

Oct. 5, 1948.

E. A. WATSON ET AL
MEANS FOR AUTOMATICALLY CONTROLLING THE SUPPLY
OF LIQUID FUEL TO A PRIME MOVER
Filed Feb. 7, 1944

2,450,535

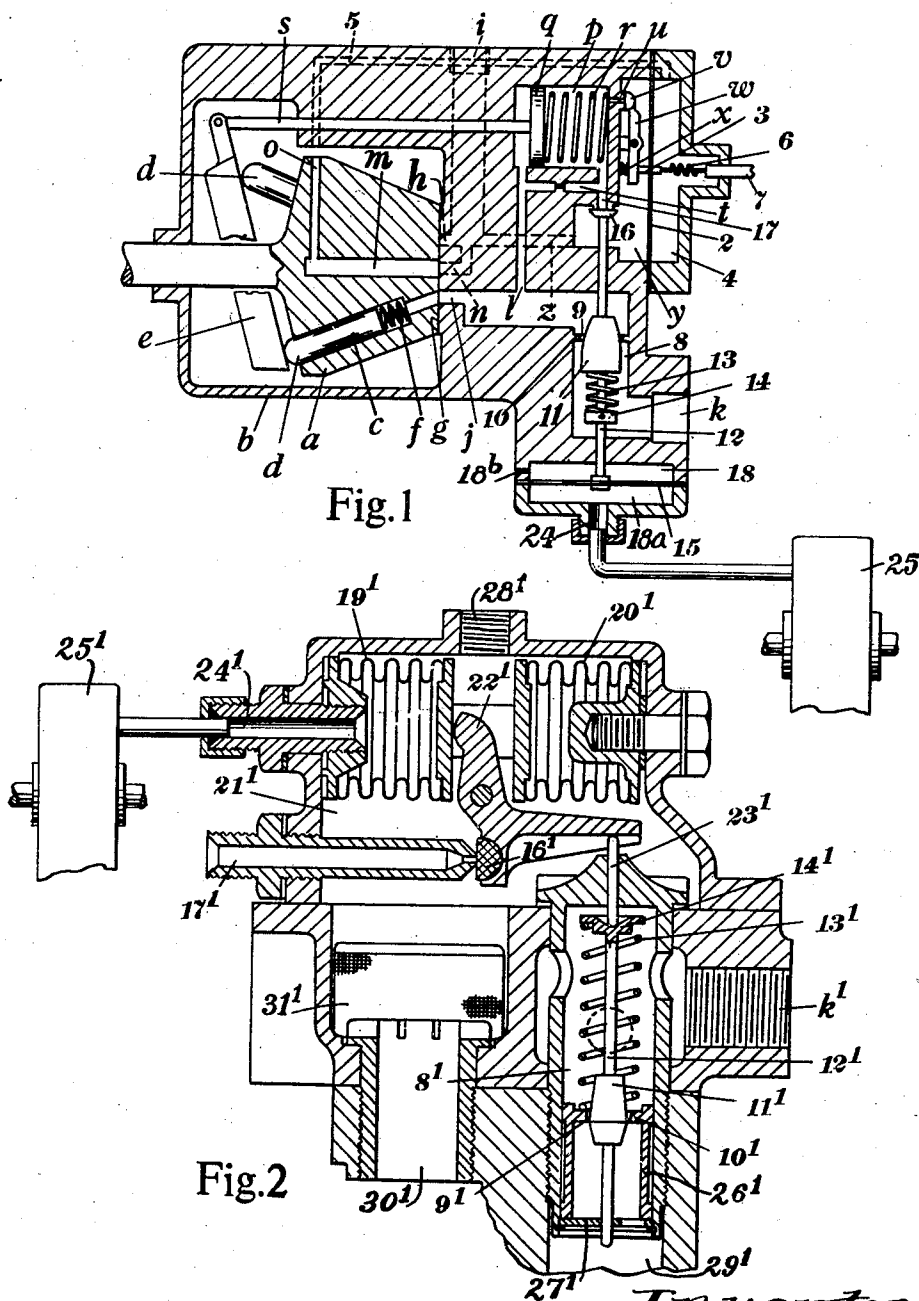


Fig. 1

Fig. 2

Inventors
E. A. Watson
R. J. Ifield
By *Glenn W. Conners* *Attys.*

UNITED STATES PATENT OFFICE

2,450,535

MEANS FOR AUTOMATICALLY CONTROLLING THE SUPPLY OF LIQUID FUEL TO A PRIME MOVER

Ernest Ansley Watson, Gibbet Hill, Coventry, and
Richard Joseph Ifield, Ealing, London, Eng-
land, assignors to Joseph Lucas Limited, Bir-
mingham, England

Application February 7, 1944, Serial No. 521,470
In Great Britain December 16, 1942

3 Claims. (Cl. 158—36.3)

1

This invention relates to prime movers to which fuel is supplied in liquid form, and to which the air required for combustion of the fuel is supplied by a blower. The object of the invention is to provide improved means for controlling the rate of fuel supply in a manner which is correlated with the pressure of the air delivered by the blower.

In the accompanying sheet of explanatory drawings—

Figure 1 is a diagrammatic sectional side elevation of a variable-output fuel pump embodying the invention.

Figure 2 is a sectional view illustrating a modified form of the invention.

The liquid fuel pump shown in Figure 1 comprises a rotary body part *a* arranged in a casing *b* and having formed around its axis a plurality of bores as *c* in each of which is arranged a reciprocating plunger as *d*. The body part *a* is adapted to be driven in any convenient manner by the prime mover (not shown) to be supplied with liquid fuel from the pump. During rotation of the body part *a* the plungers *d* are moved in one direction by an angularly movable swash plate *e* and in the opposite direction by springs as *f*, the latter being situated within the bores *c*, and serving to hold an end face of the body part in contact with a flat seating *g* in the casing *b*. The seating *g* is formed with a port *h* communicating with a liquid inlet *i* in the casing *b*, and with another port *j* communicating with a liquid outlet *k* in the casing.

To enable the pump above described to be governed in response to variations in speed, the body part *a* is adapted to serve as a centrifugal pump. Thus, the body part *a* is formed with an axial bore *m* which at one end communicates with the inlet *i* through another port *n* in the seating *g*, and at the other end communicates with a plurality of radial passages as *o* in the body part. Liquid fuel from the inlet *i* flows through the bore *m* and is expelled by centrifugal action through the radial passages *o* into the interior of the casing *b* around the body part *a*. In one end of the pump casing *b* is formed a cylinder *p* having closed ends. Within the cylinder *p* is arranged a piston *q* loaded by a spring *r*, and extending from one side of this piston and through a bore in the casing *b* at the inner end of the cylinder is a rod *s* connected to the swash plate *e*. The inner portion of the cylinder *p*, that is the portion at the piston-rod side of the piston *q*, is in free communication with the outlet *k* through a passage *l* in the casing *b*, and this portion of the cyl-

2

inder also communicates with the other or outer portion of the cylinder (which contains the spring *r*) through a restricted passage *t*. The outer end of the cylinder *p* is provided with a small vent *u* which at its outer end forms a seating for a closure member *v* on one end of a lever *w*, the latter being pivoted at a position between its ends on the outer end of the cylinder, and being loaded by a spring *x* which tends to hold the closure member on its seating. The lever *w* is contained in a chamber *y* formed on or secured to the adjacent end of the casing *b*, and this chamber communicates with the pump inlet *i* through a passage *z*. The outer side of the chamber *y* is bounded by a controlling diaphragm *2* having at its centre an abutment *3* which is adapted to bear on the end of the lever *w* remote from the closure member *v*. At the outer side of and bounded in part by the diaphragm *2* is another chamber *4*, this latter chamber being in communication with the above-mentioned centrifugal pump through a passage *5* in the casing *b*. Also the diaphragm *2* is loaded by a spring *6* connected to an adjusting member *7*, the latter being operable in any convenient manner by an attendant to vary the effect of the spring.

Assuming the swash plate *e* to be in the position of maximum obliquity, that is to say the position in which the pump gives its maximum output, the swash plate will remain in this position so long as the pressure in the chamber *4* (and thus acting on the controlling diaphragm *2*) is below some predetermined amount. In this condition the vent closure member *v* is in its closed position and the liquid pressures at the two sides of the piston *q* are equal. But when the pressure acting on the diaphragm *2* exceeds the predetermined amount the diaphragm will move the closure member *v* off its seating. The liquid pressure in the outer portion of the cylinder *p* will now fall and the piston *q* will be moved by the fluid pressure in the inner portion of the cylinder against the action of the spring *r*, so moving the swash plate *e* in the direction for reducing the pump output until a new condition of equilibrium is reached.

From the foregoing it will be seen that as the position of the swash plate *e* is dependent on the pressure of the liquid in the chamber *4*, and as this pressure is dependent on the speed of the pump, the latter is governed by the speed of the prime mover which drives the pump.

In applying the invention to the pump shown in Figure 1, we arrange in a cylindrical chamber *8* interconnecting the delivery port *j* and the out-

3

let k , an automatically variable orifice 9 through which the liquid fuel is caused to flow. This orifice 9 is formed by a fixed annulus 10 in the chamber 8, and a coaxial tapered plug 11 slidably axially relatively to the annulus. The plug 11 is slidably mounted on an axially arranged stem 12, and is supported at one end by a helical spring 13 mounted on the stem between the plug and a collar 14 on the stem. The peripheral surface of the plug 11 is made to any appropriate shape such as will cause the area of the orifice 9 to change with the axial movement of the plug in a predetermined manner. Movement of the plug 11 relatively to the annulus 10 in opposition to the spring 13 depends on difference of fluid pressure at the two sides of the orifice 9 and consequently on the rate of flow of liquid through the orifice, the area of the orifice being automatically varied by the plug with variation in the rate of flow.

To regulate the rate of flow of liquid through the orifice 9 we employ any convenient means which is responsive to the said difference of liquid pressure and the blower-air pressure. As shown in Figure 1 such means consists of a diaphragm 15 to which one end of the stem 12 is attached, and which serves to divide a chamber in the pump casing b into two compartments 18, 18^a. The compartment 18 is open to the atmosphere or evacuated through an opening 18^b, and the compartment 18^a is adapted to receive air through a connection 24 from a blower 25, this latter being driven by, and serving to supply air required for combustion of the fuel to the prime mover. The stem 12 is adapted to control the flow of liquid fuel to the chamber 8, and for this purpose in the example shown is provided at the end remote from the diaphragm 15 with a valve 16. The latter serves by controlling a vent passage 17 in the outer end of the cylinder p to vary the output of the pump in response to axial movement of the stem 12.

When the pump above described is in action the area of the orifice 9 depends automatically on the rate of flow of liquid through the orifice, variation in the rate of flow being accompanied by a corresponding change in the position of the plug 11. For a given rate of flow there will be a corresponding pressure difference between the two sides of the annulus 10. So long as this pressure difference is balanced by the blower-air pressure acting on the diaphragm 15, the rate of flow of liquid through the orifice 9 will remain constant. Variation of blower-air pressure or of liquid flow will upset the balance, and cause the stem 12 to effect an appropriate adjustment of the pump regulating valve 16.

In the modification shown in Figure 2, we employ an annulus 10¹ which is slidably in a cylindrical chamber 8¹, and which is formed by one end of a sleeve 26¹ in the chamber, the other end of the sleeve being open and arranged to abut against an apertured disc 27¹ through which liquid can flow. In association with the annulus 10¹ is arranged a co-axial stem 12¹ on which is formed or secured a tapered plug 11¹. The plug 11¹ and annulus 10¹ are loaded by a helical spring 13¹ whose ends abut respectively against a collar 14¹ on the stem 12¹ and against the annulus. Also we employ a pair of similar corrugated metal capsules 19¹, 20¹, the interior of one (19¹) of which is adapted to receive air through a connection 24¹ from the blower 25¹, and that of the other (20¹) is evacuated, these capsules being coaxially arranged in a chamber 21¹ which is either open

4

to the atmosphere through an aperture 28¹ or is charged with the liquid fuel at reservoir pressure, and being interconnected at their adjacent ends. Between and in contact with one of the adjacent ends of the capsules 19¹, 20¹ is arranged one arm of a three-armed lever 22¹. One of the other arms of the lever 22¹ abuts against one end of the plug stem 12¹ through the medium of a thrust piece 23¹, and the remaining arm carries a valve 16¹ which serves by controlling a vent passage 17¹ to control the output of a liquid fuel pump as in the example previously described. Fuel from the outlet of this pump flows through an inlet 29¹ and the perforated disc 27¹ to the interior of the sleeve 26¹, and thence through the orifice 9¹ formed by the annulus 10¹ and plug 11¹ to the outlet k ¹. As in the previously described example, the area of the orifice 9¹ depends automatically on the rate of flow of liquid through the orifice, variation in the rate of flow being accompanied by a corresponding change in the position of the plug 11¹. So long as the difference of fluid pressure at the two sides of the orifice 9¹ is balanced by the blower-air pressure acting on the stem 12¹ through the lever 22¹, the rate of flow of liquid through the orifice will remain constant, but variation of blower-air pressure or liquid flow will upset this balance and cause the stem to effect an appropriate adjustment of the valve 16¹ through the lever. The chamber 21¹ is provided with an outlet 30¹ which at its inner end is provided with a filter 31¹, and which is adapted to communicate with a reservoir (not shown) connected to the pump inlet.

The invention is not, however, limited to the examples above described, as details may be varied without departing from the essential features of the invention. Thus, instead of being used to actuate a valve, the stem in either of the examples above described may be adapted to actuate any other regulating device in the fuel supply system. By utilizing the pressure difference at the opposite sides of an automatically variable orifice through which the liquid fuel passes, and the pressure of the blower-air, we are able to correlate the supply of liquid fuel and air to a combustion chamber in a very simple and satisfactory manner.

Having thus described our invention, what we do claim as new and desire to secure by Letters Patent is:

1. Means for automatically controlling the supply of liquid fuel from a pump to a prime mover having associated with it a blower for supplying the air required for combustion of the fuel, comprising the combination of a chamber through which the liquid fuel can flow, from the pump to the prime mover, an annulus slidably mounted in the chamber, a tapered plug arranged in the chamber coaxially with the annulus and forming with the latter a variable orifice for controlling the flow of fuel through the chamber, the annulus and plug being such that their relative positions and consequently the area of the orifice are dependent on the difference of fluid pressure at the opposite sides of the orifice, an axially movable stem on which the plug is provided, a loading spring associated with both the annulus and plug, a lever adapted to be moved by and to impart movement to the stem, means for actuating the lever in response to blower-air pressure, and means operable by the lever for controlling the flow of fuel to the said chamber.

2. Means for automatically controlling the sup-

5

ply of liquid fuel from a pump to a prime mover having associated with it a blower for supplying the air required for combustion of the fuel, comprising the combination of a chamber through which the liquid fuel can flow from the pump to the prime mover, a pair of relatively movable coaxial parts forming in the chamber a variable orifice for controlling the flow of fuel through the chamber, the said parts being such that their relative positions and consequently the area of the orifice are dependent on the difference of fluid pressure at the opposite sides of the orifice, and means responsive to both this difference of pressure and the blower-air pressure for controlling the supply of fuel to the chamber.

3. Means for automatically controlling the supply of liquid fuel from a pump to a prime mover having associated with it a blower for supplying the air required for combustion of the fuel, comprising the combination of a chamber through which the liquid fuel can flow from the pump to the prime mover, a fixed annulus arranged in the chamber, a tapered plug arranged in the chamber coaxially with the annulus and forming with the latter a variable orifice for controlling the

6

flow of fuel through the chamber, the annulus and plug being such that their relative positions and consequently the area of the orifice are dependent on the difference of fluid pressure at the opposite sides of the orifice, a stem on which the plug is axially slidable, a spring supporting the plug on the stem, a diaphragm responsive to blower-air pressure attached to the stem, and means operable by the stem for controlling the flow of fuel to said chamber.

ERNEST ANSLEY WATSON.
RICHARD JOSEPH IFIELD.

REFERENCES CITED

- 15 The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
20 2,004,869	Hogg -----	June 11, 1935
2,082,397	Hiscock -----	June 1, 1937
2,222,919	Trapp -----	Nov. 26, 1940
2,273,670	Udale -----	Feb. 17, 1942
2,290,921	Udale -----	July 28, 1942