinder non-return valves N², the valves N' and N² operating as in ordinary practice. The cams m' and m^2 for the various cylinders are so formed that the cylinders are cut off from the starting air and placed on fuel in a predetermined order as the manoeuvring shaft is turned.

As applied to, say, an eight cylinder engine when the manoeuvring wheel is turned from "stop" to the initial starting position the air valves N of the cylinders are all opened and the engine starts running. At the second movement of the wheel the shaft M is rotated so as to bring the operative portion of the cams m' off the rollers h^2 of, say, two of the cylinders with the result that the levers H of these cylinders are lowered around a fulcrum formed by the end of the connecting rods h^2 , lowering the

connecting rods h' and turning the corresponding eccentric fulcrums e so as to lower the cam levers C onto the cams D or D'. The corresponding air valves N are at the same time cut out. At the next position of the manoeuvring wheel two more cylinders may be cut off from air and placed on fuel and so on until all the cylinders are in normal running condition. The starting and stopping operations involve a complete revolution of the shaft M, the wheel L being also given a complete turn with the one to one gear m, l' shown, and for succeeding starting and stopping operations the wheel L is given a complete revolution in the same direction. When the engine has properly started, the adjustment of the fuel injection is effected by the hand lever F and shaft G. The operative parts of the cams m' are so co-related that the injection valves of the several cylinders are brought into operative position in any desired sequence and will generally be arranged so that after all the injection valves have been brought into action further turning of the wheel L will lift the levers H simultaneously thus stopping the engine. The air valves are preferably operated through the same manoeuvring wheel and shaft, as shown, but may be otherwise operated.

The diagram Figure 7 illustrates the various stages in starting the six-cylinder engine of Figure 6, the positions of the cams m' and m^2 being shown in progressive positions for all the cylinders with relation to their rollers h^2 and n , the latter belonging to the valve N.

The three diagrams at the top of the figure show the normal stopping position in which both cams m' and m^2 for all the cylinders are in similar positions with respect to their rollers. It will be noted that for cylinders 1 and 2, 3 and 4, and 5 and 6, respectively, the cams are of different lengths as the starting operations for the three pairs of cylinders are not simultaneous. The second group of three diagrams of Figure 7 reading vertically, shows the first stage, in which all the cylinders are placed on air by the movement of the cams m^2 , all the cams acting simultaneously at this stage. The third group of diagrams show two cylinders on fuel, while the remainder remain on air. The cylinders on fuel are numbers 5 and 6 corresponding to the right hand diagrams of the figure, and it will be seen that while the cams m' and m^2 of the cylinders 1 to 4 are still holding their rollers up the cams of cylinders 5 and 6 have allowed their rollers to fall, cutting off the air and simultaneously placing the cylinders on fuel. The fourth group of three diagrams shows cylinders 1 and 2 only on air, cylinders 3 and 4 now having their cams also turned to the position corresponding to the cutting

off of air and placing on fuel. The bottom set of three diagrams shows the normal running of the engine, in which the cams m' and m'' of all the cylinders are in the position of air cut off and fuel on.

The manœuvring wheel L has been turned through a half circle for these operations and the engine is now running in the ordinary manner. Stopping is effected by cutting the cylinders off from fuel successively in the reverse order to the starting operations when the manœuvring wheel L is turned to the "stop" position, the cams m' coming successively into operation again so as to move their corresponding rollers h'' into the position in which the cylinders are cut off.

What I claim and desire to secure by Letters Patent of the United States is:—

1. Fuel injection valve and lever gear for multi-cylinder internal combustion engines, comprising means for controlling the injection valve levers of all the cylinders for ordinary running of the engine, means for placing the said valve lever into inoperative position, and starting gear for the engine, which gear comprises a set of associated operating members each belonging to an individual cylinder and a common controlling mechanism for all the said members, the operating members of the group of cylinders being so displaced relatively to each other and to the gear as to come into operation in a predetermined succession for the successive cylinders and, on movement of the said single starting gear to successive positions, to bring the previously inoperative injection valve levers of the various cylinders into operative condition successively in the required order for starting the engine on fuel.

2. Fuel injection valve and level gear for multi-cylinder internal combustion engines, comprising an injection valve lever for each cylinder mounted so as to be moved into and out of operative position and to be adjusted while in operative position, and two associated gears common to all the engine cylinders, one of which gears is adapted to control the valve action when the valve levers are in operative position, while the other comprises a member for each cylinder adapted to displace a transmitting part of the aforesaid control gear into or out of valve-operating position progressively for different cylinders and a member common to all the cylinders which effects the operation of the said displacing members, for the purpose specified.

3. Fuel injection valve and lever gear for multicylinder internal combustion engines, comprising an injection valve lever for each cylinder mounted so as to be moved into and out of operative position, and to be adjusted while in operative position, and two associated gears of which one is adapted to

give common control of the injection valves when the valve levers are in operative position and the other is a single starting gear having a shaft common to all the cylinders and provided at each cylinder with a starting cam adapted on operation of the said gear to place the injection valve levers of the working cylinders into operative condition in the required order and number for starting the engine on fuel.

4. Fuel injection valve gear for multicylinder internal combustion engines, comprising an adjustable valve lever and a valve operating cam for each cylinder, means whereby the said lever may be moved into or out of contact with the cam, a controlling lever, a connection from said means to the controlling lever, a controlling shaft common to all the cylinders and having operative connections to the said levers, a second shaft common to all the cylinders, a starting cam for each cylinder adapted to act upon the said controlling lever, all the starting cams being carried upon the said second shaft, and a hand operated device adapted to actuate the said second shaft for starting the engine on fuel.

5. Fuel injection valve gear for multicylinder internal combustion engines, comprising an eccentrically fulcrumed valve lever and a valve operating cam for each cylinder, a lever and link connection from the said eccentric fulcrum, a controlling lever system to which the said link is attached, a controlling shaft common to all the cylinders and operating the said lever system, a starting shaft also common to all the cylinders, a cam for each cylinder adapted to actuate a member of the said lever system for placing the fuel valve lever into operative position for starting the engine on fuel after the usual starting on compressed air and a hand operated device adapted to actuate the starting shaft for starting the engine on fuel.

6. Fuel injection valve gear for multicylinder internal combustion engines, comprising an adjustable valve lever and a valve operating cam for each cylinder, means whereby the said lever may be moved into or out of contact with the cam, a controlling lever, a connection from said means to the controlling lever, the fulcrum of which is movable, a controlling shaft common to all the cylinders, a lever arm on the said shaft for each cylinder and a link connecting the said lever arm to the controlling lever, a starting shaft common to all the cylinders, a starting cam for each cylinder adapted to act upon the movable fulcrum of the said controlling lever, all the said cams being mounted upon the starting shaft, and a hand operated device adapted to actuate the said shaft, for starting the engine on fuel.

7. In a multi-cylinder internal combustion

tion engine, means for progressively bringing into operation the fuel valves, means for simultaneously regulating the fuel injection valves from fully open to fully closed position, thereby to vary the quantity of fuel injected and to stop the operation of said valves, means for independently bringing into and out of operation each of said valves, means movable into and out of operative position for operating the compressed air starting valves, and a common means for operating said first named and said last named means in alternation. 10

In testimony whereof, I affix my signature.

JAMES McKECHNIE.