

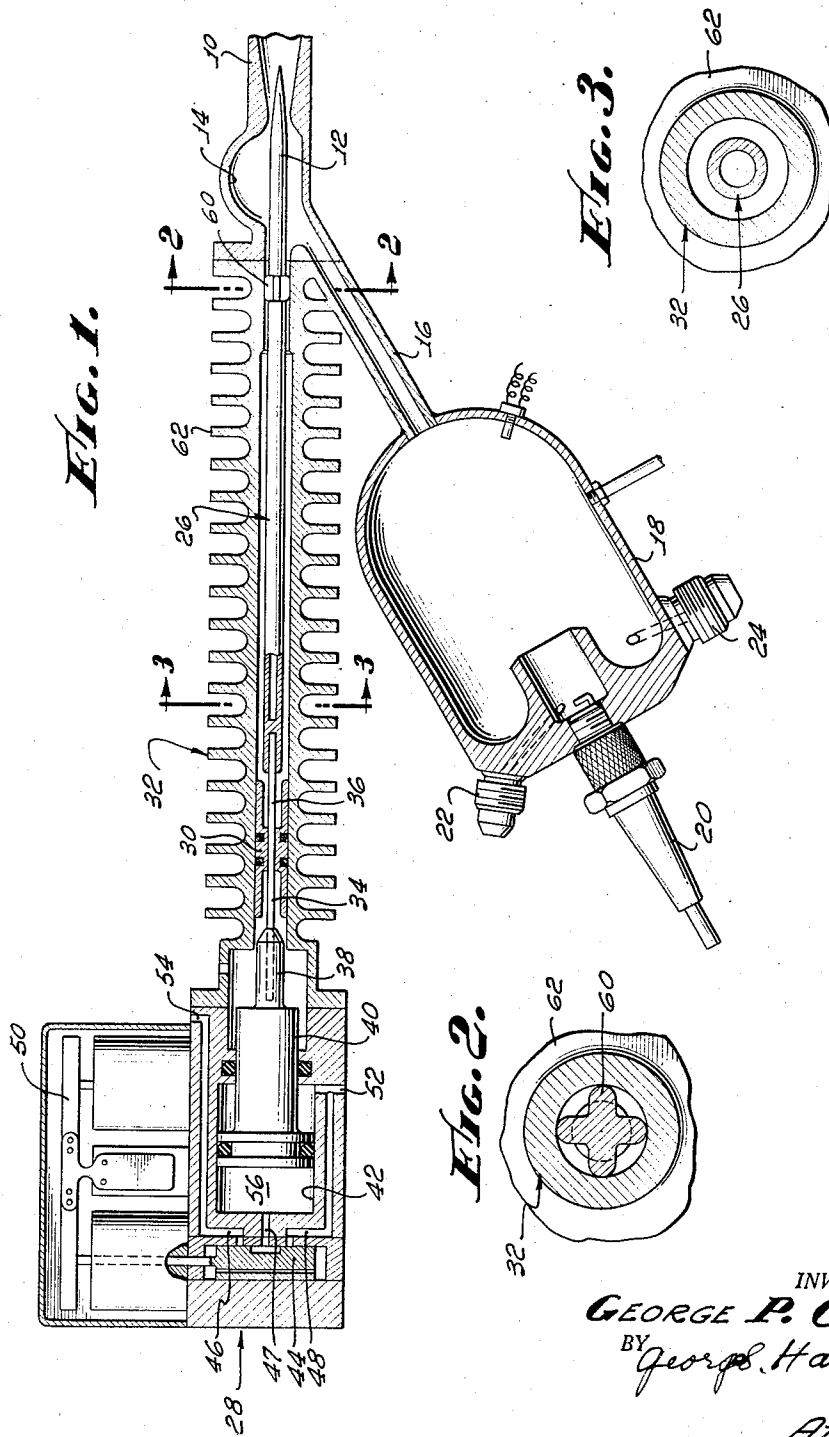
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HOT GAS VALVE FOR TURBINE SPEED CONTROL

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## HOT GAS VALVE FOR TURBINE SPEED CONTROL

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This invention relates to servo-motor controlled hot gas valves capable of withstanding high temperature of gases leaving a decomposition chamber or combustion chamber, these gases being used for actuating a gas turbine wheel, such as an impulse turbine.

It is an object of this invention to provide a needle valve for controlling the flow of hot gases through a nozzle, the valve being actuated by a servo-mechanism, with a long, high heat resistance pintle being interposed between the needle portion of the valve and the servo-mechanism so that only a limited amount of heat reaches a servo-mechanism even though the needle valve may be at a temperature in the order of 1850° F.

Still another object of the invention is to provide a control valve for hot gases having a temperature in the order of 1850° F., the valve also including a long, hollow pintle or stem which offers high resistance for the flow of heat from the hot gases to the outer end of the pintle which terminates in a lapped or packed seal independently floating in a pintle housing, this lapped seal having a flexible portion on both sides of the seal. Such flexible portions provide two metallic fingers for actuating the needle valve without producing any binding action between the valve, its housing, and the seal.

It is also an object of this invention to provide a needle valve with a long hollow stem, a flexible member connected to the outer end of said hollow stem and a seal surrounding the central portion of the flexible member, said seal forming a gas tight joint between the needle valve and a servo-mechanism used for operating the needle valve.

The novel features which are believed to be characteristic of the invention, both as to their organization and method of operation, together with further objects and advantages thereof will be better understood from the following description taken in connection with the accompanying drawings in which one embodiment of the invention is illustrated by the way of an example. It is to be expressly understood however, that the drawing is for the purpose of illustration only, and is not intended as a definition of the limits of the invention.

Referring to the drawings:

Figure 1 is a longitudinal section of the needle valve, a servo-mechanism, and a decomposition chamber;

Figure 2 is a transverse section of the valve taken along line 2—2.

Figure 3 is an enlarged longitudinal section of the valve pintle.

Referring to the drawings, the needle valve includes a nozzle 10 which is positioned next to a turbine wheel for directing hot gases having high kinetic energy into the flow channels defined by the airfoils of the turbine. The nozzle is provided with a needle valve 12 which partially closes the throat of nozzle 10. The nozzle is connected to a gas chamber 14 for receiving hot gases through a tube 16 from a decomposition chamber 18. This chamber is provided with a spark plug 20, and bi-propellant

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fuel injectors 22 and 24 which introduce the fuel into the chamber. The fuel may be gasoline and oxygen, the temperature of the reaction being adjusted by controlling the proportions of oxygen and gasoline in this mixture, the amount of the injected gasoline being in excess of the stoichiometric mixture. Whenever gasoline and oxygen is used, the temperature of the burning gases is adjusted to be in the order of 1650° F. When a mono-propellant fuel is used, the temperature is in the order of 1800° F. In order to regulate the speed of the gas turbine wheel, it is necessary to advance or withdraw the needle valve 12 so as to admit either a smaller or a larger amount of hot gases to the turbine. To accomplish such flow regulation, the needle valve is connected through a long stem 26 a flexible rod 34—36 and a pushrod 38 to a servomechanism 28. A lapped and packed seal 30 is mounted on, and surrounds rod 34—36. Seal 30 forms a sliding, gas-tight seal with the cylinder of a needle valve housing 32. The diameter, the length and the concomitant flexibility of the seal-supporting rod 34—36 are adjusted so as to act as a reasonably flexible shaft for transmitting any movement of a piston 41, mounted within a cylinder 42, to the needle valve. By making the unsupported portions 34 and 36 of this rod flexible, it becomes possible to slide freely seal 30 within the valve housing 32 even if this housing becomes slightly distorted because of the temperature differential which exists between the nozzle portion 10 and the seal portion of the housing. A sliding valve 44, positioned in sliding relationship with respect to ports 46, 47 and 48, is connected to an electrically actuated lever arm 50 which slides valve 44 into two different positions, so as to connect port 48 with port 47, or port 47 with port 46 or into a neutral position indicated in the drawing. Port 48 is connected to a pressure line 52, while port 46 is connected to a return line 54; accordingly, when the slide valve 44 connects port 48 to port 47, pressure reaches the internal chamber 56, or the cylinder, with the result that the piston and cylinder 40 are made to travel from left to right, as viewed in Fig. 1, thus decreasing the flow of gases through nozzle 10 because of the partial closing of the needle valve. The opposite takes place when port 47 becomes connected to port 46.

Referring to Fig. 2, which illustrates the transverse sectional view of the needle valve stem 26 and housing 32 in a plane 2—2 illustrated in Fig. 1, it is apparent that the needle valve has a plurality of semi-cylindrical surfaces produced by cutting out, or fluting, or scalloping, the portion of the shaft which is positioned at the transverse section 2—2. The four projecting ribs 60 keep the needle of the valve in proper alignment with the throat portion of the nozzle. Since the semi-cylindrical portions 60 have a very small radius as compared to the radius of bore, the contact formed by them with the wall of the bore may be considered as a four point contact. Therefore, such contact produces a minimum amount of friction and is free of the binding effect.

In order to increase the thermal resistance of stem 26 to the flow of heat from needle 12 to seal 30 and cylinder 42, by far the largest portion of the stem between the scalloped portion 60 and its outer end, adjacent to the flexible rod 36, is made hollow, as illustrated in Figs. 1 and 3. This outer end of stem 26 is connected to the flexible rod, or stem, 36—34 which is prevented from buckling within the stem housing 32 by means of seal 30 which forms a sliding contact with the stem housing.

The operation of the valve is as follows:

Hot gases are generated in the combustion, or decomposition, chamber 18, and reach the needle valve 12 through tube 16. Although the temperature of these gases may be of the order of 1850° F., only a small amount

of heat reaches the seal in the cylinder because of the construction of the valve stem 26, and valve housing 32, which is provided with a plurality of heat dissipating ribs 62. Accordingly, the temperature at the seal 30 may be as low as 300°–350° F., and the temperature at the valve-actuating cylinder 42 is still lower.

When bi-propellant or mono-propellant fuels are used, there may be some formation of carbon around the needle of valve 12, within chamber 14, and in the vicinity of the nozzle throat. The valve is so constructed that any reduction in the flow of gases due to the formation of free carbon at the nozzle, will at once produce a corresponding movement of the needle valve so as to admit that amount of hot gases through the nozzle which is necessary for maintaining the speed of the turbine substantially constant.

The disclosed valve has the following advantages:

It will allow the operation of the turbine at constant speed even though there is some carbon build-up between the nozzle and the needle of the valve; the path between the needle-nozzle combination and the seal has a high thermal resistance to heat flow which permits the operation of the seal without the necessity of providing any fluid cooling for the seal. The latter is accomplished by the tubular construction of the stem, by making the stem from the so-called "super alloys" such as "Allegheny Ludlum A-286" or "Westinghouse Discalloy," all of which are capable of withstanding high temperatures without excessive deformations, and which offer high resistance to flow of heat from the needle to the seal. The outer housing of the needle valve may be cast from stainless steel alloy #310 or "Stellite." This is also true of the nozzle and of the needle valve itself, and of the reaction chamber 18.

In the prior art, the regulation of the amount of gas flow, as a rule, has been accomplished by regulating the amount of fuel entering the reaction chamber 18. Since the reaction chamber has a finite volume, there always has been a time lag between the gas pressure within the chamber and the speed of the turbine. Such regulation of the turbine speed is inadequate, but has been resorted to because of the inability to obtain low temperature operation at the outer end of the needle valve. Lower temperatures are obtainable at seal 30 with the disclosed valve. The construction of the valve also permits its operation at high temperatures without producing any excessive distortion and binding action by making the stem and the housing poor conductors of heat and using a flexible rod 34–36 on both sides of the seal.

What is claimed as new is:

1. A hot gas valve including a nozzle having a throat,

a needle valve having a needle, said needle partially closing said throat, a long hollow stem connected to said needle for actuating said needle, a valve housing having a plurality of external, heat-radiating ribs and a cylindrical bore for accommodating said stem, a flexible rod, or shaft, connected to the outer end of said stem, a seal surrounding the mid-portion of said shaft and movable therewith; said seal forming a sliding fit with the wall of said cylindrical bore; and a servo-mechanism connected to said shaft for moving said needle valve with respect to said nozzle.

2. A hot gas valve as defined in claim 1 in which said long hollow stem has a diameter smaller than the inner diameter of said cylindrical bore for preventing any binding action between the stem and said bore.

3. A hot gas valve as defined in claim 2 which also includes a fluted, or scalloped portion on said stem between the inner end of said needle and said shaft for providing a plurality of semi-cylindrical guiding surfaces having a smaller diameter than the inner diameter of said cylindrical bore without producing a binding action between said bore and the fluted portion of said stem.

4. A hot gas valve comprising an elongated valve housing having a cylindrical bore throughout the length of said housing, a plurality of circumferential heat-radiating ribs surrounding said housing, one end of said housing being connected to a plenum chamber terminating in a nozzle, a needle valve having a needle extending through said plenum chamber and, in part, through said nozzle, a hollow stem connected to the inner end of said needle, said hollow stem extending through the greater length of said housing, a flexible rod, or shaft, connected with its one end to the outer end of said hollow stem and with its other end to means for regulating the position of said needle valve in said nozzle, and a seal forming a sliding engagement with said cylindrical bore and being fixedly connected to said flexible rod; said seal, said hollow stem and said needle valve all traveling as a unit in response to any movement of said means.

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