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INTERNAL-COMBUSTION TURBINE WITH PLURAL GENERATORS SELECTIVELY OPERABLE

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FIG.1.

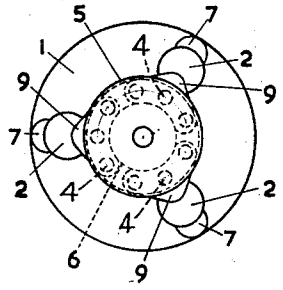

FIG.2.

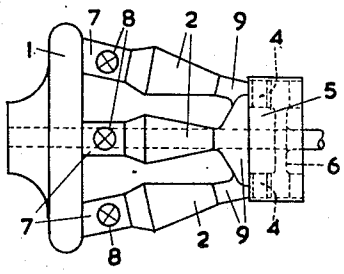

FIG.3.

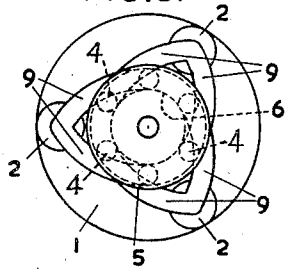

FIG.4.

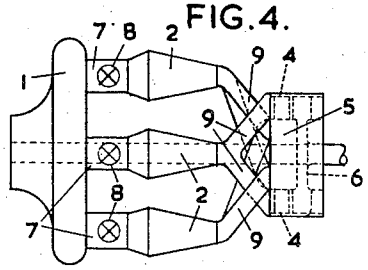

FIG.6.

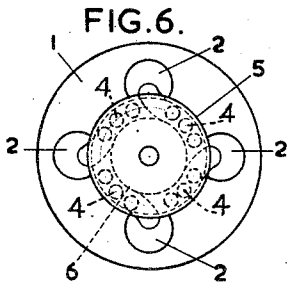

FIG.7.

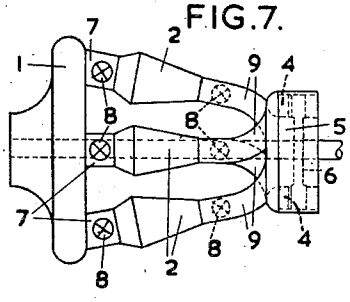

FIG.5.

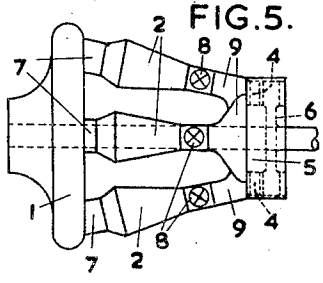

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FIG.8.

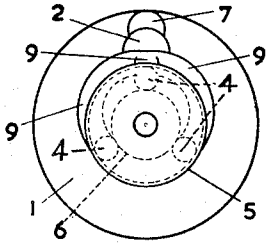



FIG.9.

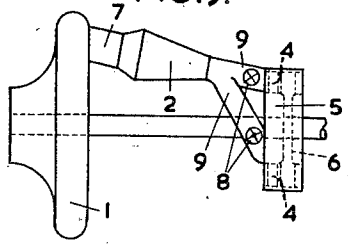
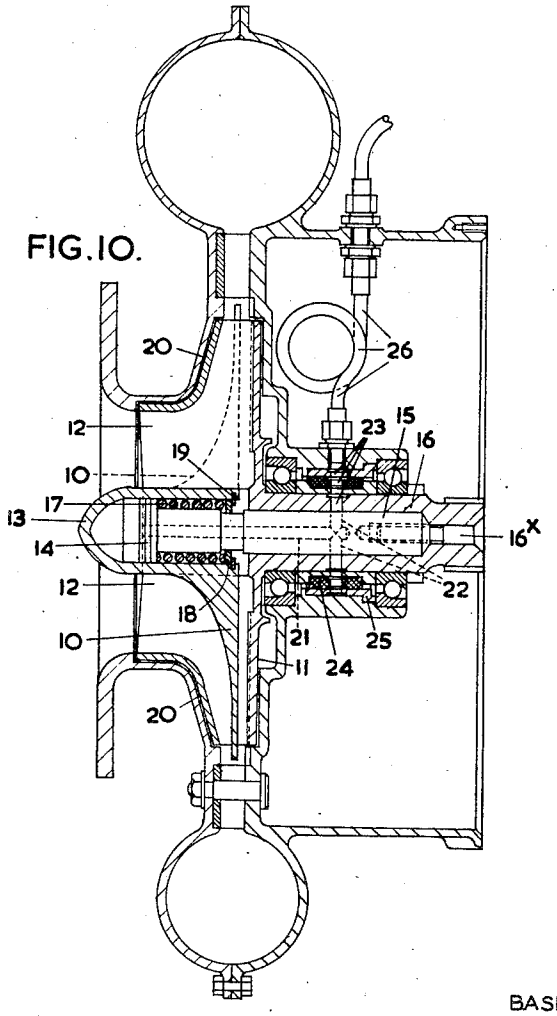



FIG.10.

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# UNITED STATES PATENT OFFICE

2,662,371

## INTERNAL-COMBUSTION TURBINE WITH PLURAL GENERATORS SELECTIVELY OPERABLE

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Application July 20, 1950, Serial No. 174,812

8 Claims. (Cl. 60—39.21)

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This invention relates to internal combustion turbines.

It is well known, that internal combustion turbines, designed to give maximum efficiency at full loads, have considerably reduced efficiency when operating under part load conditions, and the object of the present invention is to overcome or minimise this disadvantage.

Internal combustion turbines can be run on part loads by (*a*) reducing the pressure ratio, (*b*) reducing the working temperature, or (*c*) reducing the amount of air used, or by a combination of any of these three well-known methods.

In an internal combustion turbine according to the present invention, means are provided whereby the number of turbine nozzles in use can be varied, the arrangement being such as to enable the flow of air to be reduced without substantially altering the operating temperatures and pressures. Preferably also the control would be such as to maintain the balance of the turbine rotor under all operating conditions.

The invention will now be described with reference to various applications shown, diagrammatically and by way of examples, in the accompanying drawings, in which—

Figs. 1 and 2 are a side elevation and an end elevation respectively of an internal combustion turbine.

Figs. 3 and 4 are similar views to Figs. 1 and 2 respectively, but illustrate a modified arrangement.

Fig. 5 is a side elevation of an internal combustion turbine but showing a further modification.

Figs. 6 and 7 are similar views to Figs. 1 and 2 respectively but illustrate a further modified arrangement.

Figs. 8 and 9 are similar views to Figs. 1 and 2 respectively but showing yet a further modified arrangement.

Fig. 10 is a diametrical section of a variable capacity compressor, of the centrifugal type, suitable for supplying air to any of the arrangements shown in the previous figures of the drawings.

Referring to Figs. 1 and 2 of the drawings, 1 represents a compressor supplying air to combustion chambers 2 from which the heated air and products of combustion pass to the nozzles 4 of a turbine 5 so as to drive the turbine rotor 6 from which power may be taken. The combustion chambers 2 have their inlets 7 controlled by valves 8 so that the supply of air to each such chamber can be varied or cut off without altering the operating temperatures and pressures of

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the other two combustion chambers. The combustion chamber outlets 9 are flared so that each embraces or includes a number of turbine nozzles 4, or a number of sections of a nozzle ring.

The arrangement in Figs. 3 and 4 is similar to that shown in Figs. 1 and 2 except that the outlet 9 of each combustion chamber 2 has two branches which supply diametrically opposed turbine nozzles 4, so that any valve 8 can be closed without disturbing the balance of the load on the turbine rotor 6. With this arrangement one, two or all three combustion chambers 2 may be operative at any time to suit requirements, the balance of the load on the turbine rotor being preserved since each valve 8 controls the air supply to a combustion chamber feeding diametrically opposed, or a balanced set of, turbine nozzles 4.

In Fig. 5 the arrangement is similar to that shown in Fig. 1 except that the valves 8 are in the outlets 9 of the combustion chambers 2, instead of the inlets 7, so that the nozzles 4 are directly controlled by the valves.

Referring now to the modification shown in Figs. 6 and 7, the arrangement includes four combustion chambers 2, each controlled by a valve 8 in its inlet 7, as shown in full lines, or by a valve 8 in its outlet 9, as shown in chain dotted lines, and each such outlet feeds a single nozzle 4 or a set of such nozzles. With this arrangement the valves 8 associated with either of the diametrically opposed pairs of combustion chambers 2 can be closed without causing a state of unbalance of the load on the turbine rotor 6.

The modification shown in Figs. 8 and 9 includes only one combustion chamber 2 and its outlet 9 has three branches each fitted with a valve 8 through which the various nozzles 4, or sets of nozzles, are supplied and controlled.

With any of the arrangements above described, it will be understood that the characteristics of the compressor would require to be controlled to suit the number of nozzles in use at any time. If the compressor is of the positive displacement type, its delivery would be controlled by varying its speed. If, however, the compressor is of the centrifugal type, as shown, means would be required to provide for varying its capacity to suit the number of turbine nozzles in use at any time, since to vary the speed of this type of compressor would alter the compression ratio and reduce the efficiency.

The means for varying the capacity of the centrifugal compressor may, as shown in Fig. 10, comprise a shroud disc 10 which is axially adjustable in relation to the rotary impeller 11 of

the compressor to vary the effective cross sectional area of the air passages between the impeller blades 12. The shroud disc 10 is radially slotted from its periphery to a hollow central boss 13 so as to interdigitate with the radial blades 12 of the impeller 11, and said hollow central boss 13 works as a hollow piston upon the headed end 14 of a spindle 15 which is held against axial movement in an axial bore in the impeller shaft 16 by a screw 16x. The shroud disc 10 is urged toward the disc of the impeller 11 by a helical compression spring 17 which encircles the spindle 15 and operates between the head 14 thereof and a washer 18 which is retained in the rear end of the boss 13 by a circlip 19. In order to adjust the shroud disc 10 away from the disc of the impeller 11, and thereby alter the effective cross-sectional area of the air passages between the impeller blades 12, inlet casing 20 and shroud disc 10, oil or other appropriate fluid under pressure is admitted to the chamber afforded in the hollow piston or boss 13 and in front of the headed end 14 of the spindle 15, so as to overcome, to the requisite degree, the compression spring 17. Such oil or working fluid is admitted through an axial passage 21 and lateral ports 22 in the spindle 15, which ports 22 are in communication, through ports 23 in the impeller shaft 16 and associated bearing packing 24 and liner 25, with a pressure supply pipe 26.

Having fully described our invention, what we claim and desire to secure by Letters Patent is:

1. An internal combustion turbine comprising a variable delivery compressor through which all of the air must flow, means to vary the volumetric capacity of the compressor while maintaining substantially the same outlet pressure therefrom, combustion chamber means supplied with air from said compressor, and a turbine in which heated air from the combustion chamber means is expanded to drive the turbine rotor, turbine nozzles in communication with said combustion chamber means for directing heated air to the turbine, control means whereby the number of turbine nozzles in use can be varied so as to enable the compressor delivery to be reduced to compensate for the reduction in turbine nozzles without altering the operating temperatures and pressures.

2. In an internal combustion turbine comprising a variable delivery compressor through which all of the air must flow, means to vary the volumetric capacity of the compressor while maintaining substantially the same outlet pressure, a number of combustion chambers supplied with air through inlets from said compressor, and a turbine in which heated air from the combustion chambers is expanded to drive the turbine rotor, turbine nozzles in communication with said combustion chambers for directing heated air to the turbine, each combustion chamber feeding certain of the turbine nozzles, valve means selectively controlling the combustion chamber inlets so that the supply of air to any of the combustion chambers can be cut off at will thus rendering ineffective the corresponding nozzles of the turbine and enabling the compressor delivery to be reduced to compensate for the reduction in turbine nozzles without altering the operating temperatures and pressures.

3. An internal combustion turbine including a variable delivery compressor through which all of the air must flow, means to vary the volumetric capacity of the compressor while maintaining substantially the same outlet pressure, a number



of combustion chambers supplied with air through inlets from said compressor, turbine nozzles in communication with said combustion chambers, a turbine in which heated air from the combustion chambers is expanded to drive the turbine rotor, each combustion chamber feeding a balanced complement of the turbine nozzles, and valve means selectively controlling the combustion chamber inlets so that the supply of air to any of the combustion chambers can be cut off at will thus rendering ineffective the corresponding nozzles of the turbine and enabling the compressor delivery to be reduced to compensate for the reduction in turbine nozzles without altering the operating temperatures and pressures.

4. An internal combustion turbine including a variable delivery compressor through which all of the air must flow, means to vary the volumetric capacity of the compressor while maintaining substantially the same outlet pressure therefrom, a number of combustion chambers supplied with air through inlets from said compressor, turbine nozzles in communication with said combustion chambers, a turbine in which heated air from the combustion chambers is expanded to drive the turbine rotor, each combustion chamber feeding a balanced complement of the turbine nozzles, and valve means selectively controlling the combustion chamber outlets so that the supply of heated air to any such set of turbine nozzles can be cut off at will enabling the compressor delivery to be reduced to compensate for the reduction in turbine nozzles without altering the operating temperatures and pressures.

5. An internal combustion turbine comprising a variable delivery compressor through which all of the air must flow, means to vary the volumetric capacity of the compressor while maintaining substantially the same outlet pressure, a single combustion chamber supplied with air from said compressor and having a number of outlets, a turbine in which heated air from the combustion chamber is expanded to drive the turbine rotor, nozzles in communication with said outlets for directing heated air to said turbine, and variable means selectively controlling the said outlets so that the supply of heated air through any of said outlets can be cut off at will thus rendering ineffective the corresponding nozzles of the turbine and enabling the compressor delivery to be reduced to compensate for the reduction in turbine nozzles without altering the operating temperatures and pressures.

6. An internal combustion turbine comprising a centrifugal compressor through which all of the air must flow through a passage, combustion chamber means supplied with air by said compressor, a turbine in which heated air from the combustion chamber means is expanded to drive the turbine rotor, nozzles in communication with said combustion chamber for directing heated air to said turbine, control means whereby the number of turbine nozzles in use can be varied, and a shroud axially adjustable in relation to the bladed impeller of the compressor to vary the effective cross-sectional area of air passages between the impeller blades so that the compressor delivery can be varied to suit the number of turbine nozzles in use and without altering the operating temperatures and pressures.

7. An internal combustion turbine comprising a centrifugal compressor, combustion chamber means supplied with air by said compressor, a turbine in which heated air from the combustion

chamber means is expanded to drive the turbine rotor nozzles in communication with said combustion chamber for directing heated air to said turbine, control means whereby the number of turbine nozzles in use can be varied, and a shroud axially adjustable in relation to the bladed impeller of the compressor to vary the effective cross sectional area of air passages between the impeller blades so that the compressor delivery can be varied to suit the number of turbine nozzles in use and without altering the operating temperatures and pressures.

8. An internal combustion turbine comprising a compressor for supplying gas, means to vary the quantative capacity of the compressor while maintaining substantially the same outlet pressure, a combustion chamber in communication with said compressor for receiving the compressed gas from said compressor, a turbine, turbine nozzles in communication with said combustion chamber directing heated gas from said combustion chamber to said turbine, and manually controlled means for preventing the flow of gas through some of said nozzles, the means to vary the quantity of gas from said compressor and the manually controlled means being arranged for maintaining constant operating conditions of temperature and pressure in the chamber and nozzles.



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