United States Patent [19]

Lewis

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[54] **REVERSIBLE TURBINE WITH INLET AND BRAKE CONTROL SYSTEM**

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[73] Assignee: **Lucus Aerospace Limited,** Birmingham, England

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **415/153,** 415/18, 415/123, 415/47

[51] **Int. Cl.** **F01d 1/30,** F01d 11/00, F01d 21/14

[58] **Field of Search** 415/18, 36, 145, 152, 153, 415/40, 42, 154

[56] **References Cited**

UNITED STATES PATENTS

1,186,726	6/1916	Allen	415/153
2,658,345	11/1953	Mosher	415/153
2,718,751	9/1955	Huber	415/153
3,207,473	9/1965	Madden	415/42
3,252,685	5/1966	Madden	415/42
3,286,982	11/1966	Scheper	415/154

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Assistant Examiner—Louis J. Casaregola
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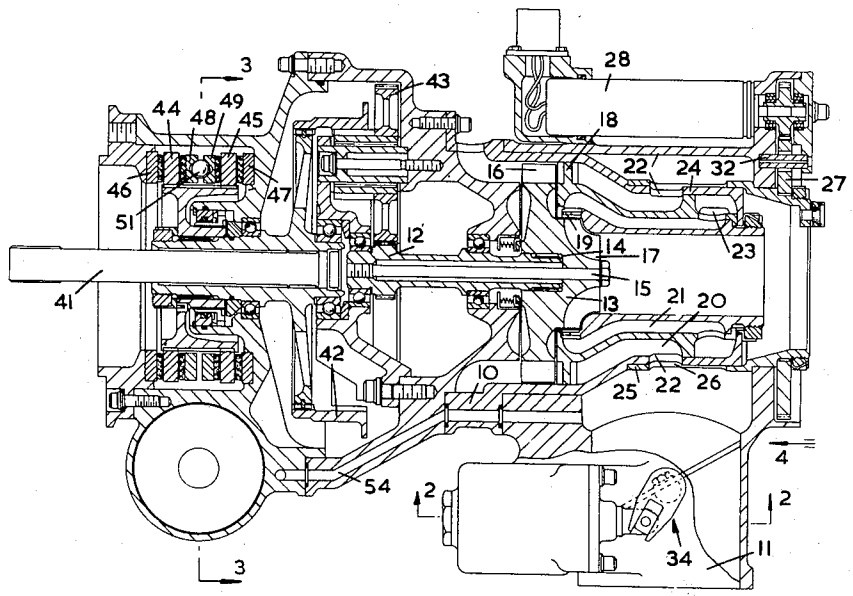
[57] **ABSTRACT**

A turbine includes a rotor having two sets of blades, gas flow through one blade set urging the rotor in the opposite direction to gas flow through the other blade set. A valve between the rotor and the turbine inlet enables gas flow to the blade sets to be selectively controlled, an increased flow to one of the sets being preceded by a decreased flow to the other set.

18 Claims, 6 Drawing Figures



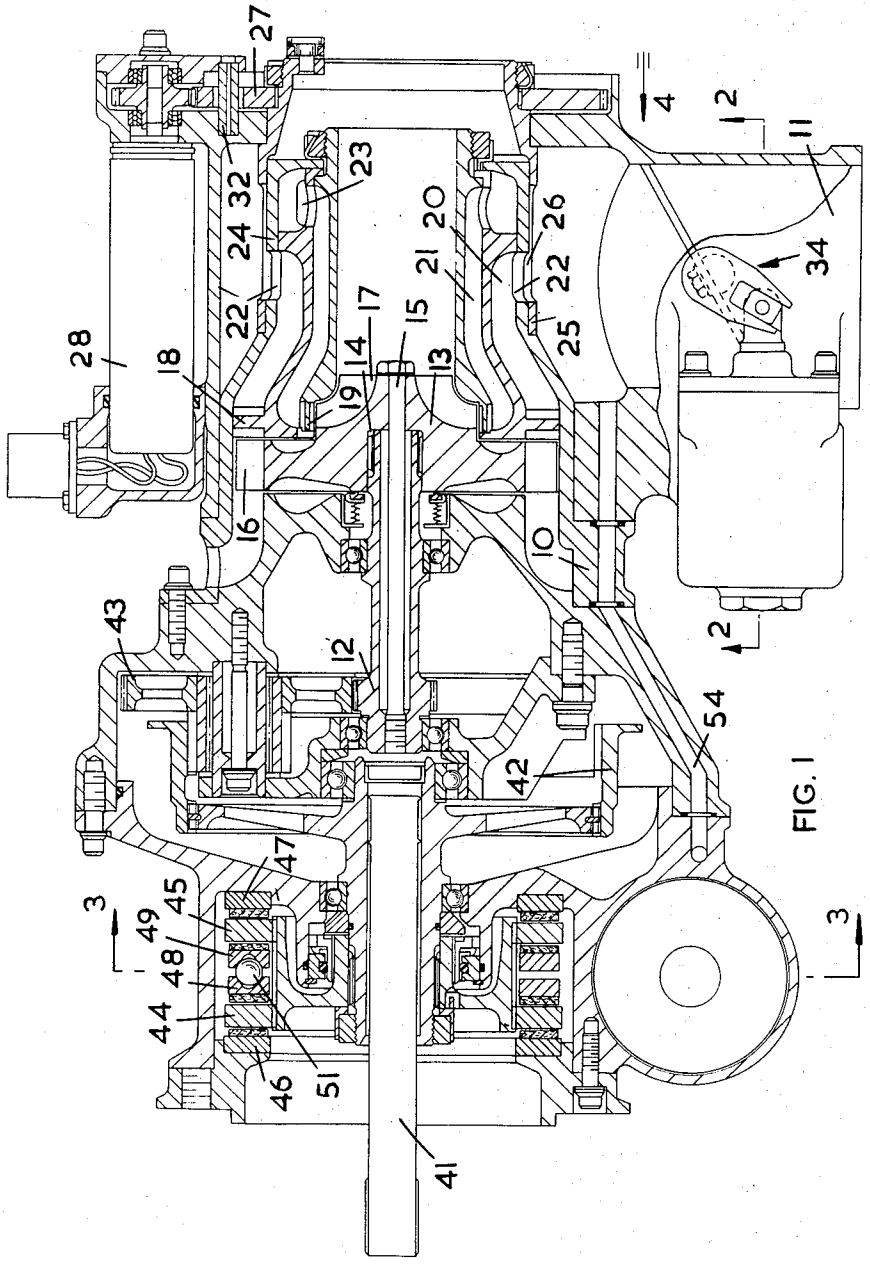

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FIG. 1

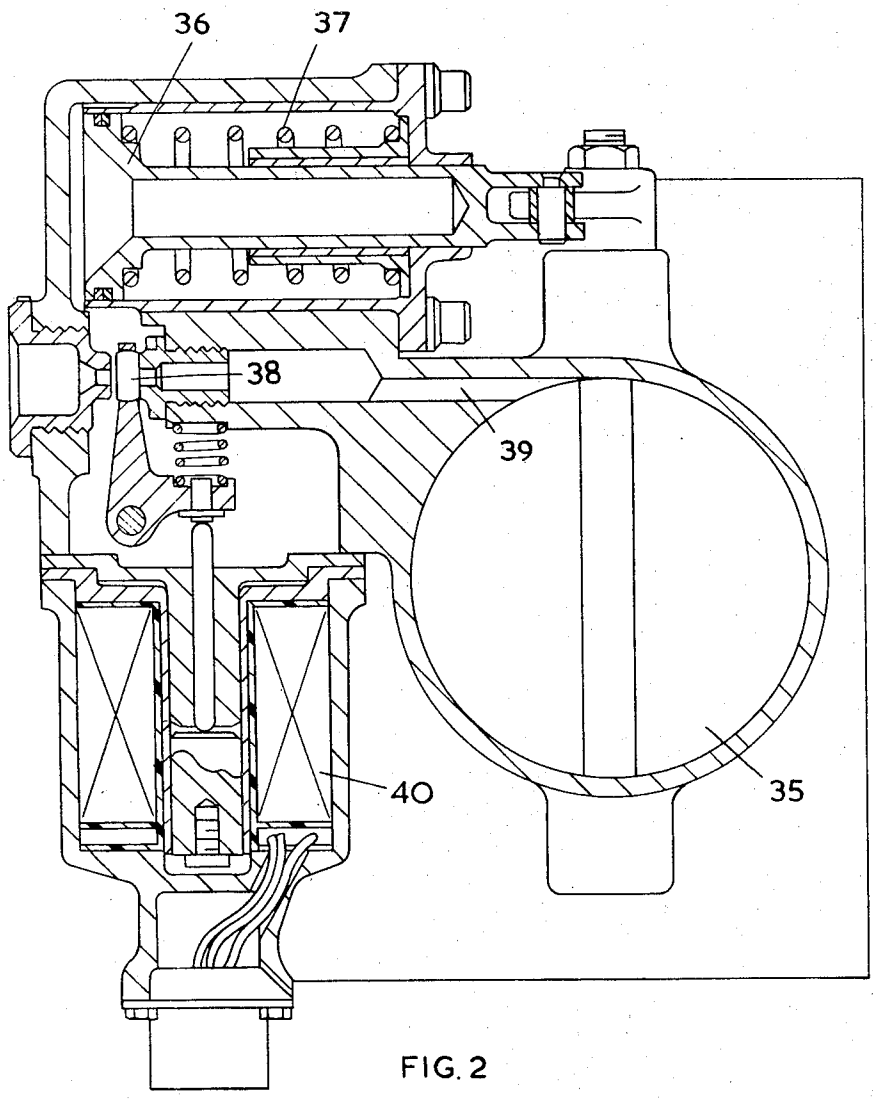

FIG. 2

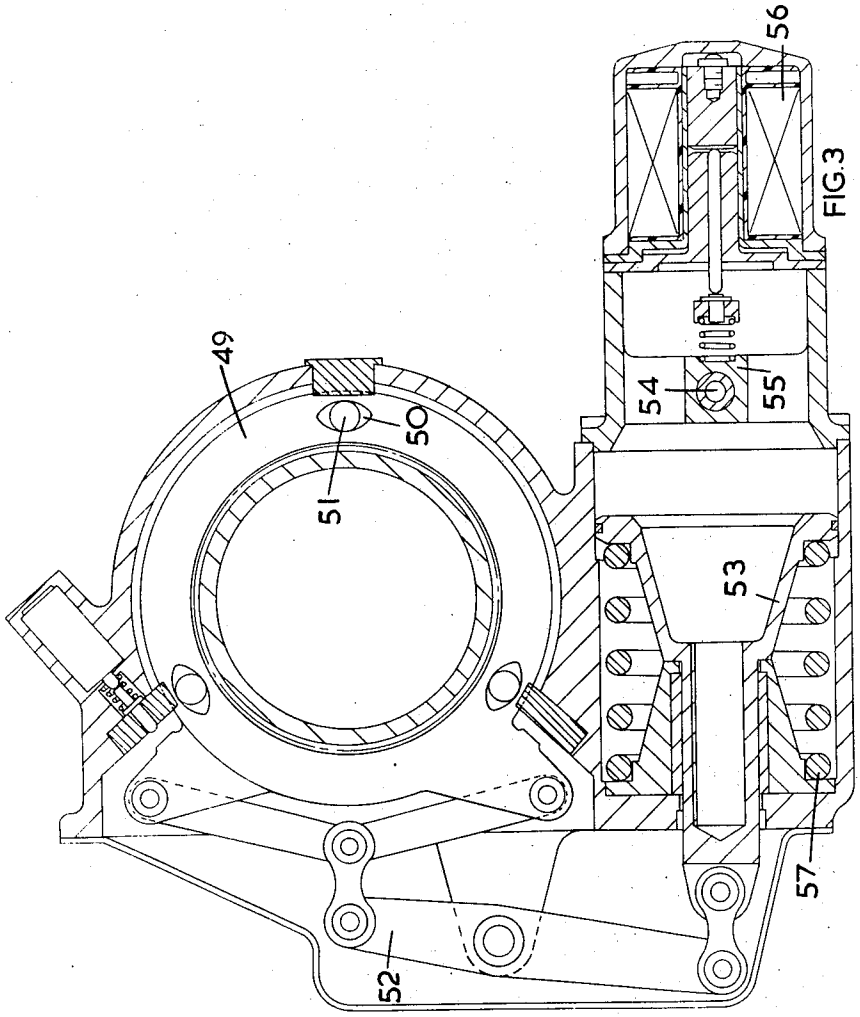

FIG.3

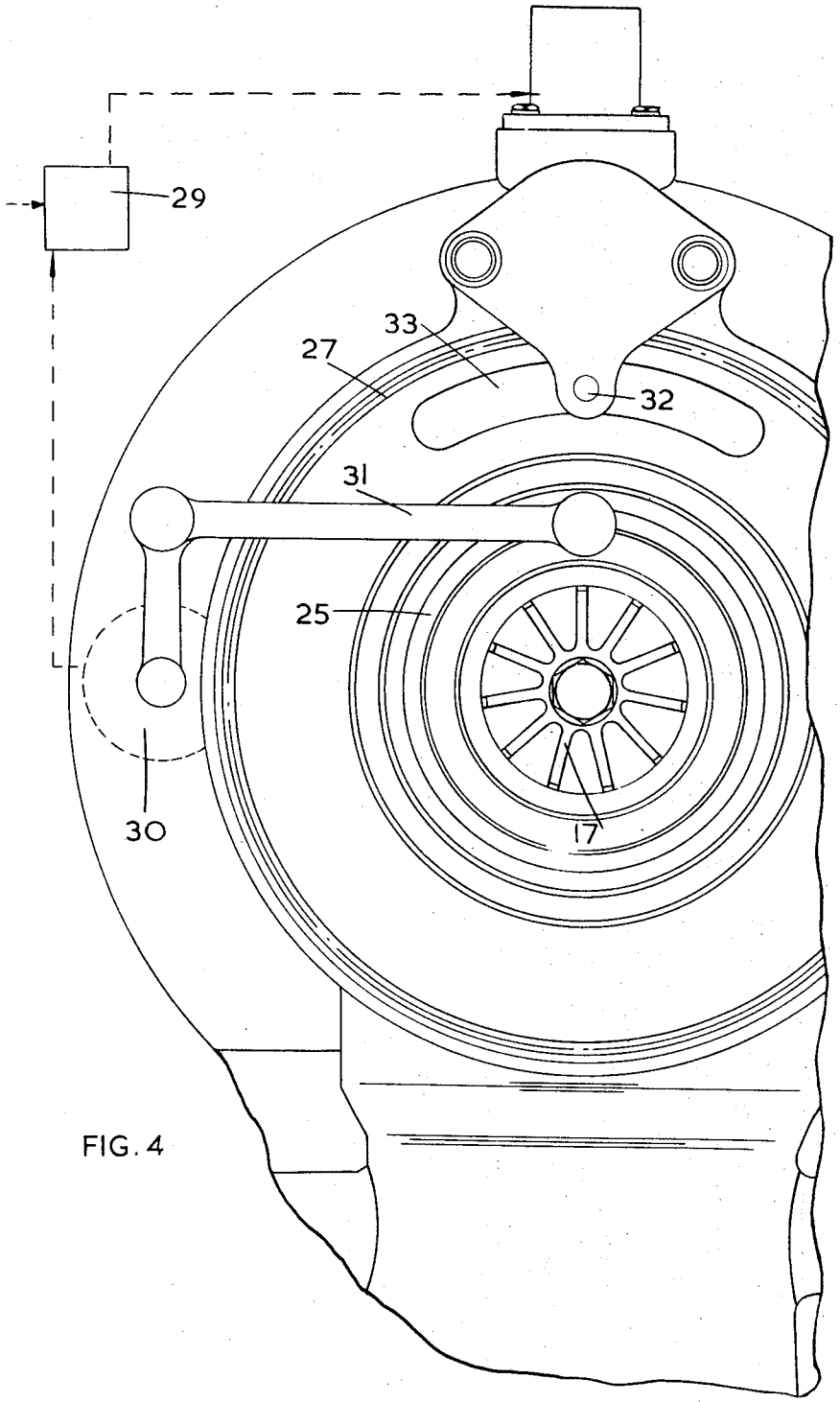

FIG. 4

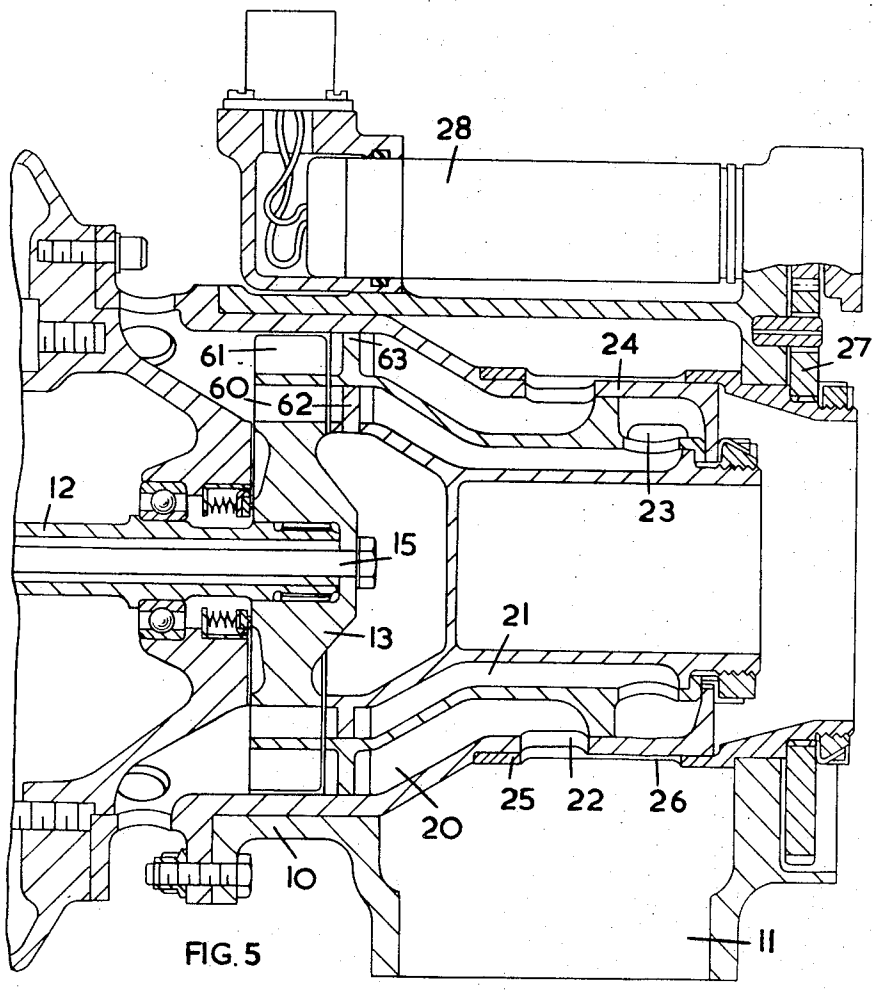

FIG. 5

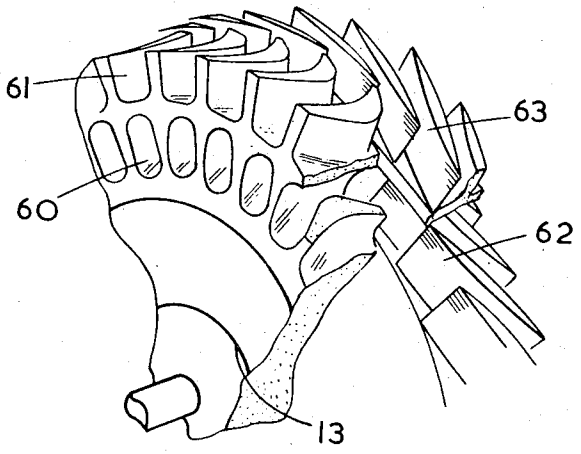

FIG. 6

REVERSIBLE TURBINE WITH INLET AND BRAKE CONTROL SYSTEM

This invention relates to reversible turbine, and has an object to provide such a turbine in a convenient form.

According to the invention a turbine comprises a housing, a fluid inlet in the housing, a shaft rotatable in the housing, first and second turbine rotor blade arrangements drivingly connected to said shaft, a fluid flow to said first and second blade arrangements respectively acting to rotate said shaft in opposite directions, and a valve for controlling fluid flow from said inlet to said rotors, said valve being arranged so that an increase in fluid flow to a selected one of said blade arrangements is preceded by a decrease in the flow to the other blade arrangement.

Examples of the invention will now be described with reference to the accompanying drawings, in which:

FIG. 1 is a section through a gas turbine,

FIGS. 2 to 3 are sections on the corresponding lines in FIG. 1,

FIG. 4 is a view on arrow 4 in FIG. 1,

FIG. 5 is a section through an alternative form of turbine, and

FIG. 6 is a pictorial view of a detail of FIG. 5.

Referring first to the turbine shown in FIGS. 1 to 4 a body 10 has an inlet 11 which is, in use, supplied with a gas under pressure. Journalled in the body 10 is a shaft 12 to which a rotor 13 is secured by splines 14 and a bolt 15. Rotor 13 has an arrangement of axial flow turbine blades 16 and also an arrangement of radial flow blades 17. Associated with the blades 16, 17 respectively are stator vanes 18, 19. The arrangement is such that a gas flow through vanes 18 and blades 16 rotates rotor 13 in the opposite direction to a flow through vanes 19 and blades 17.

An outer annular passage 20 communicates with vanes 18 and a concentric inner annular passage 21 communicates with vanes 19. Passages 20, 21 terminate in respective ports 22, 23 in a cylindrical portion 24 of body 10. Surrounding portion 24 is a sleeve 25 having slotted ports 26. Sleeve 25 is rotatable on portion 24 and co-operates with ports 22, 23 to provide a valve between the respective passages 20, 21 and inlet 11. The ports 22 are angularly spaced from ports 23 so that sleeve 25 shuts off ports 22 before opening ports 23, and vice versa.

Sleeve 25 is rotatable, via gears 27, by an electric motor 28. Motor 28 is controlled by a circuit 29 which is responsive to an input control signal and to a signal from a position transducer 30 coupled to sleeve 25 by a link 31. A stop 32 slidable in a slot 33 in one of the gears 27 limits rotation of sleeve 25.

Between inlet 11 and the valve sleeve 25 is a butterfly valve arrangement 34, which comprises a disc 35 movable to open inlet 11 by a piston 36. Piston 36 is biased in a direction to shut valve 34 by a spring 37. Piston 36 is movable against spring 37 by gas pressure controlled by a valve 38 operated by a solenoid 40. Valve 38 is a two-way valve movable between a position in which piston 36 is subjected, via a passage 39, to the pressure in inlet 11, and a position in which passage 39 is shut off and piston 36 is subjected to atmospheric pressure. Energisation of solenoid 40 thus opens butterfly valve 34, provided there is a sufficient pressure within inlet 11.

Also journalled within body 10 is an output shaft 41 axially aligned with shaft 12. Splined on to shaft 41 is an internal ring gear 42 which forms part of a reduction gear train 43 driven by shaft 12. Shaft 41 also carries a pair of brake discs 44, 45 whose outer faces are respectively engageable by friction discs 46, 47 secured to the body 10. Discs 44, 45, are mounted for axial movement relative to each other and to shaft 41. The inner faces of discs 44, 45 are respectively engageable by friction discs 48, 49 which are both rotatable and axially movable relative to discs 46, 47.

Adjacent faces of discs 48, 49 have aligned tapered recesses 50 in which are located balls 51, so that relative rotation of discs 48, 49 urges them apart, brake discs 44, 45 thus being frictionally engaged by the discs on either side.

Discs 48, 49 are relatively rotatable by a linkage 52 operable by a piston 53. Piston 53 is responsive to a gas pressure in a passage 54 which communicates with inlet 11 downstream of valve 34. Pressure in passage 54 is applied to piston 53 under control of a two-way valve 55 similar to the valve 38 and operated by a solenoid 56. When solenoid 56 is energised piston 53 moves against a spring 57 to the position shown in FIG. 3 to align recesses 50 and therefore release the brake. If solenoid 56 is de-energised, or in the absence of a pressure in passage 54, the brake is applied to arrest shaft 41.

In use, with a pressure applied to inlet 11 and with solenoids 40, 56 energised, shaft 41 will be rotated in a direction dependent on the position of sleeve 25. Shaft 41 is thus readily reversible, gas flow to selected one of the turbine blade arrangements 16, 17 being progressively reduced, and finally shut off, before sleeve 25 permits a progressively increasing flow to the other of the blade arrangements.

Failure of the gas supply causes valve 34 to shut and the brake to be applied. De-energisation of solenoid 40, for any reason, has the same effect, since the pressure in passage 54 falls.

The alternative ofrm of turbine shown in FIGS. 5 and 6 is generally the same as that described above, similar components being assigned identical reference numbers. In this case, however, rotor 13 has two arrangements 60, 61 of axial flow turbine blades, arrangement 61 surrounding arrangement 60, as shown pictorially in FIG. 6. Associated with the respective blade arrangements 60, 61 are stator vanes 62, 63. A gas flow through vanes 62 and blades 60 turns rotor 13 in the opposite direction to a flow through vanes 63 and blades 61. Operation of sleeve 25 thus enables the direction of rotation and power output to shaft 12 to be varied, as before.

I claim:

1. A turbine comprising a housing, a fluid inlet in the housing, a shaft rotatable in the housing, a braking arrangement operable to arrest rotation of said shaft, first biasing means urging said braking arrangement to arrest said shaft, a first piston movable against said first biasing means to cause said braking arrangement to release said shaft, first and second turbine rotor blade arrangements drivingly connected to said shaft, said first and second blade arrangement being respectively responsive to a fluid flow from said inlet to rotate said shaft in opposite directions, a first valve means for providing a decrease in fluid flow from said inlet to one of said blade arrangements prior to providing an increase

in fluid flow to the other blade arrangement second valve means between said inlet and said first valve means, second biasing means urging said second valve means towards a shut position, a second piston movable against said second biasing means to open said second valve means, a first control valve movable between a first position in which the pressure in said inlet is applied to said second piston and a second position in which said second piston is subjected to atmospheric pressure, and a second control valve movable between a first position in which a fluid pressure downstream of said second valve means is applied to said first piston, and a second position in which said first piston is subjected to atmospheric pressure.

2. A turbine as claimed in claim **1** which includes a first annular passage between said first blade arrangement and said valve, and a second annular passage between said second blade arrangement and said valve, one of said annular passages surrounding the other of said annular passages.

3. A turbine as claimed in claim **1** in which said first blade arrangement comprises axial flow turbine blades and said second blade arrangement comprises radial flow turbine blades.

4. A turbine as claimed in claims **1** in which both said blade arrangements comprise axial flow turbine blades.

5. A turbine as claimed in claim **1** which includes first and second ports in a part of said body, through which ports fluid can flow to aid first and second blade arrangements respectively, and in which said valve includes a closure member movable to selectively uncover said ports.

6. A turbine as claimed in claim **5** in which said closure member comprises a ported sleeve surrounding said body part.

7. A turbine as claimed in claim **6** in which said sleeve is rotatable relative to said body part.

8. A turbine as claimed in claim **7** which includes a gear train meshing with said sleeve, and an actuator for driving said gear train.

9. A turbine as claimed in claim **7** which includes means for limiting relative rotation between said sleeve and said body part.

10. A turbine as claimed in claim **8** in which said actuator comprises an electric motor and which includes means for providing a first electrical signal dependent on the relative angular positions of said sleeve and said body part.

11. A turbine as claimed in claim **10** which includes an electrical control circuit responsive to said first electrical signal and to an input control signal to provide an output signal to said motor.

12. A turbine as claimed in claim **1** which includes a spring urging said control valve to said second position thereof.

13. A turbine as claimed in claim **12** which includes an electro-magnetic actuator energisable to move said control valve against said spring to its first position.

14. A turbine as claimed in claim **1** which includes a spring biasssing said further control valve to said second position thereof.

15. A turbine as claimed in claim **14** which includes a further electro-magnetic actuator energisable to move said further control valve against its spring to its first position.

16. A turbine as claimed in claim **1** in which said braking arrangement comprises a first disc mounted on said shaft, a friction ring on said body, and means, responsive to said biassing means for the braking arrangement, for urging said disc and said friction ring into engagement.

17. A turbine a claimed in claim **16** which includes a second disc on said shaft, axially spaced from said first disc a further friction ring on said body, said further ring being located on a side of said second disc remote from said first disc, and means for biassing said first and second discs apart and into frictional engagement with said ring and said further ring respectively.

18. A turbine as claimed in claim **17** in which said means for biassing said discs apart comprises third and fourth discs between said first and second discs and axially aligned therewith, adjacent faces of said third and fourth discs having ramp faces, members engaged between said ramp faces, and said third and fourth discs being relatively rotatable by said brake biassing means to engage said first and second discs respectively.

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