June 5, 1934. J. L. ROTH ET AL 1,961,791

FUEL CONTROL SYSTEM

Filed Feb. 24, 1932 2 Sheets-Sheet 1

Fig. 2.a

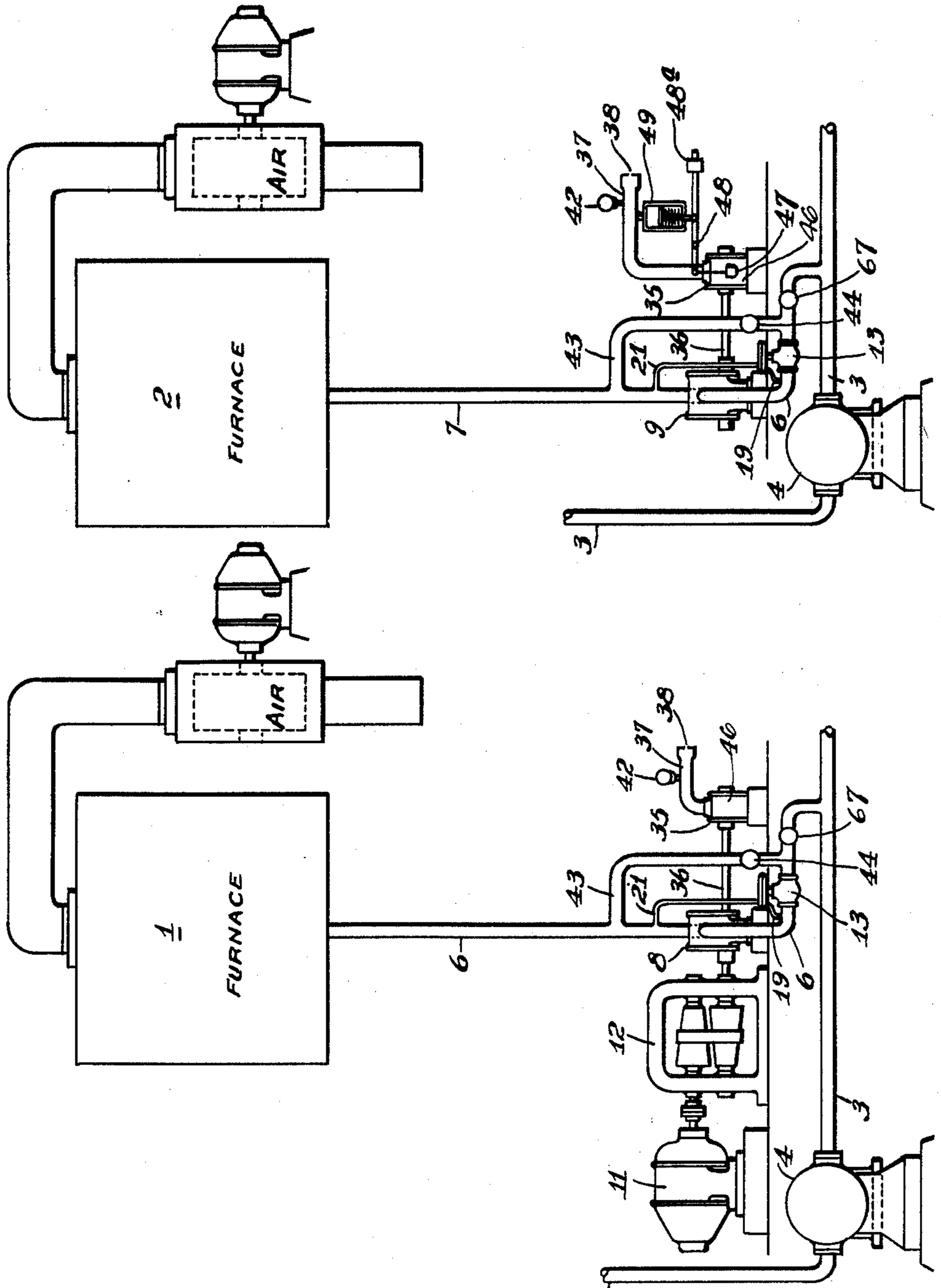

Fig. 1.

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Fig. 2.

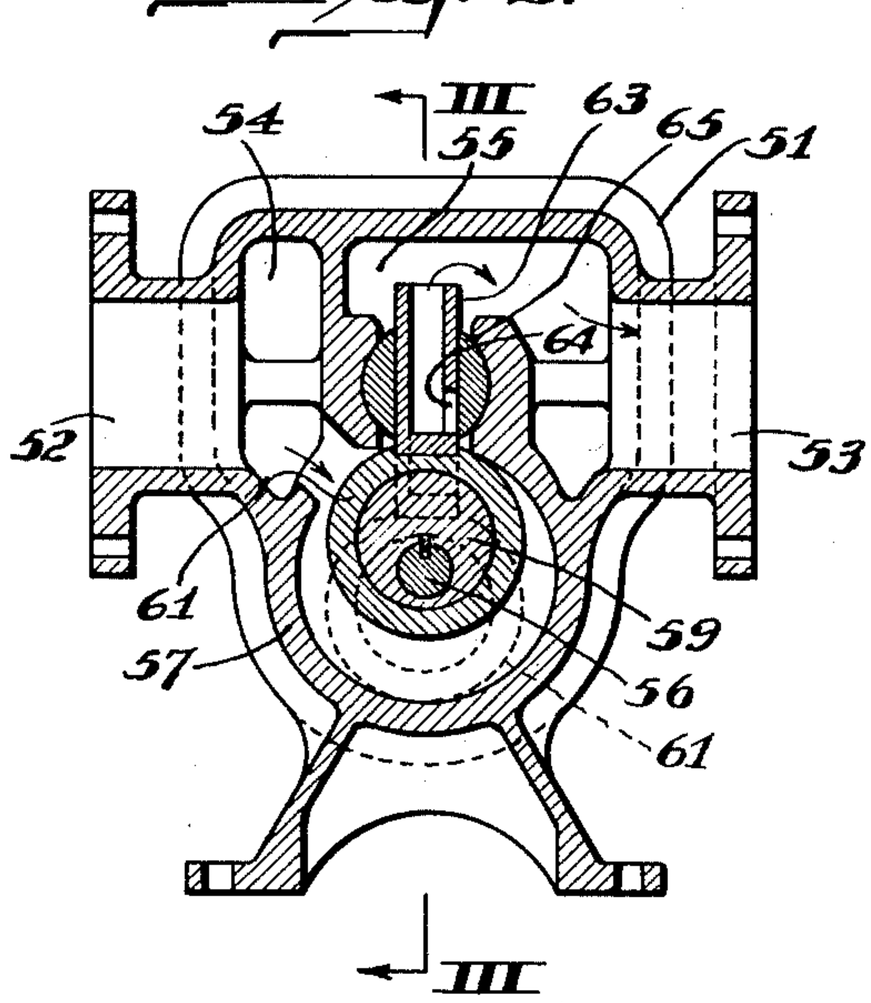


Fig. 3.

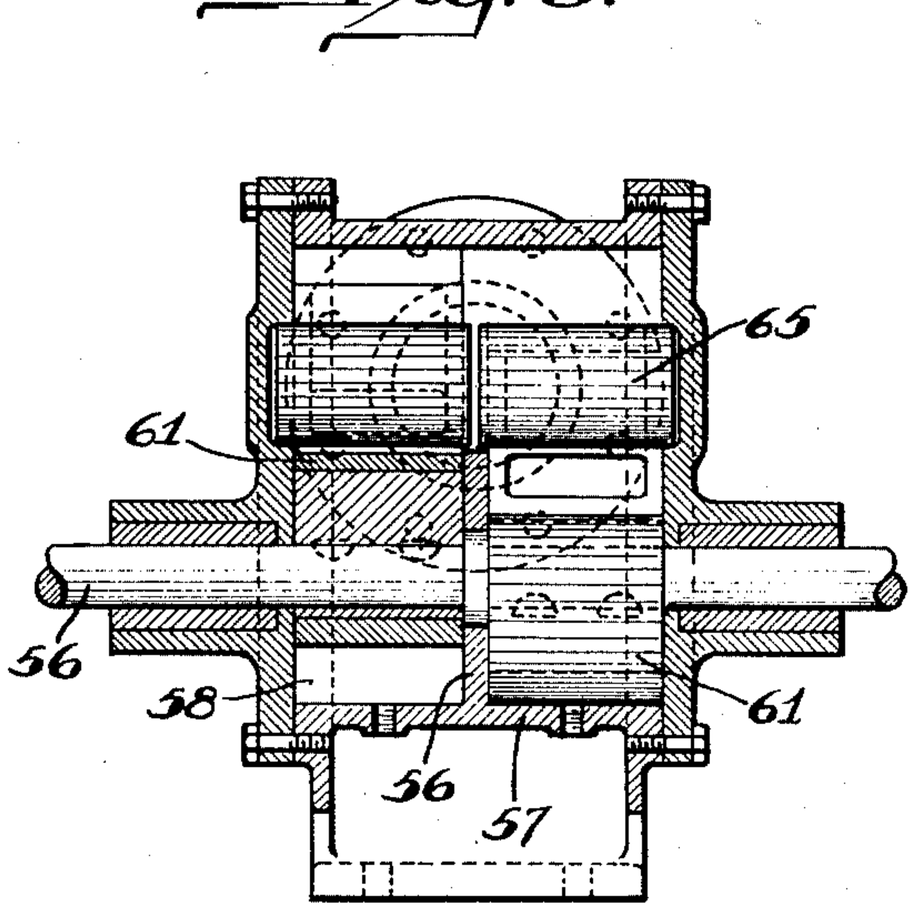
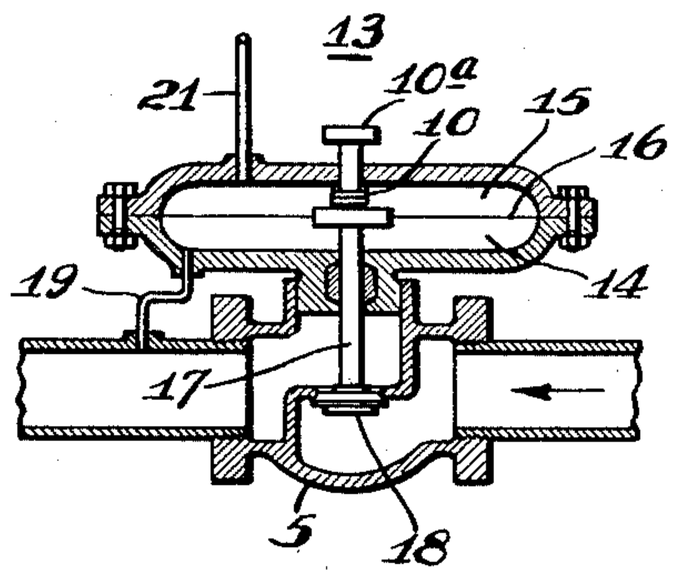


Fig. 4.



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UNITED STATES PATENT OFFICE

1,961,791

FUEL CONTROL SYSTEM

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9 Claims. (Cl. 137—78)

This invention relates to an improved system of apparatus for regulating the flow of liquids and particularly the flow of liquid fuels to a furnace combustion chamber or the like.

The primary object of the invention generally stated is to provide a dependable and comparatively simple system of control for positively regulating the rate of flow of liquids through a conduit and particularly the flow of heavy fuels such as heavy oils, coal tar and the like to the combustion chamber of an open hearth furnace or similar liquid fuel consumer.

Another object is to provide apparatus of the character referred to for accomplishing the aforementioned result which is economical to construct and efficient in operation.

These and other objects as well as the various other novel features and advantages of the invention will be apparent when the following detailed description is read in conjunction with the accompanying drawings of which Fig. 1 is a diagrammatic illustration of a liquid fuel burning furnace equipped with apparatus constituting one embodiment of the invention; Fig. 2*a* a view similar to Fig. 1 illustrating another embodiment of the invention; Fig. 2 a vertical section taken on the line of flow through the rotary valve or pump arranged in the fuel lines leading to the respective furnaces shown in Figs. 1 and 2*a*; Fig. 3 a vertical section of the same taken on the line III—III of Fig. 2; and Fig. 4 a vertical section taken through the pressure-regulating valve employed for maintaining a substantially constant pressure drop across the rotary valve as employed in the systems shown in Figs. 1 and 2*a*.

In the past there has been considerable difficulty experienced in the regulation of furnaces and burners in which liquid fuels are employed, and especially so where heavy fuels such as heavy oils, coal tar and the like constitute the fuel. This difficulty has resulted to a very considerable extent from the use of simple variable orifice type valves for controlling the flow of such fuels as has been the customary practice in the past. It has been found that liquids of the nature of these fuels have a tendency to foul and clog up valve orifices so rapidly or otherwise impair their operation that it is practically impossible to satisfactorily regulate the flow of such fuels through the use of simple valves.

In accordance with this invention, to overcome such difficulties, a rotary type metering device such as a freely working rotary pump is employed as a valve for regulating the flow of such liquids and the liquids supplied to such device under pressure. With such provision the amount of fuel passing the device is determined by the rate of speed at which it is operated. To render the flow of fuel positively and directly proportionate to the speed of rotation of the pump, valve pressure-regulating mechanism is arranged to maintain a substantially constant differential of pressure on its two sides whereby it is caused to always operate under substantially the same pressure conditions, and hence is uninfluenced by any variation in pressure in either the fuel line ahead of it or by reason of any variation in the pressure conditions established in the furnace.

Referring to the drawings, and first to Fig. 1, the numeral 1 designates a furnace to which liquid fuel is furnished by a pipe 3 which may be connected to any suitable source of supply. In accordance with the invention a pressure sufficient to force the fuel into the furnace is exerted on the fuel in this line. Such pressure may be produced in any suitable manner such for example as by connecting the pipe to a reservoir having a sufficient elevation to supply the necessary pressure or by employing a motor driven pump, such as the pump 4, which as shown is arranged in the supply line 3 ahead of the furnace.

For conducting the fuel to the furnace from the pipe or header 3, as it is more commonly known, a pipe 6 is employed. In this pipe a positive displacement rotary pump or metering valve 8 is arranged to regulate the flow of fuel to the furnace. This device may be of any suitable type or form having positive displacement characteristics, but is illustrated here, as shown more particularly in Figs. 2 and 3, as comprising a well known form of rotary pump the details of which are described more clearly hereinafter.

For controlling the operation of pump 8 a motor 11 is utilized, and to provide for varying the speed of the pump with respect to that of the motor a speed-changing device 12 is arranged between it and the motor. To render the rate of flow of the fuel in line 6 directly and positively proportionate to the speed of rotation of pump 8, a pressure-regulating valve 13 is provided in the line at some suitable point between the pump and the feeder line 3. This valve is adapted to maintain a substantially constant difference in pressure across the pump independently of any pressure variations which may occur in the header. As shown in detail in

Fig. 4 the valve comprises a casing 5 having in it an inlet and an outlet chamber separated by a valve opening in which a valve 18 is arranged to seat. At the top of the casing there are located a pair of pressure chambers 14 and 15 divided by a flexible diaphragm 16 to which a valve 18 is connected by a stem 17. The pressure chamber 14 is connected to feed line 6 between valve 13 and pump 8 by a pipe 19, while the chamber 15 is connected to line 6 between the pump and the furnace by a pipe 21. With this arrangement the diaphragm 16 and valve 18 are rendered responsive to the difference in pressure on the two sides of the pump. Consequently it is adapted to automatically determine and maintain a substantially constant difference in pressure across the pump, thus causing the pump to operate under uniform pressure conditions at all times. With such an arrangement the volume displacement of the pump is directly dependent upon the speed at which the pump is rotated. Accordingly, instead of functioning as a pump it merely functions as a metering valve and is in no way affected by the variations in pressure in either the feeder line 3 or the flow line 6. To provide for varying the difference in pressure drop across the device 8 a spring 10 may be mounted on the diaphragm 16 and a screw 10*a* used to determine the pressure the spring exerts upon the diaphragm.

In the embodiment of the invention illustrated in Fig. 2*a*, similar reference characters are employed for designating similar parts of the apparatus except for the pump which is referred to by the numeral 9. In this modification of the invention instead of utilizing a motor for operating the pump or metering device 9, as is done in the aforementioned embodiment, a sufficient pressure drop is provided across the pump through the adjustment of the spring 10 on the valve 13 to drive the pump itself as a motor. With such an arrangement, in order to insure positive control of the pump a positive displacement blower 46, which may have the same details of construction as the pump 9 is connected to a drive shaft 36 constituting an extension of the drive shaft or the pump to function as a fluid brake. In order to operate this blower in such a capacity a valve 47 is arranged in its inlet and is operated by a lever 48. This lever is in turn connected to a piston disposed in a pressure cylinder 49 connected by a pipe 21 to a pressure tube 37 forming the outlet of the blower. Accordingly, any variations in pressure in tube 37 such as may be produced by variations in the speed of blower 46 by pump 9 are transmitted to the piston of cylinder 49 and thence to the valve 47 with the result that the speed of the pump is prevented from exceeding a preselected value. In an inverse fashion the braking effort is reduced in a manner to permit the pump to regain its speed by reason of the lowering of the pressure in tube 37 in case the speed of the pump falls below its preselected value. Obviously with such an arrangement the flow of fuel may be increased or decreased in various ways such, for example, as by changing the fulcrum on lever 48 or by arranging a slideway 48*a* on the tail end of this lever.

If desired, with a system of this character a meter 42 may be connected to the tube 37 so as to indicate at all times the pressures produced by the blower 46 and hence indicate the amount of fuel supplied to the furnace. Various meters of well known form may be used for this purpose and provided with means for making a graphic record of the pressures obtaining in the foregoing pressure tube and so calibrated as to record the amount of fuel delivered to the furnace per unit of time as well as for indicating the total amount of fuel supplied during any period of operation. Furthermore, if desired, as shown in connection with the control for furnace 1 a by-pass line 43 may be connected about valve 13 and pump 8 so that in case either of these mechanisms fail for any reason or if for any purpose it is desired to cut them out of the system the fuel may be passed around them through this by-pass line. For controlling the flow of fuel when so directed a hand valve 44 is provided in line 43.

Referring to the details of construction of the pumps and blowers referred to hereinbefore, reference may be had to Figs. 3 and 4 wherein a construction suitable for use as either pump 8 or blower 46 is illustrated. As shown this apparatus comprises a cylindrical casing 51 having therein suction and discharge openings 52 and 53 which communicate with inlet and outlet chambers 54 and 55, respectively. These latter chambers are divided by a center plate 56 into two compartments. Communicating with each of these compartments is a pair of pump chambers 57 and 58 also of cylindrical form. Through the center of these chambers drive shaft 36 is passed, being suitably supported in the casing. Upon such shaft a pair of annular plungers 59 are eccentrically keyed, the two being diametrically opposed to each other on opposite sides of partition 56 and adapted to communicate with the walls of the pump chamber as the shaft rotates. Attached to the upper sides of plungers 59 is a pair of hollow extensions 63 having openings 64 near their lower ends and openings 65 in their upper ends, the latter communicating with the pump outlet chamber 55 and the former with the compression chambers on the outlet sides of the rotating plungers. These extensions are arranged to move in ball and socket guides 65 and to connect the pump compression chambers with the pump outlet chambers 55.

In practicing the invention as shown in Fig. 1, the motor operated pump 4 is first started to provide the necessary pressure in header 3. The pump motor 11 is then set in motion and the hand valve 67 in pipe 6 opened. When this is done the liquid fuel flows into pipe 6 and through the pressure regulating valve 13 and rotary valve 8 to the furnace. At the starting of this operation valve 13 acts under the influence of the inlet pressure only. However, as soon as the fuel passes valve 8 a pressure is set up in pipe 21 causing valve 13 to adjust itself automatically to maintain a preselected pressure drop across the pump 8. Hence the amount of fuel supplied thereafter through pipe 6 is definitely proportionate to the speed at which the motor 11 is operated.

With a construction such as that shown in Fig. 2*a*, after motor 4 has been started and valve 67 opened pump 9 will be operated by the pressure in the header 3. The pressure utilized for this purpose will, as in the aforementioned system be positively controlled by the regulating valve 13 as soon as the fuel reaches the pipe 21 inasmuch as such valve is adapted to maintain the pressure across the pump constant, and, as previously described, the blower 46 which func-

tions as a brake through the operation of the piston 49 will definitely regulate the speed of the pump 9 and thereby the amount of fuel flowing through the pump.

Among the chief advantages of the invention as referred to above is that through its use a flow of fuel through a pipe line may be positively and effectively regulated independently of any variations which may occur in the fuel line or in a furnace to which fuel is being supplied.

According to the provisions of the patent statutes, we have explained the principle and mode of operation of our invention, and have illustrated and described what we now consider to represent its best embodiment. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. A liquid flow control comprising a supply of fluid under pressure, a flow line connected to said supply, a positive displacement valve arranged in said line, means for maintaining a predetermined difference in pressure of substantially constant value across said valve, and means for determining the speed of operation of the valve whereby the volume of fluid passing through the flow line is positively determined.

2. A liquid flow regulating system comprising a supply of liquid under pressure, a flow line connected to said supply, a positive displacement rotary pump disposed in said flow line, means for maintaining the differential in pressure on the two sides of said pump at a substantially constant predetermined value, and means for controlling the speed of said pump.

3. A liquid flow regulating system comprising a supply of liquid under pressure, a flow line connected to said supply, a metering valve arranged in said line, a pressure regulating valve disposed in the flow line, pressure responsive means for operating said pressure-regulating valve, and means for rendering said pressure responsive means responsive to the differential of the pressure obtaining in said flow line between said pressure-regulating valve and said metering valve and the opposite side of said metering valve.

4. A flow control comprising a supply of liquid under pressure, a flow line connected to said liquid supply, a positive displacement pump arranged in said line, a pressure-regulating valve arranged in said flow line and adapted to maintain a substantially constant selected pressure difference across said pump, and a variable speed motor coupled to the pump for driving it at a selected speed.

5. A flow control comprising a supply of liquid under pressure, a flow line connected to said supply, a positive displacement pump arranged in said flow line, said pump being adapted to be operated by the pressure in the flow line, means for maintaining the pressure differential on the two sides of said pump at a substantially constant preselected value, and means for preventing said pump exceeding a predetermined speed.

6. A flow control comprising a supply of liquid under pressure, a flow line connected to said supply, a positive displacement pump arranged in said flow line, said pump being adapted to be operated by the pressure in the flow line, means for maintaining the pressure differential on the two sides of said pump at substantially constant selected value, a braking device coupled to said pump, and means controlled by the speed of said pump for controlling the operation of said braking device to control the speed of the pump.

7. A flow control comprising a source of liquid under pressure, a flow line connected to said source of liquid, a positive displacement valve arranged in said flow line and adapted to be driven by the pressure in the line, a blower coupled to said positive displacement valve for producing a force having a definite relation to the speed of the pump, a brake also coupled to the said valve, and means operated by the pressure produced by said blower for controlling the operation of said brake.

8. A flow control comprising a source of liquid under pressure, a flow line connected to said source of liquid, a positive displacement rotary valve arranged in said flow line and adapted to be driven by the pressure in the line, a pressure-regulating valve disposed in said flow line, means for operating said pressure-regulating valve to maintain a substantially constant preselected pressure drop across the rotary valve, a blower operably coupled to the rotary valve and adapted to produce a force bearing a definite relation to the speed of said valve, a brake mechanism for controlling the speed of said rotary valve, and means responsive to the force produced by said blower for controlling the operation of the brake.

9. A flow control comprising a supply of liquid under pressure, a flow line connected to said supply, a positive displacement rotary valve arranged in said flow line for controlling the flow of liquid in the line, means for controlling the speed of said valve, means for maintaining a substantially constant pressure differential across said positive displacement valve, and means operated in accordance with the speed of the valve for recording the volumetric flow of liquid through the flow line.

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