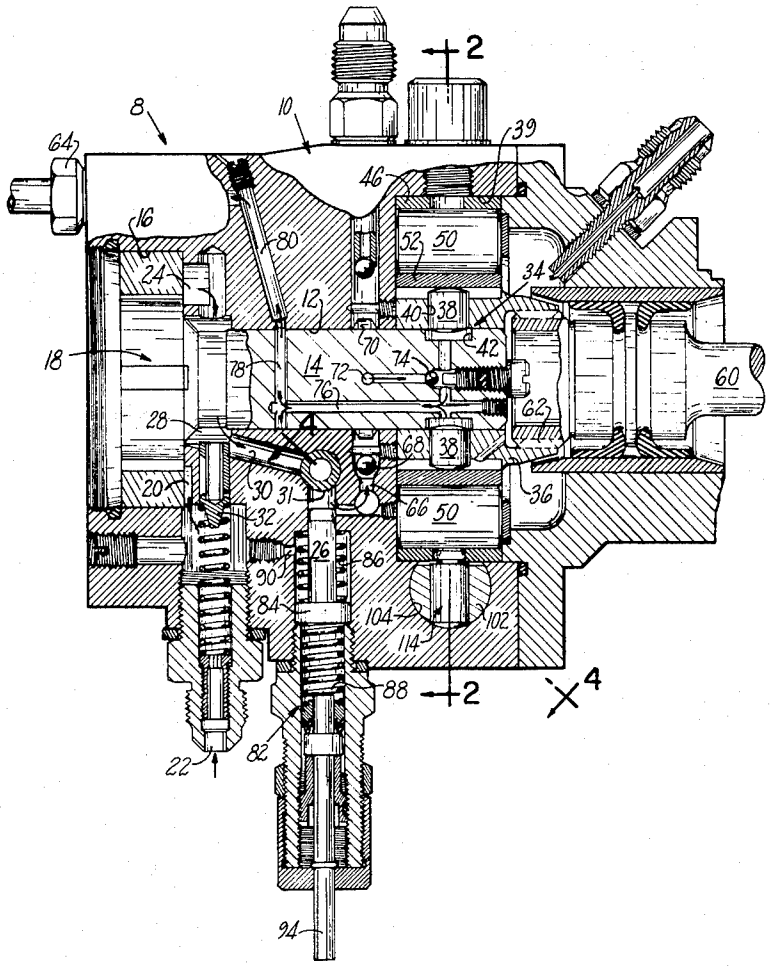
Sept. 7, 1965 V. D. ROOSA 3,204,622

FUEL INJECTION PUMP TIMING DEVICE

Filed July 12, 1963 3 Sheets-Sheet 1

FIG. 1



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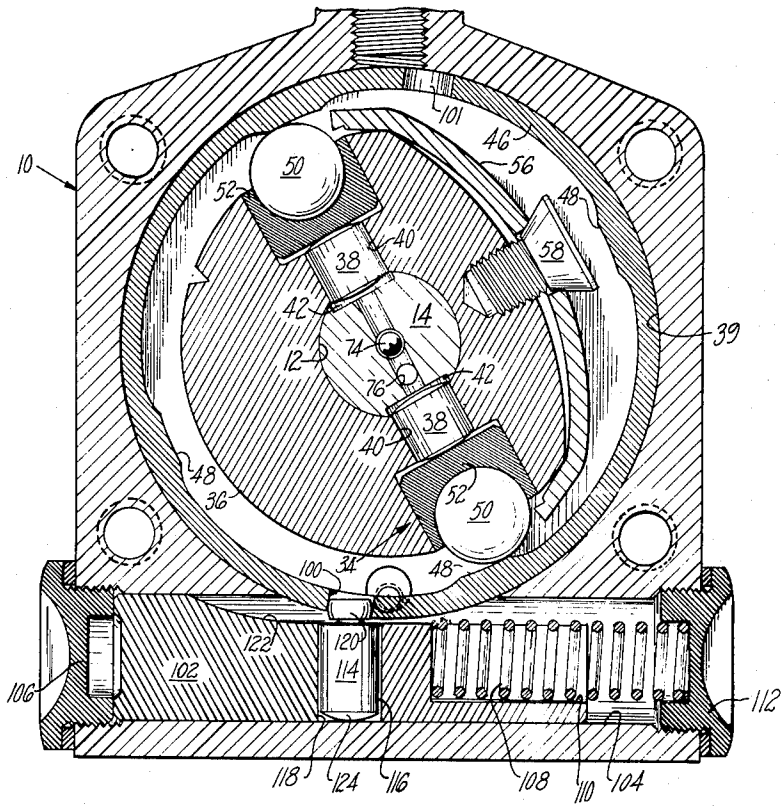
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FUEL INJECTION PUMP TIMING DEVICE

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FIG.2



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FUEL INJECTION PUMP TIMING DEVICE

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FIG. 3

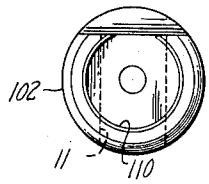
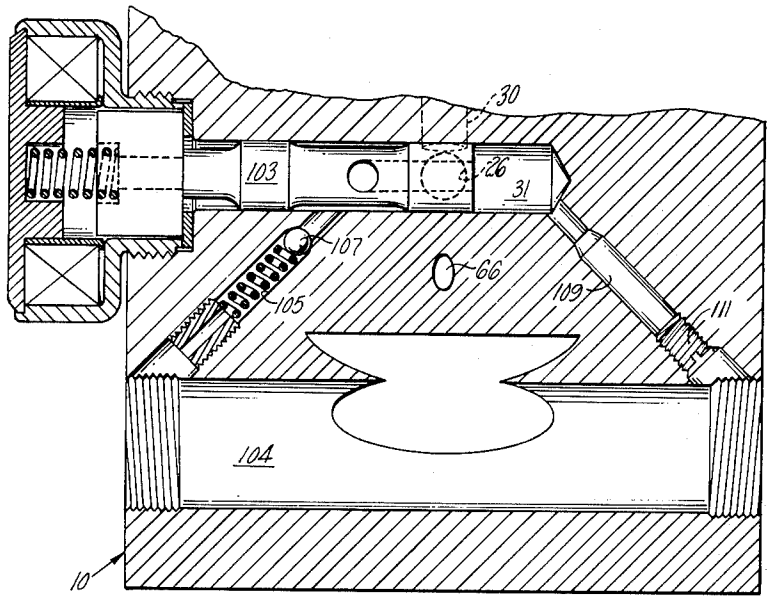


FIG. 4



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3,204,622

FUEL INJECTION PUMP TIMING DEVICE

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Filed July 12, 1963, Ser. No. 294,513
5 Claims. (Cl. 123—139)

The present invention relates in general to pumps of the type utilized in fuel injection systems for delivering measured charges of fuel to the nozzles of an internal combustion engine. More particularly, the present invention relates to pumps of the type disclosed in my United States Patent No. 2,660,992 entitled, Automatic Timing Means for Fuel Pumps, issued Dec. 1, 1953, in which the fuel charges are delivered by pistons radially slideable in a driven rotor and inwardly actuated by an annular cam encircling the pistons.

As disclosed in my aforementioned patent, the annular cam may be angularly shifted to adjust the timing of the fuel delivery to the engine. This has been accomplished in the past by use of an arm threaded to the annular cam which engages a reciprocable plunger axially adjusted in accordance with engine speed to provide the desired timing of fuel delivery to the engine. In order to provide the necessary mechanical strength to withstand the sharp intermittent loads encountered in such an arrangement, it has been necessary to substantially increase the thickness of the annula cam beyond that otherwise required. Not only has this increased the size and weight of the pump, but in some instances, the stress concentration caused by the threads has resulted in the breakage of the threaded arm and the high unit pressures and minute motions between the spherical head of the threaded arm and the mating bore of the reciprocable plunger under the high vibration conditions encountered has resulted in fretting corrosion and excessive wear. Therefore, it is a principal aim of the present invenution to provide an improved fuel injection pump having a cam operator which gives reliable and maintenance free operation over a long service life without excessive wear, corrosion or breakage of the operating parts.

It is another aim of the present invention to provide a new and improved timing device of the type described which remains responsive over a long service life for maintaining optimum timing of the fuel delivery.

It is a further aim of the present invention to provide a new and improved timing device of economical construction and having readily assembled and disassembled parts.

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

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

In the drawings:

FIG. 1 is a longitudinal cross section view, partly broken away, of a pump embodying the present invention;

FIG. 2 is an enlarged transverse cross section view taken substantially along line 2—2 of FIG. 1;

FIG. 3 is an end view of a plunger of FIG. 2; and

FIG. 4 is an enlarged partial cross section view taken substantially along line 4—4 of FIG. 1.

Referring now to the drawings in detail, a pump 8 exemplifying the present invention is of a type conventionally used in fuel injection systems for supplying fuel charges to an associated internal combustion engine. The pump comprises a generally cylindrical casing or housing 10 having an axial opening or bore 12 rotatably supporting a pump rotor or distributor 14. Within an enlarged opening 16, in the left end of the housing as viewed of FIG. 1, there is mounted a vane-type fuel supply or transfer pump 18 driven by the rotor 14 and having an inlet passage 20 in fluid connection with a pump inlet 22. The transfer pump delivers fuel to an outlet passage 24 which is in communication with a reciprocable metering valve 26 through an annular cavity 28 about the rotor 14, a diagonal passage 30 and a transverse passage 31. A spring-biased valve 32 interposed between the annular cavity 28 and the inlet passage 20 regulates the output pressure of the transfer pump and returns excess fuel to the pump inlet. Conventionally, the valve 32 is designed to provide a transfer pump output pressure which increases with rotor speed with the result that the transfer pressure provides a measure of the speed of the associated engine.

A high pressure charge pump, generally denoted by the numeral 34, includes a carrier 36 suitably connected for rotation with the rotor 14. A pair of pistons or plungers 38 are reciprocably mounted in diametrically opposed radial bores 40 in the carrier and complementary enlarged radial openings 42 in the rotor 14. An annular internal cam ring 46, preferably constructed of hardened steel, encircles the rotor 14 in the plane of revolution of the plungers 38 and is mounted for angular adjustment within an annular bore 39 in the pump housing. The cam has a plurality of pairs of diametrically opposed inwardly extending camming lobes 48 which are adapted to actuate the plungers 38 inwardly simultaneously for discharging fuel from the pump. A pair of rollers 50 and roller shoes 52 are slideably mounted in the carrier 36 intermediate the plungers 38 and the annular cam whereby the rollers 50 act as cam followers for translating the cam contour into reciprocable movement of the plungers 38. A C-shaped spring 56 retained within a recess in the carrier 36 by a screw fastener 58 provides an outer resilient stop for the shoes 52.

The rotor 14 is driven by a pump drive shaft 60 through a spline connection 62 between the shaft and the carrier 36 and, in the conventional installation, the shaft 60 is driven by the associated internal combustion engine. Upon rotation of the drive shaft 60 the transfer pump 18 and the charge pump 34 are rotated to supply measured charges of fuel under pressure to a plurality of pump outlets 64 having suitable connection with the fuel injection nozzles of an associated engine. During the outward or intake stroke of the plungers 38, fuel is delivered to the charge pump from the metering valve 26 via a passage 66, an annulus 70 encircling the rotor 14 and a radially and axially extending passage 72 in the rotor having a ball check valve 74. During the inward or discharge stroke of the plungers 38 fuel is delivered under high pressure via an axial passage 76 and a radially extending distributor passage 78 adapted for sequential registration with a plurality of angularly spaced diagonal distributor passages 80 in fluid connection with the pump outlets 64.

For automatically shifting the metering valve 26 and for thereby controlling the amount or measure of the fuel charge, there is shown provided a hydraulic governor, generally denoted by the numeral 82. A piston 84 integrally formed with the metering valve 26 is acted upon by a pair of opposed compression springs 86, 88 to urge the metering valve inwardly against the force thereon created by the regulated transfer pump outlet pressure on the inside face of the metering valve. Fuel leaking past the metering valve to the chamber of the compression spring 86 is returned to the transfer pump inlet via a passage 90. Accordingly, inasmuch as the transfer pump output pressure is a function of engine speed, the metering valve 26 will shift axially to govern the engine at a speed which may be selected by varying the bias of the compression spring 88 with a control rod 94.

In accordance with the present invention, the cam ring

46 is provided with a pair of diametrically opposed radial bores 100, 101, which are preferably reamed and honed to provide a good bearing surface. A generally cylindrical control or timing plunger 102 is mounted for reciprocable movement within a bore 104 in the pump housing 10. As best seen in FIG. 2, the axis of the bore 104 extends transversely of the pump rotor axis and within the plane of the cam ring 46 and intersects the housing bore 39 with the result that a portion of the cam ring 46 extends within the bore 104. A recessed cap 106 threaded to the pump housing, at the left end of the bore 104 as seen in FIG. 2, provides a plunger stop, and a compression spring 108 received within a generally cylindrical recess 110 in the plunger and an opposed recess in a second cap 112 threaded to the housing urges the plunger 102 toward the cap 106.

Referring to FIG. 4, a diagonal passage 105 with a spring biased one-way ball check valve 107 is provided in the pump housing to provide communication between the end of the bore 104 adjacent the stop 106 and the transverse passage 31, with the result that the regulated transfer pump output pressure will urge the plunger 102 to the right, as seen in FIG. 2, against the bias of compression spring 108. Inasmuch as the transfer pump output pressure is a function of engine speed, it will be apparent that the balanced position assumed by the plunger 102 is a function of engine speed. A solenoid operated spring biased shutoff valve 103 shown in the "off" position is provided in the passage 31 for terminating the supply of fuel to the metering valve 26 and is suitably controlled in any well known manner. A second diagonal passage 109 substantially identical to the passage 105 is provided in the housing for use when the plunger 102 is inverted in the bore 104 for reverse operation, as when the pump is driven in the opposite rotational direction. The passage 109 is however blocked in the present arrangement by a plug 111 to prevent fluid flow to the end of the plunger adjacent the cap 112. Since the engagement between the rollers 50 and the leading surfaces of the camming lobes 48 produce sharp intermittent forces tending to cause cam ring 46 to move angularly, the fluid pressure in the bore 104 to the left of plunger 102 will be subjected to sharp intermittent increases at which time it will exceed transfer pump output pressure. During such intervals, check valve 107 closes to trap the fuel in the bore 104 to the left of the plunger 102. Some of such fuel may slowly leak past the plunger 102 and into the bore 39 so that the position of plunger 102 is determined by the balancing of the transfer pump outlet pressure with the bias of spring 108 as the engine speed decreases.

For operatively connecting the plunger 102 and the cam ring 46, there is provided a hardened steel connector or arm 114 having a cylindrical body 116 mounted in a complementary radial bore 118 in the plunger 102. The connector 114 has an integral partially spherical head 120 closely received within the bore 100 of the cam ring 46 which serves as a socket therefor. The plunger 102 is recessed at 122 to receive the portion of the cam ring extending within the bore 104 and the connector 114 is preferably dimensioned to reciprocate with the plunger 102 within the peripheral confines of the bore 104. The end of the connector body 116 opposite the head 120 is machined to provide a convex face 124 for minimizing any frictional retardation of the plunger 102 due to the engagement of the connector with the pump housing. The diameter of the cylindrical body 116 of the connector is of greater diameter than the bore 100 to prevent excessive axial displacement of the connector 114 within the plunger bore 118 but to allow sufficient displacement whereby the partially spherical head 120 may slide radially in the bore 100 during the operation of the pump.

Significant to the cam operator of the present invention is the provision of a connector 114 which is mounted for both axial and angular movement relative to the plunger 102 and the cam ring 46. In the conventional cam operating device of the type shown in my aforementioned patent, wherein the arm is threaded to the cam ring, it has been found that the high frequency vibration of minute amplitude imposed by the timing mechanism of the cam ring as a result of the repeated engagement of the cam lobes with the rollers cause excessive wear and/or fatigue breakdown of the contacting surfaces of the arm and plunger. Such wear has been termed "fretting corrosion." With the arm rigidly fixed to the cam ring, it can be readily appreciated that the vibrational forces on the arm are continuously concentrated on the same relatively small area of contact between the arm and plunger. This accelerates the wear and breakdown of the contacting surfaces and as a result reduces the responsiveness of the cam operator to the transfer fuel pressure. With, however, the freely mounted arm or connector 114 of the present invention, the vibrational forces are not continuously concentrated on a selected small contact area as the arm will slowly revolve due to the vibrational environment in which it operates. Consequently, the rate of wear and/or fretting corrosion is substantially reduced with the result that the operational life span of the cam operator is considerably, if not indefinitely, extended. Additionally, by the provision of a partially spherical head 120 and a cylindrical body 116, the areas of contract of the arm 114 with the cam ring and plunger are sufficiently large to provide for the transmission of the intermittently applied forces on the cam ring derived from the reaction of the inward and outward movement of the rollers 50 on the camming lobes 48. Of further significance are that the plunger 102 and the arm 114 may be readily assembled and disassembled by merely removing either one of the caps 106, 112, that the additional bore 101 on the cam ring 46 can be readily used merely by rotating the cam ring 180 degrees, and that with the present construction the cam ring can be designed with less radial thickness and thereby enable the pump to be more compactly constructed.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above described will become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

I claim:

1. In a timing device for a fuel injection pump of the type described including a camming ring member having an outer cylindrical bearing surface journalled in a complementary shaped bearing surface formed in a cavity in said pump and angularly shiftable for controlling the delivery of fuel to an associated engine, a regulating member mounted for rectilinear movement, and means operatively connecting the regulating and camming ring members, the improvement wherein the connecting means comprises an arm having a cylindrical body portion received within a complementary bore in said regulating member, an opening to said cavity exposing at least a portion of said outer bearing surface of said camming ring member at one end of said bore in said regulating member, a head portion on said arm having diametrically opposed spherical shaped bearing surfaces received within a bore in said camming ring member having surfaces of complementary contour to said opposed spherical shaped bearing surfaces, and means on said arm engageable with the outer cylindrical bearing surface of said camming ring for restricting the axial movement of said arm in one direction with respect to the bore in said regulating member.

2. In a timing device for a fuel injection pump of the type described having a pump housing with a first cavity mounting a camming ring having an outer cylindrical bearing surface journalled in a compementary shaped bearing surface formed in said first cavity in said pump and angularly shiftable therein for controlling the delivery of fuel to an associated engine, a second cavity in the pump housing mounting a plunger linearly shiftable therein, and means operatively connecting the plunger and the camming ring, the improvement wherein the connecting

means comprises an arm having a cylindrical body portion received within a complementary bore in the plunger and a head portion on said arm having diametrically opposed spherical shaped bearing surfaces received within a bore in the camming ring having surfaces of complementary contour to said opposed spherical shaped bearing surfaces, said first and second cavities in the housing have intersecting portions so as to position at least a portion of the outer cylindrical bearing surface of said camming ring in said second cavity to receive the head portion on said arm when the arm is dimensioned to be received entirely within the confines of said second cavity in said housing.

3. The improvement of claim 2 wherein the cylindrical body portion of said arm has a greater diameter than the head portion thereof and being engageable with the outer cylindrical bearing surface of said camming ring for restricting the axial movement of said arm in one direction with respect to the bore in said plunger.

4. In a timing device for a fuel injection pump of the type described including a camming ring member having an outer cylindrical bearing surface journalled in a complementary shaped bearing surface formed in a cavity in said pump and angularly shiftable therein for controlling the delivery of fuel to an associated engine, a regulating member mounted for rectilinear movement, and means operatively connecting the regulating and camming ring members, the improvement wherein the connecting means comprises an arm having a body portion mounted for axial movement within a complementary bore in one of said members, a head portion on said arm having diametrically opposed spherical shaped bearing surfaces received within a bore in the other of said members having surfaces of complementary contour to said opposed spherical shaped bearing surfaces, an opening to said cavity exposing at least a portion of said outer bearing surface

of said camming ring member at one end of the bore in said regulating member, and means on said arm engageable with the outer cylindrical bearing surface of said camming ring for restricting the axial movement of said arm in one direction with respect to the bore in said regulating member.

5. In a timing device for a fuel injection pump of the type described including a camming ring member having an outer cylindrical bearing surface journalled in a complementary shaped bearing surface formed in a cavity in said pump and angularly shiftable therein for controlling the delivery of fuel to an associated engine, a regulating member mounted for rectilinear movement, and means operatively connecting the regulating ad camming ring members, the improvement wherein the connecting means comprises an arm having a body portion mounted for axial movement within a complementary bore in said regulating member, an opening to said cavity exposing at least a portion of said outer bearing surface of said camming ring member at one end of said bore in said regulating member, a head portion on said arm having diametrically opposed spherical shaped bearing surfaces received within a bore in said camming ring member having surfaces of complementary contour to said opposed spherical shaped bearing surfaces, and means on said arm for restricting the axial movement of said arm in one direction with respect to the bore in said regulating member.

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RICHARD B. WILKINSON, *Primary Examiner.*