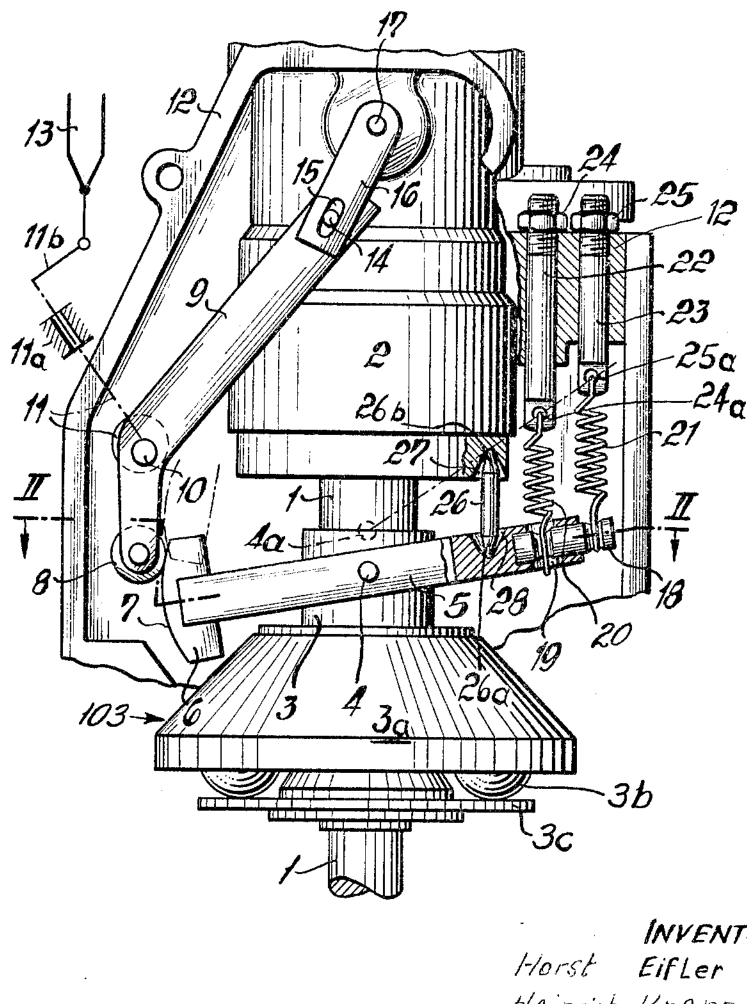
Aug. 30, 1966 H. EIFLER ET AL 3,269,378

APPARATUS IN CONTROLLING THE SUPPLY OF FUEL TO A COMBUSTION ENGINE

Filed Sept. 27, 1965 2 Sheets-Sheet 1

FIG. 1



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2 Sheets-Sheet 2

FIG. 2

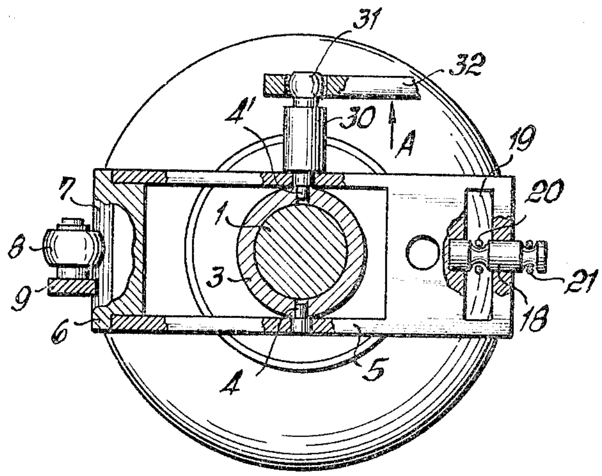
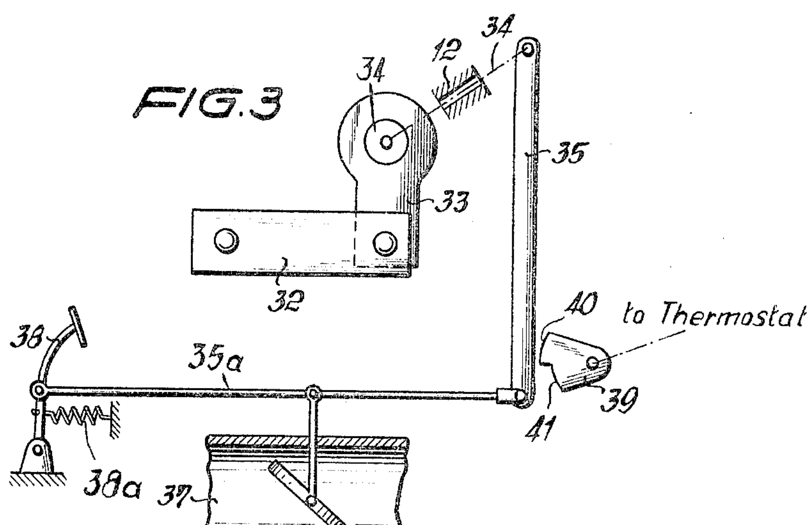


FIG. 3



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United States Patent Office 3,269,378
Patented August 30, 1966

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APPARATUS IN CONTROLLING THE SUPPLY OF FUEL TO A COMBUSTION ENGINE

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Filed Sept. 27, 1965, Ser. No. 490,744
Claims priority, application Germany, Sept. 26, 1964, B 78,683
5 Claims. (Cl. 123—139)

The present invention relates to apparatus for controlling the supply of fuel to a combustion engine, and more particularly to an apparatus in which the fuel supply is controlled not only depending on the position of the throttle controlling the supply of air to the combustion engine, but also depending on the speed at which the fuel pump operates.

The fuel valve of the fuel pump has a cam follower controlled by a three dimensional cam which is displaced in a first direction by means responsive to the position of the air throttle, and in a second transverse direction by means which are responsive to the rotary speed of the fuel pump.

It is the object of the present invention to provide an apparatus for controlling the supply of fuel to a combustion engine, which is of compact construction, consists of few parts, is easily assembled, and operates reliably.

Another object of the invention is to provide an apparatus for controlling the supply of fuel to a combustion engine by which only small forces are transmitted to the means by which the throttle is operated by the driver.

Another object of the invention is to provide an apparatus of this type which can be easily adjusted.

With these objects in view, one embodiment of the invention comprises a rotary fuel pump; a cam having a three dimensional surface engaged by a cam follower which controls means by which the amount of fuel pumped to the engine is adjusted; means for controlling the flow of air into the engine operatively connected with the cam for turning the same about a first axis; and speed responsive means moving in dependence of the speed of the fuel pump and operatively connected with the cam for turning the same about a second axis.

In this manner, the cam is displaced in two transverse directions for actuating the cam follower which engages its three dimensional surface, and the cam follower acts on the adjusting valve of the fuel pump to vary the amount of fuel pumped to the engine depending not only on the speed of the fuel pump but also on the position of the throttle which is used by the driver to control the flow of air into the engine.

In the preferred embodiment of the invention, the cam is mounted on a carrier lever which is turnable about universal joint means permitting the turning of the carrier with the cam about two perpendicular axes.

The joint means preferably include a pin having one end abutting a stationary support, and another end providing a fulcrum for the carrier. The pin has two pointed ends, permitting angular displacement of the pin in all directions.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is an elevation, partially in longitudinal section, and including a schematic view of a detail;

FIG. 2 is a cross sectional view, taken on line II—II in FIG. 1; and

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FIG. 3 is a schematic view illustrating control means connecting the throttle with the carrier of the cam, details being omitted for the sake of simplicity.

Referring now to the drawings, a fuel pump **2** has a rotary shaft **1** slidably supporting a sleeve **3** of a centrifugal governor, only partly shown. Sleeve **3** is turnable on shaft **1**, and also slidable in axial direction of the same, and is controlled by a centrifugal governor **103** to move in axial direction distances proportionate to the rotary speed of shaft **1** and fuel pump **2**. The governor **103** includes a disk **3**c fixed to shaft **1** and balls **3**b urged outwardly by the centrifugal force to act on the frustoconical inner surface of member **3**a to displace the same with sleeve **3** along shaft **1**. A pair of diameterically arranged pivot pins **4** and **4'** are fixed in bores of sleeve **3** and provide journals for the two lateral parts of a carrier **5**. A cam **6** having a three dimensional surface **7** is secured to one end of carrier **5**.

A cam follower roller **8** is mounted on a cam follower lever **9** which is connected by a pin **14** located in a slot **15** to a lever arm **16** which controls shaft **17** of a valve, not shown, which regulates the amount of fuel supplied by fuel pump **2** when angularly displaced.

Cam follower lever **9** is mounted on a journal **10** for turning movement. Journal **10** is eccentrically mounted on a shaft **11** so that turning of shaft **11** about its axis will displace the turning axis of cam follower lever **9**.

As schematically shown, shaft **11** is mounted in a bearing **11**a and has an arm **11**b operated by a thermostat **13** so that, depending on the temperature to which the thermostat is exposed, the position of the axis about which cam follower means **8**, **9** turns, and the relative position of cam follower roller **8** and cam surface **7** are adjusted. The thermostat **13** is located in the region of the combustion engine so that the cold or warm condition of the engine influences the position of the cam follower means.

The other end of carrier **5** has a cutout **19**, and a longitudinal bore in which a pin **18** is mounted so as to traverse cutout **19**. Pin **18** has spaced annular grooves, one of which is located in cutout **19**.

A pair of bolts **22** and **23** pass through bores in a stationary support frame **12** of fuel pump **2**, and have openings into which the hooked ends of a pair of springs **20** and **21** are inserted. The other end of spring **21** engages the outer groove of pin **18**, while the other end of spring **20** embraces the inner annular groove, without actually resiliently engaging the same in the position shown in FIG. 1. The threaded end of bolts **22** and **23** carry nuts **24** and **25** so that the positions of springs **20** and **21** can be adjusted.

Support frame **12** of fuel pump **2** has a conical recess **27** located opposite a corresponding conical recess **28** in carrier **5**. A pin **26** has pointed ends respectively located in recesses **27** and **28**, and held in the same by the pressure exerted by spring **21**.

In the position shown in FIG. 1, only spring **21** is effective, but if carrier **5** is turned in clockwise direction about the fulcrum provided by the pointed end **26**a due to movement of sleeve **3** along shaft **1**, pin **18** will move to a position in which it engages the hook of spring **20** so that the same is stressed, together with spring **21**, during further turning movement of carrier **5** in clockwise direction. While sleeve **3** moves along shaft **1**, carrier **5** turns relative to sleeve **3** about journal pins **4**, **4'**.

When sleeve **3** with carrier **5** is turned about shaft **1**, pin **26** is angularly displaced about its pointed end **26**b since its end **26**a is moved along an imaginary cylinder having its axis coinciding with the axis of shaft **1**, whereas the end **26**b remains stationary. When sleeve **3** moves in axial direction of shaft **1**, pin **26** provides a fulcrum and an axis about which carrier **5** turns. This axis is parallel to the axis defined by journal pins **4, 4'** and passes substantially through the pointed end **26a** of pin **26**.

When the rotary speed of fuel pump **2** is increased to a maximum, the centrifugal governor moves sleeve **3** to a position in which journal pin **4** is in the position **4a**. In this position of sleeve **3**, the axis of journal pins **4, 4'**, the pointed end **26b** of pin **26**, and the openings **24a** and **25a** are located in a plane or, in other words, the point of intersection of the axis defined by journal pins **4, 4'** with the axis of shaft **1**, and points **26b, 24a,** and **25a** are located on a straight dot-dash line shown in FIG. 1.

A stud **30** is secured to carrier **5** coaxial with journal pins **4, 4'** and has a free end with a spherical journal **31** located in an opening of a link **32**, as shown in FIG. 2.

An arm **33** is secured to a shaft **34** as shown in FIG. 3, so that angular displacement of shaft **34** will cause longitudinal displacement of link **32**, and turning of carrier **5** with sleeve **3** about shaft **1**. FIG. 3 shows shaft **34** not only in end view, but also schematically as a chain line. A lever arm **35** projects in radial direction from shaft **34**, and is connected by a link **35a** which is coupled with a throttle valve **36** and with a foot pedal **38** urged by spring **38a** to move toward the right in FIG. 4 until lever arm **35** abuts the first abutment **40** of a turnable stop **39** which is mounted on the stationary supporting frame of the fuel pump. Stop **39** has a second abutment **41** cooperating with lever arm **35** in a second angularly turned position of stop **39** permitting a greater displacement of foot pedal **38**, and of throttle valve **36** which is located in a tube **37** through which air is supplied to the combustion engine to which fuel is pumped by the injection fuel pump **2**.

Abutment **40** permits turning of throttle valve **36** to a position required for supplying air to a cold idling en-engine, while abutment **41** determines the position of throttle valve **36** for supplying air to a warm idling engine.

Stop **39** is connected with thermostat **13** by a linkage, not shown, and is shifted under control of the thermostat which senses whether the engine is cold or hot.

The apparatus is shown in a position corresponding to rotation of the fuel pump at the lowest speed, and with throttle valve **36** in a position corresponding to a partial load.

As the number of rotations increases, sleeve **3** of the centrifugal governor is displaced toward fuel pump **2** in axial direction of shaft **1**. When the maximum speed of the fuel pump is reached, journal pin **4** assumes the position **4a** shown in chain lines so that the point of intersection of axis **4, 4'** with the axis of shaft **1**, and points **26b, 24a** and **25a** are aligned. During such movement of sleeve **3**, carrier **5** turns about an axis passing parallel to the axis of journal pins **4, 4'** through the pointed end **26a** of pin **26** which is slightly displaced during this movement about an axis passing through the pointed end **26b**. During such clockwise turning of carrier **5**, only spring **21** is tensioned at first, but before the position **4a** is reached, spring **20** is also resiliently tensioned.

The engine is assumed to be in cold condition so that thermostat **13** has turned stop **39** to the position in which abutment **40** is operative. In the idling position, not shown, of throttle valve **36**, spring **38a** will move link **35a** and lever arm **35** to a position abutting abutment **40**, but FIG. 3 shows a position in which the operator has displaced foot pedal **38** corresponding to a certain load. After the engine has become warmer, thermostat **13** turns stop **39** so that abutment **41** is located opposite lever arm **35**, permitting a displacement of link **35a**, and turning of throttle valve **36** to a position reducing the free cross section of the air tube **37** so that a lesser amount of air is supplied to the engine in warm condition than in cold condition in which a greater amount of fuel is required for warming up the engine.

When throttle **36** is turned by operation of the foot pedal **38**, or by another operator controlled means, the movement is transmitted by link **35a** to lever arm **35** which turns shaft **34** in a bearing of the stationary frame portion **12** so that lever **33** is turned and shift link **32** whereby carrier **5** is turned with sleeve **3** about shaft **1**. Cam **6** turns with carrier **1** about a first axis which is the axis of shaft **1** so that the three dimensional cam surface **7** moves relative to cam follower roller **8** whereby cam follower lever **9** pivots about journal **10** so that the valve of the fuel pump is adjusted by shaft **17** and lever **16** to vary the amount of fuel supplied to the engine.

When the rotary speed of the fuel pump and of the engine vary, the centrifugal governor **103** displaces sleeve **3** in axial direction so that carrier **5** pivots about a second axis crossing the first axis of shaft **1** at right angles, and passing through the pointed end **26a** of pin **26**. Turning of carrier **5** about the second axis causes displacement of cam **6** so that cam follower roller **8** moves over the three dimensional cam surface **7** whereby cam follower lever **9** is displaced to adjust the position of the lever **16**, shaft **17** and of the valve controlling the amount of fuel supplied to the engine.

Since movements of cam **6** in two transverse directions influence cam follower means **9, 8**, the cam surface **7** must be three dimensional and designed to obtain the desired adjustments of the amount of fuel supplied to the engine.

When throttle means **36, 38** is displaced simultaneously with a speed change of fuel pump **2** with shaft **1**, carrier **5** turns simultaneously about the above described first and second axes. Pin **26** performs the function of a universal joint since it is angularly displaced about the pointed end **26b** while carrier **5** turns with sleeve **3** about shaft **1**, and also turns about pointed end **26a** to move with the sleeve in axial direction of shaft **1**.

From the above description, it will become apparent that throttle means **36, 38** are connected with cam means **6, 5** to turn the same about a first axis defined by shaft **1**, and that the speed responsive centrifugal governor **103** with sleeve **3** is connected with the cam means for turning the same about the second axis defined by the pointed end **26a** and extending parallel to journal pins **4, 4'**.

First control means **35a, 35, 34, 33, 32** connect carrier **5** of cam **6** with throttle means **38, 36**, and second control means in the form of pins **4, 4'** connect carrier **5** with the speed responsive means including sleeve **3** and a centrifugal goverenor **103**, whose portion **3a** is fixedly connected with sleeve **3**.

When the apparatus operates at maximum speed, journal pins **4, 4'** are located in the position **4a**. Since pin **26** and springs **20, 21** are located in a plane perpendicular to a plane passing through the axis of journal pins **4, 4'**, pointed end **26b**, and points **24a** and **25b**, no forces, or only very small forces are transmitted in the region of the maximum speed from springs **20, 21** by the first control means **30, 32, 33, 34, 35, 35a** to the throttle means **36** and the operator controlled foot pedal **38** so that the operation of the throttle is not influenced by forces produced by the springs or by the displaced sleeve **3**.

At low rotary speeds, such forces are very small, and can be disregarded although a turning of carrier **5** with cam **6** about shaft **1** in the position of FIG. 1 will cause tensioning of springs **20** and **21**.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of apparatus for controlling the supply of fuel to a combustion engine differing from the types described above.

While the invention has been illustrated and described as embodied in apparatus including a three dimensional cam means turnable about two perpendicular axes and cooperating with a cam follower by which the fuel supply of a combustion engine is adjusted, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. An apparatus for controlling the supply of fuel to a combustion engine, comprising, in combination, fuel pump means having means for varying the amount of fuel pumped to said engine including cam follower means; rotary drive shaft for driving said fuel pump means; a cam having a three dimensional cam face engaged by said cam follower means; a carrier for said cam; a sleeve mounted on said shaft, for turning movement about the axis of said shaft, and for sliding movement in axial direction of said shaft; a pair of journal pins pivotally supporting said carrier on said sleeve; a support having a recess, said carrier having a recess located opposite said recess in one turned position of said sleeve; a pin having pointed ends respectively located in said recesses of said support and of said carrier and supporting said carrier for turning movement about an axis perpendicular to said axis of said shaft so that said carrier and said cam turn about said second axis when said sleeve moves in longitudinal direction of said shaft; spring means connected with said carrier for urging the same to turn about said second axis so that said spring means is stressed when said sleeve moves in one direction along said axis; speed responsive means connected with said sleeve for urging the same to move in said one direction when the speed of said shaft increases; throttle means for controlling the flow of air into the engine; and linkage means connecting said throttle means with said sleeve so that displacement of said throttle means causes turning movement of said sleeve with said carrier and said cam about said first axis whereby said cam is displaced in two transverse directions under the control of said speed responsive means and said throttle means for actuating said cam follower means to vary the amount of fuel.

2. An apparatus according to claim 1 wherein said spring means include two springs attached to said carrier at two spaced points, one of said springs being longer so that during turning movement of said carrier with said cam about said second axis toward a position corresponding to an increased speed, first one and then the other of said springs becomes effective to oppose the movement of the carrier.

3. An apparatus according to claim 2 and including adjusting means for adjusting each of said springs.

4. An apparatus according to claim 2 wherein said springs are attached to said supporting means at two points located on a line passing though the pointed ends of said pin located in said recess of said support, and through the point of intersection between said axis of said shaft and the axis defined by said journal pins.

5. An apparatus according to claim 1 wherein said spring means is attached to said support at a point located on a line passing through the pointed end of said pin located in said recess of said support and through the point of intersection between said axis of said shaft and the axis defined by said journal pin.

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