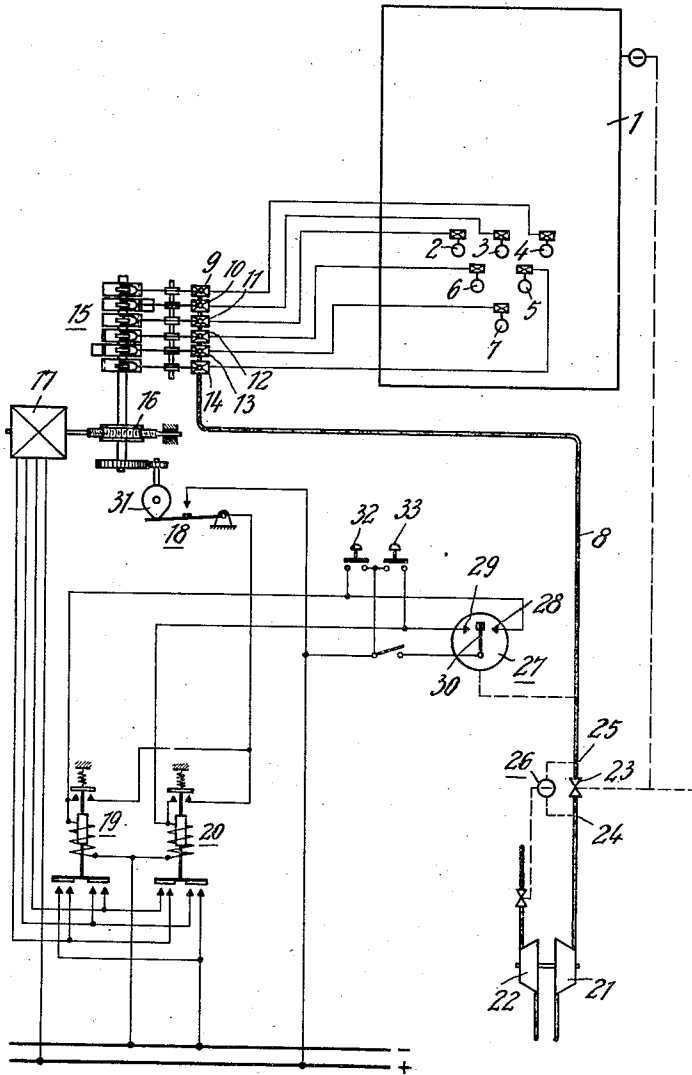


March 9, 1937.

W. PONTOW ET AL
REGULATING APPARATUS

2,073,072

Filed May 1, 1935



INVENTORS
WERNER PONTOW AND
GÜNTHER SCHROEDER
BY
a. B. R. R. R.
ATTORNEY

UNITED STATES PATENT OFFICE

2,073,072

REGULATING APPARATUS

Werner Pontow, Berlin-Wilmersdorf, and Gün-
ther Schroeder, Berlin-Charlottenburg, Ger-
many

Application May 1, 1935, Serial No. 19,152
In Germany February 13, 1934

8 Claims. (Cl. 137—78)

Our invention relates to an improved regulat-
ing apparatus for controlling the supply of a
flowing medium and generally speaking to in-
stallations of any kind in which a medium ca-
5 pable of being conveyed in a flowing manner is-
sues at the point of utilization through nozzles
or like outlets the number of which is variable.
As examples of such installations furnaces may
be mentioned in which the fuel which consists
10 of a medium, for example, in the form of coal
dust, is fed in a flowing manner and is supplied
to a number of burners. A further example is a
cooling installation in which a medium in vapor
or gaseous form is cooled by a liquid cooling me-
15 dium supplied thereto through nozzles which are
arranged in the path of flow of vapor or gas.
Such an installation is embodied in a de-super-
heater or condenser in which atomizing nozzles
are arranged in the path of flow of the steam to
20 be cooled, and through which, for example, water
as cooling medium is sprayed in finely divided
form.

In installations of the aforesaid character, to
secure the desired effect, the speed or pressure at
25 which the medium issues at the nozzle should be
maintained within certain limits: For example,
in the case of fuel supplied to a furnace, combus-
tion will be poor if the pressure of the fuel at the
burner falls below a predetermined value. With
30 a de-superheater or condenser, the cooling effect
is diminished if the cooling medium drips from
the nozzles in the form of drops, owing to an in-
sufficient atomizing pressure at the nozzle.

In order to keep the fluctuations in velocity at
35 which the medium issues from the nozzles or other
outlets in all cases substantially within permis-
sible limits, when a considerable change in the
total quantity delivered from the nozzles is neces-
sary, one or more nozzles are switched on or off.

40 Heretofore, this has been accomplished in the
simplest installations by hand. In such cases,
however, it has been necessary constantly to
watch a manometer connected to the pipe lead-
ing to the nozzles and at the same time to super-
45 vise or regulate the feed device of the flowing
medium: This procedure is very irksome with
installations which otherwise require no super-
vision, and it may be avoided by automatically
switching on and off individual nozzles in ac-
50 cordance with variations of the total quantity of
the material supplied to the nozzles, nozzles be-
ing automatically switched on or off simultaneous-
ly with an increase or decrease of the quantity
supplied. With such automatic regulation, there
55 is, however, no guarantee that fluctuations in

pressure at the nozzles is always kept within per-
missible limits. Switching in or out of nozzles
reacts upon the pressure and quantity on the
delivery side, making stable regulation extreme-
ly difficult, and in accordance with the present
5 state of the art, not achievable with certainty
and by simple means. The present invention pro-
vides in this respect satisfactory, controllable
regulating conditions, it being proposed to supply
the medium in the quantity required at any time
10 independent of the pressure in the supply pipe
and to provide a separate regulating device by
means of which nozzles are switched in and out
automatically when the pressure in the supply
pipe reaches an upper or lower limiting value. 15
Feeding means, such as a pump, is used for sup-
plying the medium to the nozzles in accordance
with requirements and, at different speeds, de-
livers quantities of the medium, which are prac-
tically independent of the delivery pressure. In
20 carrying the invention into effect, the energy sup-
plied to the prime mover for the supply pump is
automatically regulated so that the pump con-
stantly delivers a definite but variable standard
quantity of the medium.

25 The nozzles are switched progressively into and
out of operation by means of a reversible motor,
the motor operating in one direction or the other
in response to a device actuated by pressure in
the supply pipe for the nozzles. Means is as-
30 sociated with the motor to assure that opera-
tion thereof shall be adequate to fully open or to
close a nozzle. In practice, the quantity of me-
dium supplied by the pump to the nozzle or noz-
zles may be automatically varied or supervised
35 by controlling the supply of energy to the prime
mover by means of a flow meter, or other device
responsive to quantity of medium flowing, and
acting as an impulse transmitter operated in re-
sponse to the pressure difference across an or-
40 ifice, such as a valve arranged in the pipe sup-
plying medium to the nozzles. Furthermore, the
quantity of medium issuing from the nozzles may
be varied by varying the cross section of the ef-
fective passage through the orifice or valve. 45
Opening or closing of individual nozzles is pref-
erably effected by an electric motor, which op-
erates a commutator drum or cam shaft to con-
trol opening and closing of valves, and opera-
50 tion of the motor is initiated by a contact ma-
nometer through the medium of one or the other
of two relays. The relays are provided with
holding windings, which are rendered effective
upon initiation of operation of the motor to hold
an operated relay in actuated position to main- 55

tain the motor in operation even though the manometer contact is broken. The means utilizing initial movement of the motor to render the holding winding effective is also utilized to interrupt the circuit for such winding, whereby it is assured that the control apparatus will be stopped in a desired or predetermined position irrespective of prior opening of the manometer contacts.

The accompanying drawing shows a diagrammatic view of apparatus embodying our invention.

Referring to the drawing more in detail, the furnace 1 is provided with a plurality of burners, 2 to 7, inclusive. Fuel is supplied to the burners by a common supply pipe 8 having branches leading to the respective burners, and the branches are provided with cut-off valves 9 to 14, inclusive, for the burners 2 to 7, inclusive, respectively.

The valves 9 to 14, inclusive, may be actuated from the motor 17 in any suitable manner, as by means of electromagnets controlled by the commutator drum 16, the arrangement being such that, if the motor is operated in one direction, the valves are progressively opened, and, if operated in the other direction, the valves are progressively closed. As shown, the commutator drum is rotated by the motor 17 through the medium of suitable reduction gearing 18. The motor 17 also actuates an interrupter 19, the arrangement being such that, when the motor is at rest, the circuit through the interrupter is open, the interrupter closing such circuit immediately after the motor starts in order that the holding circuit for the relays 19 and 20 may be rendered effective as hereinbefore pointed out.

Fuel for operating the furnace is supplied to the pipe 8 by means of a pump 21 driven by a suitable prime mover, such as a turbine 22.

The supply pipe 8 is provided with an orifice, such as a throttle valve 23, arranged between the pump and the series of cut-off valves, and the difference in pressure prevailing at the points 24 and 25 across the orifice or valve 23, and which pressure difference is a measure of the quantity of fuel passing at any time through the pipe 8, is, in a well known manner, caused to act on a quantity measuring device or meter 26. The quantity measuring device or meter 26 is illustrated diagrammatically and it functions as an impulse transmitter or regulator to adjust the supply of energy to the prime mover or turbine 22, whereby the delivery of the pump 21 may be maintained independent of the pressure prevailing in the supply pipe 8.

With the motor 17 and the parts operated thereby in the inactive position shown on the drawing, starting of the motor is effected by the contact manometer 27, operatively associated with the pipe 8 and responsive to pressure therein. The manometer has two spaced stationary contacts 28 and 29 and a cooperating contact 30 movable therebetween and arranged to contact with either one or the other thereof. The movable contact 30 is arranged to be moved in accordance with the magnitude of pressure existing in the pipe 8 and the stationary contacts 28 and 29 are positioned according to the desired maximum and minimum pressures for the pipe 8.

The method of operation of the regulating apparatus is as follows:—

Assuming, for example, that firing of a steam boiler is to be regulated and that the main regulator of the boiler transmits an impulse for increasing the heat supply to the furnace, then, as diagrammatically illustrated, the impulse is ar-

ranged to act on the valve 23 to move the latter in a direction to increase the flow-area of the pipe 8. In consequence of movement of the valve 23 in an opening direction, the pressure difference across such valve or the orifice diminishes, resulting in actuation of the regulator 26 and thereby causing an increased flow of energy to the motor or turbine 22, this operation continuing until the pump 21 delivers a sufficiently increased quantity of fuel to restore the normal pressure difference across the valve 23. Thus, independently of the pressure of fuel prevailing in the pipe 8, the pump 21 will supply an increased quantity of fuel to such pipe, as determined by the main regulator. If the increased quantity of fuel conveyed through the pipe 8 does not increase the pressure in such pipe up to the permissible maximum value, the increased quantity of fuel flows through the burners in operation, resulting merely in an increase in pressure and velocity at which the fuel flows from the burners. If, however, the increased quantity of fuel delivered by the pump 21 results in a sufficiently large increase in pressure in the pipe 8 to cause the movable contact 30 to engage the stationary contact 28, the circuit for the relay 19 is thereby closed and operation of the motor 17 is initiated.

As shown in the drawing, each of the relays is provided with a holding circuit including the interrupter 19, the interrupter being operated from the motor 17. As shown, the interrupter is opened and closed by means of a cam 31 operated through suitable gearing from the motor 17, the arrangement being such that operation of the motor is terminated by the cam opening the interrupter. Assuming that there is a sufficient increase in pressure in the pipe 8 to cause the movable contact 30 to engage the stationary contact 28, then a circuit is completed through the winding of the relay 19 to secure operation of the relay to start operation of the motor 17, and, soon after starting of the motor, the cam 31 operates to permit the interrupter 19 to reengage, whereupon the holding circuit for the relay 19 is rendered effective to hold such relay in actuated position to assure continuance of operation of the motor irrespective of disengagement of the movable contactor 30 from the stationary contactor 28, operation of the motor 17 being terminated by the cam 31 opening the interrupter. The effect of operation of the motor in the manner indicated in response to increase in pressure in the pipe 8 is to cause progressive opening of further valve or valves, and termination of operation of the motor by means of the cam operated thereby assures that the valve or valves for further nozzle or nozzles shall be fully opened.

If the quantity of fuel delivered by the pump is reduced by regulation of the valve 23 in the direction opposite to that immediately hereinbefore described, and, in consequence, if there is sufficient fall in pressure in the pipe 8 for the movable contact 30 to engage the stationary contact 29, then the relay 20 is rendered effective and the motor 17 is operated in the direction to cause a burner or burners to be switched off.

Since, in general, only a coarse regulation can be effected with the main regulator in the form in which this is generally used with boiler plants, there is also provided in the present case means for producing a further correcting impulse which corrects the position of the valve 23 in accordance with the temperature at the furnace 1.

It has been shown above how the regulating apparatus of an installation according to the in-

vention functions when the quantity of heat produced at the furnace is varied by a regulating impulse. The described operation, however, does not reveal an important advantage of the improved method of regulation which may be obtained. Thus the case may arise that the pressure in the pipe 8 varies without the quantity of fuel delivered by the pump 21 having to undergo any variation. Such variations in pressure occur for example when one or more of the burners in use foul up in the course of their use in such a manner as to result in an increased resistance to the outflow of the fuel. If in consequence the pressure in the pipe 8 thereby increases to such an extent that the movable contact 30 of the manometer 27 engages the stationary contact 28 for the maximum permissible pressure, then a further burner is automatically switched into operation. A disturbance in working which might otherwise occur by carbonization of one or more burners is thus automatically prevented by the improved regulating apparatus and consequently the apparatus also serves as a safety device for the installation.

The circuits for the relays 19 and 20 include push button switches 32 and 33 so that the burners may be switched on or off manually at any time. If the switch 32 is closed, then one or more further burners may be opened, as desired, and closing of the switch 33 results in switching off of one or more burners. The additional feature of manual control is advantageous when one or more of the burners in use has suffered damage and which makes it advisable to reduce the load falling on the individual burners by switching a further burner into use.

Obviously, in accordance with our invention, the burners or nozzles 2 to 7, inclusive, may be used for discharging any suitable material or medium, for example, powdered fuel or liquid fuel. Furthermore, as hereinbefore indicated, the nozzles may be used for supplying steam or gaseous medium to any suitable apparatus. Therefore, the term "fluent medium", as used herein, is intended to indicate any media capable of flowing.

We claim as our invention:

1. In apparatus of the character described, a plurality of nozzles, a conduit for supplying fluent medium to the nozzles, a pump for delivering fluent medium to the conduit, a prime mover for driving the pump, a variable orifice in the conduit between the pump and the nozzles, means responsive to an operating condition of the apparatus for controlling the area of the variable orifice, means responsive to the pressure difference across the orifice for controlling the supply of energy to the prime mover so that the pump may be operated so as to deliver fluid medium quantitatively in accordance with operating requirements of the apparatus, a reversible electric motor for progressively opening and closing the nozzles, first and second relays for controlling the motor for operation in nozzle-opening and in nozzle-closing directions, respectively, control circuits for said relays including a pair of spaced stationary contacts, a movable contact cooperating with the stationary contacts and movable in response to change in pressure in the conduit between the orifice and the nozzles, a circuit for holding the relays in operated position and including an interrupter, and means operated by the motor for opening and closing the interrupter.

2. In apparatus of the character described, a plurality of nozzles, a conduit for supplying fluid medium to the nozzles, means for delivering fluid medium to the conduit, means for regulating the last-named means to cause the latter to deliver fluid medium quantitatively to the conduit in accordance with operating requirements of the apparatus, and means for regulating the pressure in said conduit and including means for opening one or more nozzles in case of increase in pressure and for closing one or more nozzles in case of decrease in pressure.

3. In apparatus of the character described a plurality of nozzles, mechanism for progressively opening and closing the nozzles and including an operating motor, a conduit for supplying fluid medium to the nozzles, means for delivering fluid medium to the conduit, means for regulating the last-named means to cause the latter to deliver fluid medium quantitatively to the conduit in accordance with operating requirements of the apparatus, and means responsive to pressure in the conduit for controlling the operation of said motor so as to cause the latter to open or close nozzles to minimize variations in conduit pressure.

4. The combination as claimed in claim 2 with means operated by the motor to assure that a nozzle is completely opened or completely closed when the motor comes to a stop.

5. In apparatus of the character described, a plurality of nozzles, mechanism for opening and closing the nozzles progressively and including a reversible operating motor, a conduit for supplying fluid medium to the nozzles, means for delivering fluid medium to the conduit, means for regulating the last-named means to cause the latter to deliver fluid medium quantitatively to the conduit in accordance with operating requirements of the apparatus, means responsive to pressure in the conduit for controlling said motor to effect opening and closing of nozzles so as to limit variation in conduit pressure, and means operated by said mechanism to assure of nozzles being completely opened or completely closed when the motor is stopped.

6. In apparatus of the character described, a plurality of nozzles, a conduit for supplying fluid medium to the nozzles, a pump for delivering fluid medium to the conduit, a motor device for driving the pump, means responsive to operating requirements of the apparatus to control the supply of motive medium to the motor device to cause the pump to deliver fluid medium quantitatively to the conduit in accordance with operating requirements of the apparatus, and means responsive to pressure in the conduit for opening one or more nozzles in case of increase in pressure and for closing one or more nozzles in case of decrease in pressure in order to minimize variation in pressure in the conduit.

7. In apparatus of the character described, a plurality of nozzles, a conduit for supplying fluid medium to the nozzles, means providing a variable orifice in the conduit, a pump for delivering fluid medium to the conduit, a motor device for driving the pump, means responsive to an operating condition of the apparatus for adjusting the area of said orifice, means responsive to differential pressure across the orifice for controlling the admission of motive medium to the motor device, and means responsive to pressure in the conduit for opening one or more nozzles in case of increase in conduit pressure and for closing one or

more nozzles in case of decrease in conduit pressure in order to minimize pressure variations.

8. In apparatus of the character described, a plurality of nozzles, mechanism for progressively opening and closing the nozzles including a motor, a conduit for supplying fluid medium to the nozzles, means providing an orifice of variable area in the conduit, a pump for delivering fluid medium to the conduit, a motor device for driving the pump, means responsive to an operating condition of the apparatus for adjusting the area of said orifice, means responsive to differential

pressure across the orifice for controlling the admission of motive medium to the motor device, means responsive to pressure in the conduit for controlling said motor so as to cause the latter to open one or more nozzles in case of increase in conduit pressure in order to limit variations in conduit pressure, and means operated by said mechanism to assure that a nozzle shall be completely opened or completely closed when the motor comes to a stop.

WERNER PONTOW.

GÜNTHER SCHROEDER.