April 22, 1958 R. SEIFERT ET AL 2,831,433

FUEL INJECTION CONTROL SYSTEM FOR INTERNAL COMBUSTION ENGINES

Filed May 7, 1953 2 Sheets-Sheet 1

Fig.1

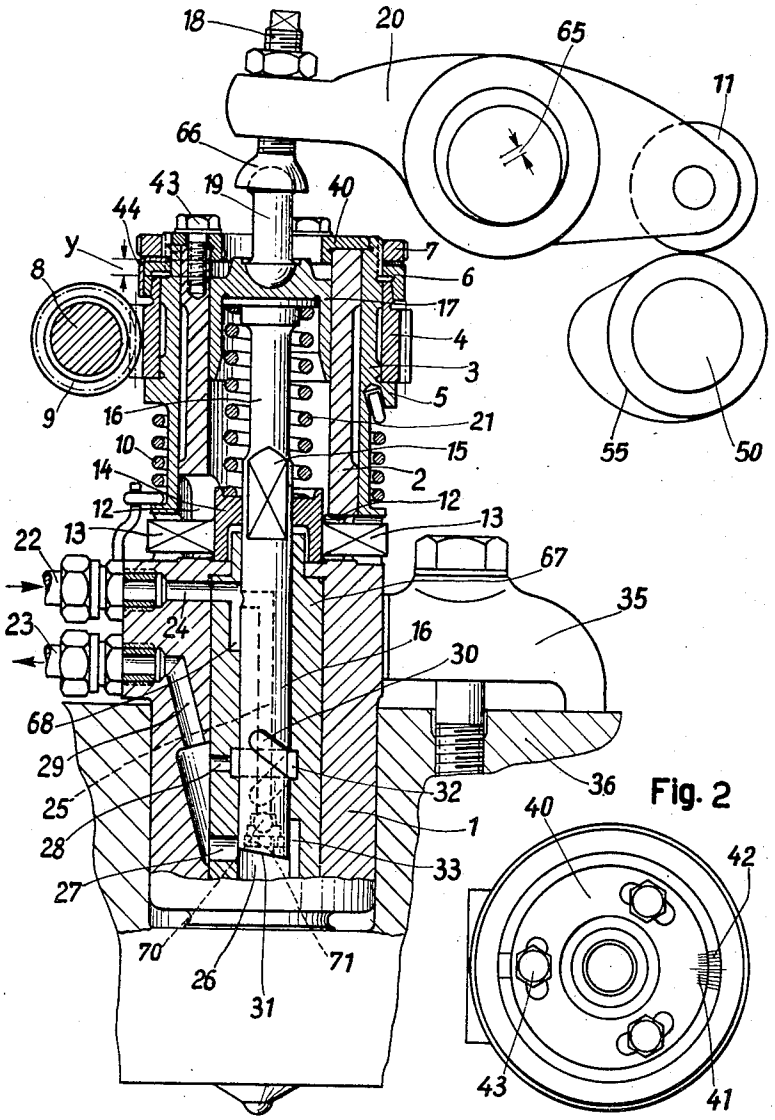


Fig. 2

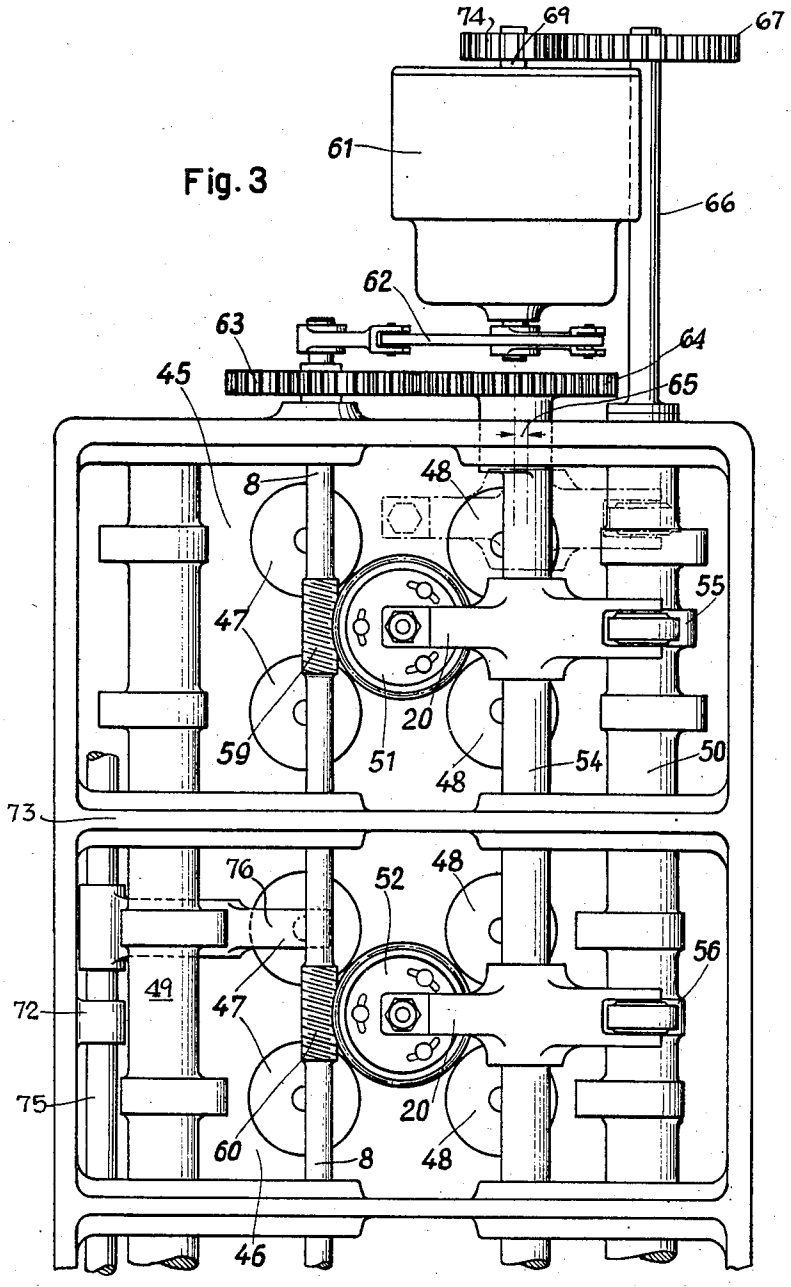
INVENTORS.
RICHARD SEIFERT.
WALTER BARTH.
by K. A. Mayr.
ATTORNEY.

April 22, 1958 R. SEIFERT ET AL 2,831,433

FUEL INJECTION CONTROL SYSTEM FOR INTERNAL COMBUSTION ENGINES

Filed May 7, 1953 2 Sheets-Sheet 2

Fig. 3



INVENTORS
RICHARD SEIFERT.
WALTER BARTH.
by K. B. Mayer
ATTORNEY.

United States Patent Office

2,831,433

Patented Apr. 22, 1958

2,831,433

FUEL INJECTION CONTROL SYSTEM FOR INTERNAL COMBUSTION ENGINES

Richard Seifert and Walter Barth, Friedrichshafen, Germany, assignors, by mesne assignments, to L'Orange G. m. b. H., Glatten, Wurttemberg, Germany, a German firm

Application May 7, 1953, Serial No. 353,579

Claims priority, application Germany September 16, 1950

2 Claims. (Cl. 103—41)

The invention relates to a system for adjusting and controlling fuel injection devices of internal combustion engines having a plurality of cylinders arranged in a row, particularly for motor vehicles.

The present application is a continuation-in-part of our application Ser. No. 246,782, filed September 15, 1951, which matured into Patent No. 2,717,805 on September 13, 1955.

The fuel injection devices may be of the conventional type in which the injection pump forms a unit with the injection nozzle and which are actuated by means of rockers. The reason why these devices have not been more widely used in spite of their advantages is primarily the fact that their mounting and interchanging is difficult particularly because of the adjustment of the individual devices for simultaneous starting of the injection and equal output which is necessary because of manufacturing and mounting tolerances. These adjustments require much time and skill when mounting the devices and can be made only by trained experts. The injection device forms a part of the internal combustion engine which part does not only cause difficulties during assembly but also frequently causes uneconomic operation of the engine and other disturbances. These disadvantages are particularly undesired in internal combustion engines for motor vehicles, because the devices can be replaced only in specially equipped workshops and by skilled labor.

It is an object of the invention to provide a fuel injection system the fuel injection devices of which may be made as spare parts and held in stock and which can be carried along similarly as is done with spark plugs. The new injection devices can be quickly mounted and adjusted by the average operator. Each device can be accurately adjusted by simple means which can be easily manipulated and each device responds correctly to the pulses of a regulator, assuring uniform supply of fuel to the cylinders and uninterrupted economic operation of the engine.

To produce the desired result, the system according to the invention comprises (*a*) a fuel injection device which is mounted on the engine as a unit having a fixed basic adjustment of the fuel control element which is connected with the regulator in its basic adjustment; (*b*) a single revolving regulating shaft for uniform control of the output of a plurality of injection devices, for example for one row of cylinders. This assures absolutely simultaneous and uniform transmission of the regulating movements to the individual injection devices; (*c*) an adjusting screw on the rocker-arm lever for actuating the pump piston of the fuel injection device for adjusting the inner dead-center position of the pump piston of each device so that all devices start fuel injection at the same moment.

With the system according to the invention, the beginning of the fuel injection can be regulated according to an operating value, for example according to the speed or to the output of the engine, as in conventional injection pumps. According to the invention, the rocker-arms

for actuating the pump pistons are eccentrically supported and the eccentrics can be revolved.

In the system according to the invention, the actuating shaft for the inlet valves or the actuating shaft for the exhaust valves is used for actuating the pumps of the injection device. An additional cam shaft is not needed so that the construction is considerably simplified.

In order to eliminate clearance between the element transmitting the control motions to the pump piston, for example a worm gear wheel sleeve, and a worm on the control shaft and in order to automatically return the regulating element to a position in which the fuel supply is interrupted, the system according to the invention comprises a pull-back spring interposed between the worm wheel sleeve and the pump casing. Advantages in the manufacture of the device and operating accuracy are obtained according to the invention by cutting the worm for actuating the control element into the control shaft.

The novel features which we consider characteristic of our invention are set forth with particularity in the appended claims. The invention itself, however, and additional objects and advantages thereof will best be understood from the following description of an embodiment thereof when read in connection with the accompanying drawing in which—

Fig. 1 shows a longitudinal section through the fuel injection device with the regulating shaft and the actuating elements;

Fig. 2 is a top view of the injection device;

Fig. 3 is a diagrammatic plan view of the system according to the invention.

Like parts are designated by like numerals in all figures of the drawing.

Referring more particularly to Figs. 1 and 2 of the drawing, numeral 1 designates a one-piece casing whose upper part 2 guides a regulating sleeve 3 supporting a worm gear wheel sleeve 4. The latter rests on a collar 5 of sleeve 3 and can be fixed against rotation on the sleeve 3 by means of a conical ring 6 which can be pressed against sleeve 4 by means of a nut 7. Numeral 8 designates a rotatable regulating shaft on which a worm 9 is fixed. A pull-back spring 10 having one end connected with the sleeve 3 and the other end connected with the casing 1 prevents clearance between the teeth on sleeve 4 and the worm 9 and assures permanent engagement of elements 4 and 9 for transmitting the regulating movement. Spring 10 tends to rotate the sleeve 3 in a direction in which fuel injection is reduced so that the fuel supply is interrupted when the drive for the regulating mechanism is out of order.

The upper part 2 of casing 1 is provided with openings 12 through which extend protuberances 13 of a sleeve 14. The latter is pushed onto a portion 15 of square cross-sectional configuration of a pump plunger 16 and serves for effecting rotation of the pump plunger, affording, at the same time, axial movement of the plunger. The upper end of the plunger 16 abuts against a cap 17 guided in the casing portion 2 and is pressed by a rocker-arm 20 through a pressure transmitting member 19 against a compression spring 21. The outer end of the rocker-arm 20 carries an adjusting screw 18 for changing the distance between the rocker-arm and the member 19. The lower end of screw 18 has a cap 66 covering the top of member 19.

The fuel enters a channel 24 in the lower part of casing 1 through a supply conduit 22 for conducting fuel into a groove 68 in a sleeve 67 provided in the casing and can be returned through a bore 29 to a return conduit 23. Sleeve 67 is provided with bores 27 and 28 for discharging fuel into the bore 29.

A control groove 30 in the pump plunger 16 and the inclined face 31 at the end of plunger 16 serve for con-

trolling the amount of fuel and the periods during which the fuel is injected. The groove **30** cooperates with an annular recess **32** and a small groove **33** in sleeve **67**; the end face **31** cooperates with the bore **27**.

A valve **70** is provided at the end of an axial bore **25** in the lower part of the plunger **16**. The space in the plunger below valve **70** is connected with the outside, i. e. with the space **26** by means of discharge channels **71**.

The fuel injection device is held in the cylinder head **36** by means of a bracket **35**.

A calibrating disc **40** is provided with a scale **41** (Fig. 2) and can be fixed in the desired position by means of screws **43** extending into the upper part **2** of the casing **1**. The top of sleeve **3** is provided with a scale **42**. A locking ring **44** is inserted between the annular nut **7** and the compression ring **6**.

Fig. 3 illustrates an arrangement of the injection devices and a mechanism for regulating the devices. Numerals **45** and **46** designate two cylinder heads which are arranged in a row. The inlet valves are designated by numerals **47** and the exhaust valves by numeral **48**. Numeral **49** designates the control shaft for the rocker-arms **76** actuating the inlet valves. The rocker-arms are mounted on a shaft **75** revolvable in bearings **72** and in intermediate walls **73**. Numeral **50** designates the control shaft for the exhaust valves. Shaft **50** is used for actuating the pumps of the injection devices **51** and **52**. The rocker-arms **20** swing on a shaft **54** and are actuated by cams **55** and **56**.

The revolvable regulating shaft **8** is provided with worms **59**, **60** for transmitting the regulating motions to the injection devices. The shaft **8** is actuated by a speed regulator **61** through a linkage **62**. The shaft **69** of the regulator is driven by the exhaust control shaft **50** with which it is connected by a shaft **66** and spur gear wheels **67** and **74**.

In the illustrated injection device the injected amount of fuel is determined in the conventional manner by the duration of the closure of the pressure chamber **26**, i. e. by the time during which the discharge ports **27** and **28** do not communicate with the pressure chamber. The injection begins when the edge of the face **31** of the pump plunger moves past the lower edge of the bore **27**. The injection ends when the pressure chamber **26** communicates through the groove **33**, the control groove **30**, the annular groove **32**, and the bores **28** and **29** with the return conduit **23**. The positions of the control edge of the plunger face **31** and of the control groove **30** relatively to the return ports is decisive for the beginning and ending of the injection and must be the same in all injection devices after they have been mounted on the engine. Valve **70** closes after a determined pressure has been built up in space **26** by a down stroke of piston **16**, so that no fuel can escape through the valve **70** during the injection period. Valve **70** opens upon the upstroke of the pump plunger and permits flow of fuel from the bore **25** and through ports **71** into the pressure chamber **26**, which remains filled also upon the upstroke of plunger **16**.

After assembly, the injection devices are calibrated on the test bed for a determined amount of fuel to be injected, the basic adjustment being indicated by the relative positions of the regulating sleeve **3** and the upper part **2** of the pump casing **1**. In the illustrated embodiment of the invention markings **41** and **42** on the annular calibrating or scale element **40** (or casing **1**) and on the sleeve **3**, respectively, are used for determining the position of the revolvable sleeve **3** and consequently of the fuel admission control element (control groove **30** on plunger **16**) relatively to the stationary casing. At first the regulating sleeve **3** provided with the markings **42** is revolved until the control groove **30** stops injection at a predetermined moment, the beginning of the injection being fixed, to determine the amount of fuel injected. When the sleeve **3** is in the desired position, the position of element **40** is adjusted to align the marking **41** thereon with the marking **42** whereupon the cover is fixed on casing part **2** by means of the screws **43**. The regulating sleeve **3** can now be left alone until the device is mounted on the internal combustion engine, the spring **10** turning the sleeve **3** into abutting position which is determined by the width of the opening **12**. If in this position the protuberances or pins **13** abut against the lateral walls of openings **12**, the pump plunger does not deliver any fuel so that no damage is done in case of operating irregularities.

The adjusted devices can be put in storage and shipped without changing the initial adjustment. The devices can be readjusted after mounting on the internal combustion engine by revolving the sleeve **3** until the relative position of its marking **42** and of the marking **41** on the cover **40** corresponds to the basic adjustment. After meshing the teeth of parts **4** and **9**, the freely rotatable sleeve **4** is made fast on sleeve **3** by tightening the nut **7** and thereby the ring **6**. The pull-back spring **10** eliminates play between the worm **9** and the worm wheel sleeve **4**.

The guide cap **17** includes an abutment abutting against a corresponding abutment formed on the calibrating or scale element **40** prior to mounting of the device on the internal combustion engine so that the measure *y* (Fig. 1) is zero. The measure *y*, which is found on the test-bed, determines the basic position of the face **31** for a determined beginning of the injection. The measure *y* is restored by adjustment of screw **18** and is exactly measured after placement of the rocker-arm **20** on the member **19** and after abutment of the cam follower roller **11** against the base circle of the cam **55** has been effected. Since the measure *y* has been previously determined, all devices can be adjusted in the aforedescribed manner after they have been installed for simultaneously initiating fuel injection.

Beginning of the injection can be changed by changing the distance *y* and by consequently changing the position of the face **31**. This change can be effected, for example, by providing an eccentric bearing **65** for the rocker-arm **20** on the shaft **54** (Fig. 3). The fulcrum of the rocker-arm is lifted when the eccentric is revolved, causing lifting of the face **31**. This delays beginning of the injection. Revolving the eccentric in the opposite direction advances beginning of the injection.

As shown in Fig. 3, the rocker-arm shaft **54** can be revolved by the regulator **61** through spur gear wheels **63** and **64**, according to an operating value of the internal combustion engine, for example its speed. In this case the beginning of the injection is advanced upon an increase of the speed of the engine and is retarded when the speed of the engine decreases.

Regulation of the end of the injection period, i. e. revolving of the pump plunger **16** and of the control groove **30**, is effected, as has been described, by means of the regulating shaft **8**, the worm **9**, and the regulating sleeve **3**, in accordance with pulses produced by the regulator **61**.

The aforedescribed injection device can be easily mounted and dismounted without impairing accuracy of time and amount of fuel injection.

While we have shown and described a specific embodiment of our invention, it will be apparent to those skilled in the art that various changes, modifications, substitutions, additions and omissions may be made therein without departing from the spirit and scope of our invention as set forth in the appended claims.

What we claim as our invention is:

1. A rocker arm actuated fuel pump for an internal combustion engine in which the start and the amount of fuel injection can be adjusted prior to mounting the pump on the engine, comprising a casing, a pump plunger movable in said casing, the latter having an opening for insertion and removal of the pump plunger, connecting

means for connecting the rocker arm with said plunger, said connecting means extending through said opening and including a member adjustably connected with the rocker arm for adjusting the length of said connecting means and the position of the range in which said plunger reciprocates in said casing, an abutment connected with said plunger, a calibrating element mounted on said casing and forming an abutment adapted to abut against the abutment connected with said plunger for determining a basic axial position of said plunger in said casing, said casing having inlet and outlet ports for the fuel oil, said plunger being rotatable in said casing and having conduits communicating with said ports, the flow area between said conduits and said ports depending on the angular position of said plunger in said casing, said casing having a cylindrical portion coaxial of said plunger, means for rotating and changing the angular position of said plunger in said casing, said last-mentioned means comprising a first sleeve rotatable on the cylindrical portion of said casing, a second sleeve surrounding said first sleeve, and means connected with said sleeves for interconnecting said sleeves in a predetermined relative position, said calibrating element mounted on said casing being rotatable on the longitudinal axis of said sleeves and having a portion provided with a scale adjacent said

first sleeve, the latter having a mark cooperating with said scale for indicating a basic position of said first sleeve.

2. A fuel pump according to claim 1 comprising a spring having one end connected with one of said sleeves, the other end of said spring being connected with said casing, said spring tending to rotate said sleeves in a predetermined direction on said casing.

References Cited in the file of this patent

UNITED STATES PATENTS

1,444,778	Chadwick	Feb. 13, 1923
2,040,847	Hesselman	May 19, 1936
2,106,932	Rosen	Feb. 1, 1938
2,315,907	Starr	Apr. 6, 1943
2,410,947	Johnson	Nov. 12, 1946
2,521,919	Johnson	Sept. 12, 1950
2,540,755	Nystrom	Feb. 6, 1951
2,717,805	Seifert et al.	Sept. 13, 1955

FOREIGN PATENTS

825,628	France	Mar. 9, 1938
870,594	France	Mar. 16, 1942