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VARIABLE AREA NOZZLE FOR DOWNSTREAM END OF
JET-PIPE IN JET PROPULSION UNITS
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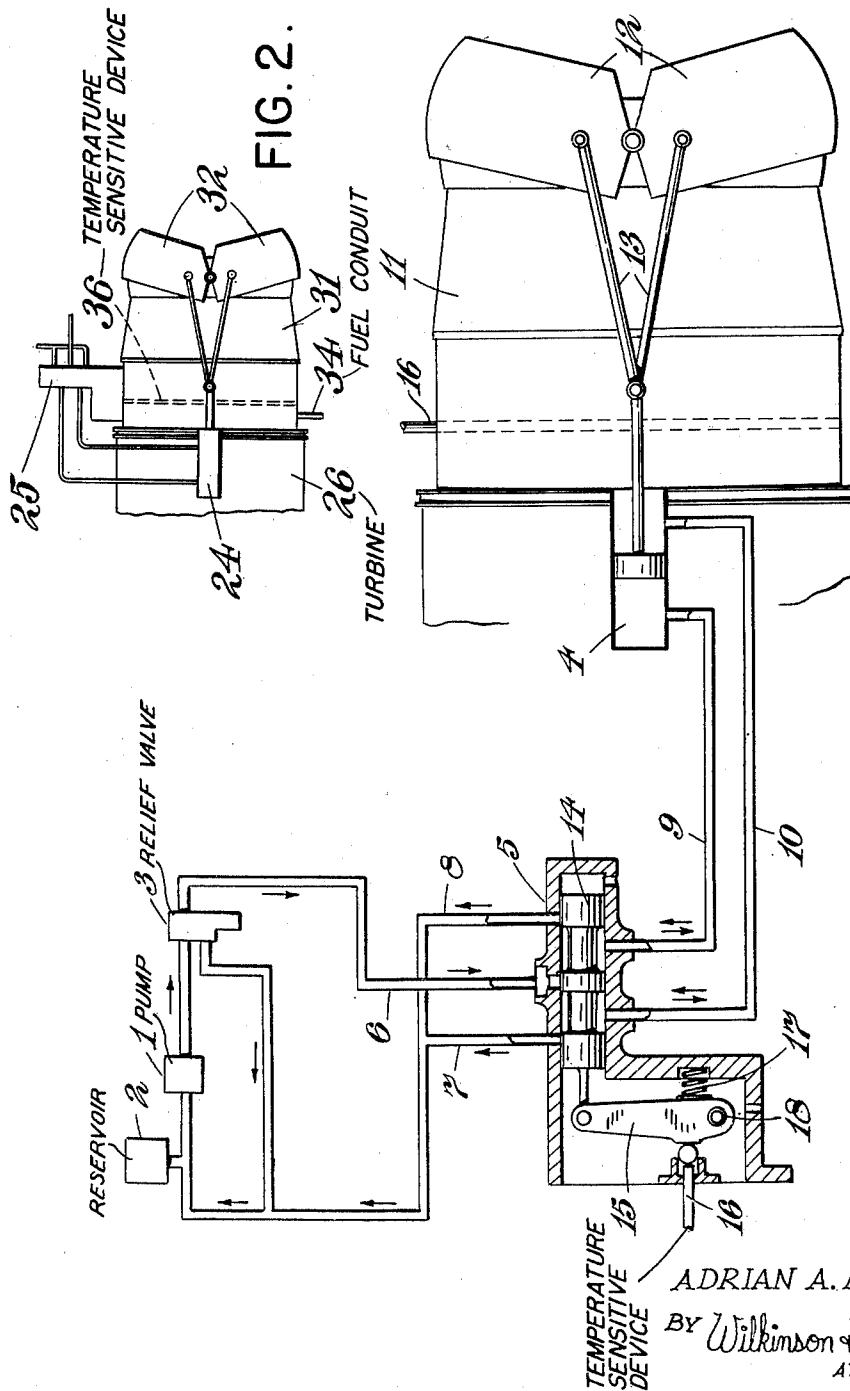


FIG. 1.

FIG. 2.

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VARIABLE-AREA NOZZLE FOR DOWN-
STREAM END OF JET PIPE IN JET
PROPULSION UNITS

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3 Claims. (Cl. 60—35.6)

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This invention relates to variable jet nozzles for jet propulsion units and has for its object to provide an automatic control therefor.

Under any given operating conditions for a jet propulsion unit, the temperature existing in the jet-pipe is partly dependent upon the area of the nozzle, and since the temperature may be one of the critical conditions it is desirable to control it by controlling the area of the nozzle.

This invention accordingly consists in the combination with a jet-pipe and a variable nozzle thereon, of a device which is sensitive to the temperature existing in the jet-pipe, and is operative to control power-means for adjusting the area of the nozzle according to changes in the temperature.

Preferably the movable part or parts of the nozzle by the movement of which the area is adjusted, is or are operated by a hydraulic ram supplied with fluid under pressure from any convenient reservoir or pump, said ram being controlled by a relay valve which is directly operated by a temperature-sensitive device.

In the drawing:

Figure 1 is a diagrammatic figure illustrating a variable jet nozzle and power means for adjusting the area thereof, and

Figure 2 is a diagrammatic view of a modified form of the invention.

In carrying this invention into effect there is provided a hydraulic system comprising a pump 1, which conveniently is driven from the turbine usually associated with a jet-propulsion unit, a reservoir 2 for oil or other hydraulic fluid supplying said pump, a relief valve 3 of any convenient type and a hydraulic ram 4. The passage of pressure fluid to and from the hydraulic ram 4 is controlled by a valve generally indicated by the reference numeral 5. As is clear from the accompanying drawing this valve is of the usual form of piston valve the piston 14 of which in its normal setting closes the pipe 6 by which pressure fluid is supplied to the valve and also closes two drain connections 7, 8 leading to the reservoir 2. Two connections 9 and 10 leading one to each end of the hydraulic ram 4 are normally open but since the connections 7 and 8 to drain are closed, the oil in the ram 4 is trapped and the ram is therefore held stationary.

The jet-pipe which is generally indicated by the reference numeral 11 carries a pair of pivotally mounted nozzle segments 12 which are adjustable about their pivot points in order to vary the area of the discharge nozzle of the jet-pipe 11. The adjustment referred to is performed

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by a pair of links 13 which are connected with the ram of the hydraulic motor 4, the arrangement being that when pressure fluid is admitted to the motor, the links 13 are moved lengthwise of the jet-pipe suitably to adjust the nozzle segments 12. In the position shown in the accompanying drawing the piston valve 14 is so disposed that oil in the hydraulic motor 4 is trapped and the ram is therefore held stationary so that the area of the nozzle is maintained constant so long as the valve 14 is in this position.

The valve 14 is coupled to a lever 15 which is pivotally mounted at 18 and engaged by a spring 17 which urges the lever 15 towards and into engagement with a temperature-sensitive device 16. It is clear therefore that the temperature-sensitive device acts directly on lever 15 to rock it in one direction and that the lever is spring urged in the opposite direction.

The temperature-sensitive device is constituted by a silica rod mounted in a stainless steel tube which is arranged to extend across the jet-pipe 11 so that the average temperature of the device closely follows that of the gas flowing through the pipe. Stainless steel is used since it will withstand any operating temperature likely to exist in the jet-pipe, and the tube is preferably stream-lined in cross-section.

With the arrangement described, as the temperature in the jet-pipe rises or falls, the temperature-sensitive device 16 acts on the rocking lever 15 so that it moves in one direction or the other and such movement is transmitted to the piston 14 of the valve 5 whereby the supply of pressure fluid in the supply pipe 6 is kept to one or the other end of the hydraulic ram 4 to effect the necessary adjustment of the nozzle, the nozzle being opened or closed as the temperature rises and falls, so as to reduce or raise the temperature in the jet-pipe 11 and thereby maintain it more or less constant.

In some circumstances the temperature of the jet-pipe is raised, as for example by burning additional fuel in it, when extra power is required, and since the area of the nozzle is a factor in determining the power, the above-described construction is particularly advantageous in that when the additional fuel is supplied to the jet-pipe, the temperature rises and the nozzle is automatically opened. When used on aircraft this additional power may be required as an emergency operation and the pilot is relieved of the necessity of adjusting the area of the nozzle as an independent operation.

Figure 2 shows in diagrammatic form such an

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embodiment of the invention. In Figure 2 the supply of pressure fluid to the hydraulic ram 24, which adjusts the setting of the nozzle segments 32, is controlled by the control valve 25, which is acted on by the temperature sensitive device 36. Thus far the arrangement described is similar to that described above with reference to Figure 1.

In this embodiment, however, fuel is supplied to the jet pipe 31 downstream of the turbine 26 through the conduit 34 so that the temperature of the exhaust gas may be raised in the jet pipe 31 when additional power is required.

The temperature sensitive device 36 is located downstream of the location at which the fuel injected through conduit 34 is burned so that the setting of the nozzle segments 32 is automatically adjusted to open the nozzle when the temperature in the jet pipe 31 is raised by burning fuel therein.

The variable jet nozzle is preferably of the form described in Patent No. 2,514,248, and there may be provided in association with valve 5 a follow-up device as described in the specification to patent application Serial No. 690,721, filed August 15, 1946.

I claim:

1. In a jet-propulsion unit, the combination of a gas-turbine, a jet pipe connected to receive the exhaust from said gas-turbine, a variable-area nozzle at the downstream end of the said jet-pipe, a temperature-sensitive device situated in said jet-pipe, power-means to adjust the area of the variable-area nozzle, and control means for said power-means operated by said temperature-sensitive device.

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2. The combination according to claim, 1 wherein said power-means comprises a hydraulic ram and a source of fluid-pressure, and said control means comprises a relay valve directly operated by the temperature-sensitive device.

3. In a jet propulsion unit, the combination of a turbine, a jet pipe connected to receive the exhaust from said gas turbine, fuel burning means in said jet pipe, a variable area nozzle on the downstream end of the said jet pipe, a temperature sensitive device situated in said jet pipe, power means to adjust the area of the variable area nozzle, and control means for said power means operated by said temperature sensitive device.

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