June 27, 1939. P. S. DICKEY 2,163,592

CONTROL SYSTEM

Original Filed Dec. 18, 1935 2 Sheets-Sheet 1

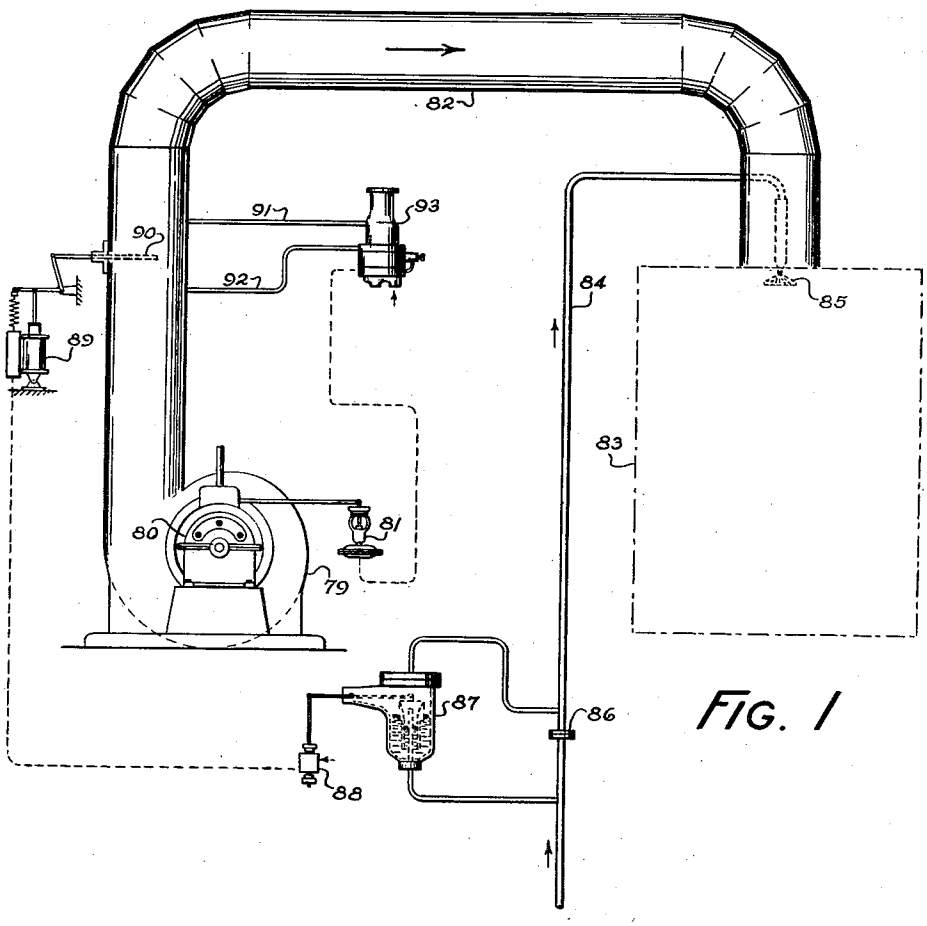


FIG. 1

INVENTOR.
PAUL S. DICKEY
BY Raymond D. Junkins
ATTORNEY

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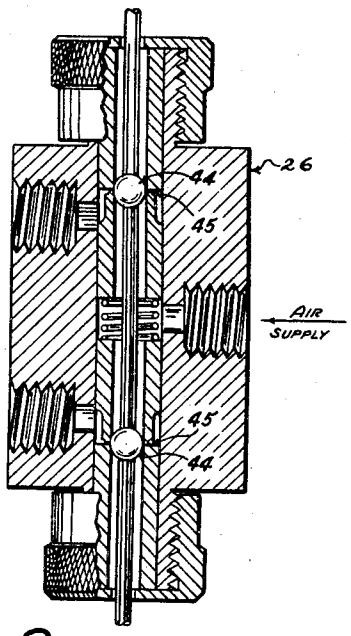


FIG. 2

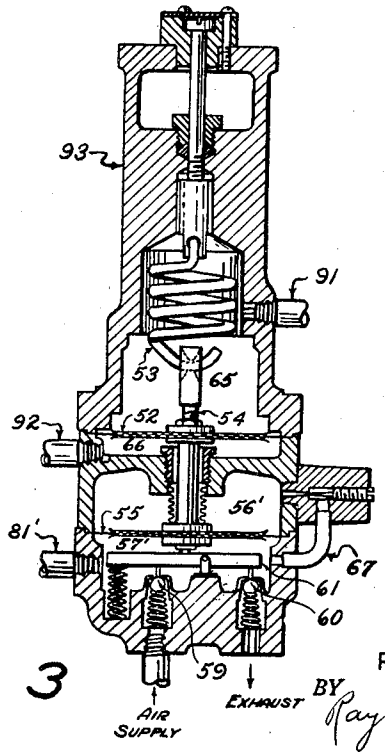


FIG. 3

INVENTOR.
PAUL S. DICKEY
BY Raymond W. Junkins
ATTORNEY

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UNITED STATES PATENT OFFICE

2,163,592

CONTROL SYSTEM

Paul S. Dickey, Cleveland, Ohio, assignor to Bailey Meter Company, a corporation of Delaware

Original application December 18, 1935, Serial No. 55,026. Divided and this application November 20, 1937, Seral No. 175,614

5 Claims. (Cl. 158—1)

This invention relates to a method and means for operating and controlling the operation of speed-governed apparatus such, for example, as elastic fluid turbine; and in particular where such a turbine is driving a pump, fan, or similar machine, and where the speed of the turbine is desirably to be maintained in accordance with the value or relation of values of variables in the operation of the system.

To make clear the arrangement and functioning of my invention I have chosen to illustrate and describe it in connection with a power producing and utilizing system comprising in general a vapor generator, a vapor utilizer, and certain auxiliaries for supplying liquids and the elements of combustion to the vapor generator.

The present invention, while particularly illustrated and described in connection with a preferred type of furnace or generator, is by no means limited in its application to this type, or in fact to vapor generators as a class. It is equally applicable as a method and apparatus in any system wherein the output of a governed machine is utilized as a function in the control of said machine.

A principal object of the invention is to provide a control sensitive to and responsive to the output of a governed machine and for controlling the speed of said machine.

A further object is to provide a control for a governed machine sensitive to the output of said machine as well as to other variables in the operation of the same or in other systems.

Further objects will become evident from a study of the specification and of the drawings, in which:

Fig. 1 diagrammatically illustrates a furnace, combined with the requisite apparatus to control the functioning thereof, and such apparatus shown in partially diagrammatic fashion.

Fig. 2 is a sectional elevation of a pilot valve.

Fig. 3 is a sectional elevation of a pneumatic relay.

In the various drawings, identical parts bear the same reference numerals.

In Fig. 1 I illustrate a preferred embodiment of the invention, wherein an air fan **79** is driven by a steam turbine **80** under the control of an air-actuated mechanism **81**. The air from the fan **79** passes through a conduit or duct **82** to a furnace **83** to provide the air to support combustion of fuel, such as fuel oil supplied through a pipe **84** to a burner **85**. The system proportions the air to the fuel, in direct or graduated value as may be desired.

In the fuel oil supply line **84** is located an orifice or other differential producing restriction **86**. A flow meter **87** is located to be sensitive to pressure differential across the orifice **86** and is of a known type, such as is disclosed in the patent to Ledoux No. 1,064,748. Such a meter is a differential pressure responsive device adapted to correct for non-linear relation between differential pressure and rate of flow, to the end that angular positioning of its external arm is by increments directly proportional to increments of rate of flow. I illustrate by dotted lines within the flow meter **87** the outline of the internal construction wherein is a liquid sealed bell having walls of material thickness and shaped as described and claimed in the above mentioned Ledoux patent. The flow meter **87** is adapted to position a pilot **88** to establish an air loading pressure at the pneumatic actuator **89** for the positioning of a slide damper **90**.

The damper or valve **90** is positioned across the duct **82** to provide a variable or adjustable orifice for the measurement of the flow of air to the furnace. The pressure drop across the damper **90** is transmitted through the pipes **91**, **92** to a stabilizing relay **93** of the type illustrated in Fig. 3. This stabilizing relay establishes a loading pressure effective upon the air actuator **81** for control of speed of the turbine **80**.

The pilot valve **88** is of the type illustrated in detail in Fig. 2 and forms the subject matter of a patent to Clarence Johnson No. 2,054,464 dated September 15, 1936.

Air under pressure is supplied to the interior of the casing **26** intermediate the pilot lands **44**, which lands are so spaced along the stem as to coincide with narrow annular ports **45**. When the pilot stem is axially moved in the casing so that the lands **44** are moved relative to the ports **45**, then a definite loading pressure is available in the annular ports bearing a known relation to the amount of such movement. For example, if the pilot stem is moved upwardly there is available at the upper left-hand exit of the casing **26** a loading pressure increasing in definite relation to said movement, while if the pilot stem is moved downwardly there is available at the lower left-hand exit a pressure increasing definitely with such movement. The air pressure pipe or capillary connecting between the pilot valve **88** and the actuator **89** is shown by dotted line in Fig. 1.

The lands of the pilot **88** may be so shaped that the flow of air will be in direct proportion to the flow of oil at all rates of operation or may

increase with rate of fuel oil supply or decrease with the rate of fuel oil supply or as desired.

Referring now to Fig. 3, the standardizing relay 93 is of a type disclosed and claimed in the patent to Harvard H. Gorrie, No. 2,098,914 dated November 9, 1937.

The connection 91 leads to a chamber 65, separated by a diaphragm or movable partition from a chamber 66 to which the connection 92 is attached. The diaphragm 52 and loading spring 53 are both connected to a stem 54, to which is also attached a diaphragm 55, separating the chambers 56', 57'. A supply of air under pressure is available to the chamber 57' under the control of a valve 59. Exhaust from the chamber 57' to the atmosphere is under the control of a valve 60. The stem 54 is adapted to position a valve actuator 61 to either admit air under pressure through the valve 59, thus increasing the pressure within the chamber 57', or to bleed air to the atmosphere through the valve 60 and thus decrease the pressure within the chamber 57'. Pressure within the chamber 57' is transmitted through a conduit or pipe to the spring loaded diaphragm actuator 81 controlling the speed of the turbine 80.

It will be observed that variations in the differential pressure effective across the diaphragm 52 will be effective to vary the air pressure within the chamber 57' and correspondingly effective upon the positioning of the actuator 81.

A controllable bleed connection 67 is connected between the chambers 56' and 57'. The function of the controllable bleed connection 67 is to supplement the primary control of the pressure effective upon the actuator 81 with a secondary control, of the same or different magnitude, as a follow-up or supplemental action to prevent over-travel and hunting, and wherein the positioning of the actuator 81 will not necessarily be directly with the positioning of the damper 90.

The damper 90 acts as a variable orifice across which there will exist a pressure differential bearing a known relation to the rate of flow of fluid through the conduit 82. Pressures on opposite sides of the damper 90 are effective through the pipes 91, 92 respectively in chambers 65, 66 of the standardizing relay 93.

In general, the control of the supply of fuel oil through the conduit 84 may be by hand or from any variable in the operation of the furnace or other process. The flow is measured by the meter 87, which establishes a loading pressure to position the actuator 89 and the damper 90 (variable orifice). The pressure differential across the damper 90 establishes a loading pressure effective for control of the steam inlet valves of the turbine 80 to vary the speed of the turbine and of the fan 79 in direction and amount such as to maintain the pressure differential effective upon the relay 93 at a constant value. Thus for every value of fuel oil rate of flow there will be a definite position of the damper 90 and the speed of the turbine 80 will be automatically controlled to maintain the pressure differential across the damper 90 constant, and thus vary and control the flow of air to the furnace in desired proportion to the supply of fuel oil.

The control of the speed of the turbine 80 is in accordance with the output of the fan 79 and of the turbine 80. It will be understood that by such a control system, all such variables as flow characteristics past the damper 90, of the admission nozzles, etc. of the turbine 80, changes in temperature, pressure, etc. of the steam for running the turbine 80, as well as characteristics of the turbine and pump, are disregarded and the final result is a flow of air through the conduit 82 definitely in accordance with the position of the damper 90.

While I have chosen to illustrate and describe certain preferred embodiments of my invention it will be understood that I am not to be limited thereby, but only as to the claims in view of prior art.

The present application forms a division of my copending application Serial No. 55,026, filed December 18, 1935, for Control systems.

What I claim as new, and desire to secure by Letters Patent of the United States, is:

1. In combination with a furnace, means for supplying one of the elements of combustion to the furnace, a meter of such supply, a conduit for another element of combustion supplied to the furnace, a valve in said conduit positioned responsive to said meter, means for pumping the element through said conduit, an engine driving said pumping means, and means responsive to the pressure differential across said valve for controlling the speed of said engine.

2. In combination with a furnace supplied with fuel and air for combustion, a conduit for fuel and a conduit for the air, a meter of the flow of fuel, valve means for the air conduit positioned under the control of said meter, and means under the control of the pressure differential across said valve effective in varying the rate of flow of the air.

3. Apparatus for proportioning two flowing fluids one to the other, comprising in combination, a conduit for each of the flows, a meter of one of the flows, an adjustable orifice in the other conduit, pumping means forcing fluid through said other conduit, said adjustable orifice positioned through the agency of said meter, and means responsive to the pressure differential across said adjustable orifice adapted to control said pumping means.

4. Apparatus for proportioning one flowing stream of fluid to another, comprising in combination, two conduits one for each stream of fluid, an adjustable orifice in one conduit and a fixed orifice in the other conduit, means responsive to the pressure differential across said fixed orifice for adjusting the adjustable orifice, and means responsive to the pressure differential across the adjustable orifice for varying the rate of flow of fluid across the adjustable orifice.

5. Apparatus for proportioning one flowing stream of fluid to another, comprising in combination, two conduits, one for each stream of fluid, an adjustable orifice in one conduit, a meter of the flow through the other conduit, said adjustable orifice positioned through the agency of said meter, and means responsive to the pressure differential across the adjustable orifice for varying the rate of flow of fluid through said first named conduit.

PAUL S. DICKEY.