

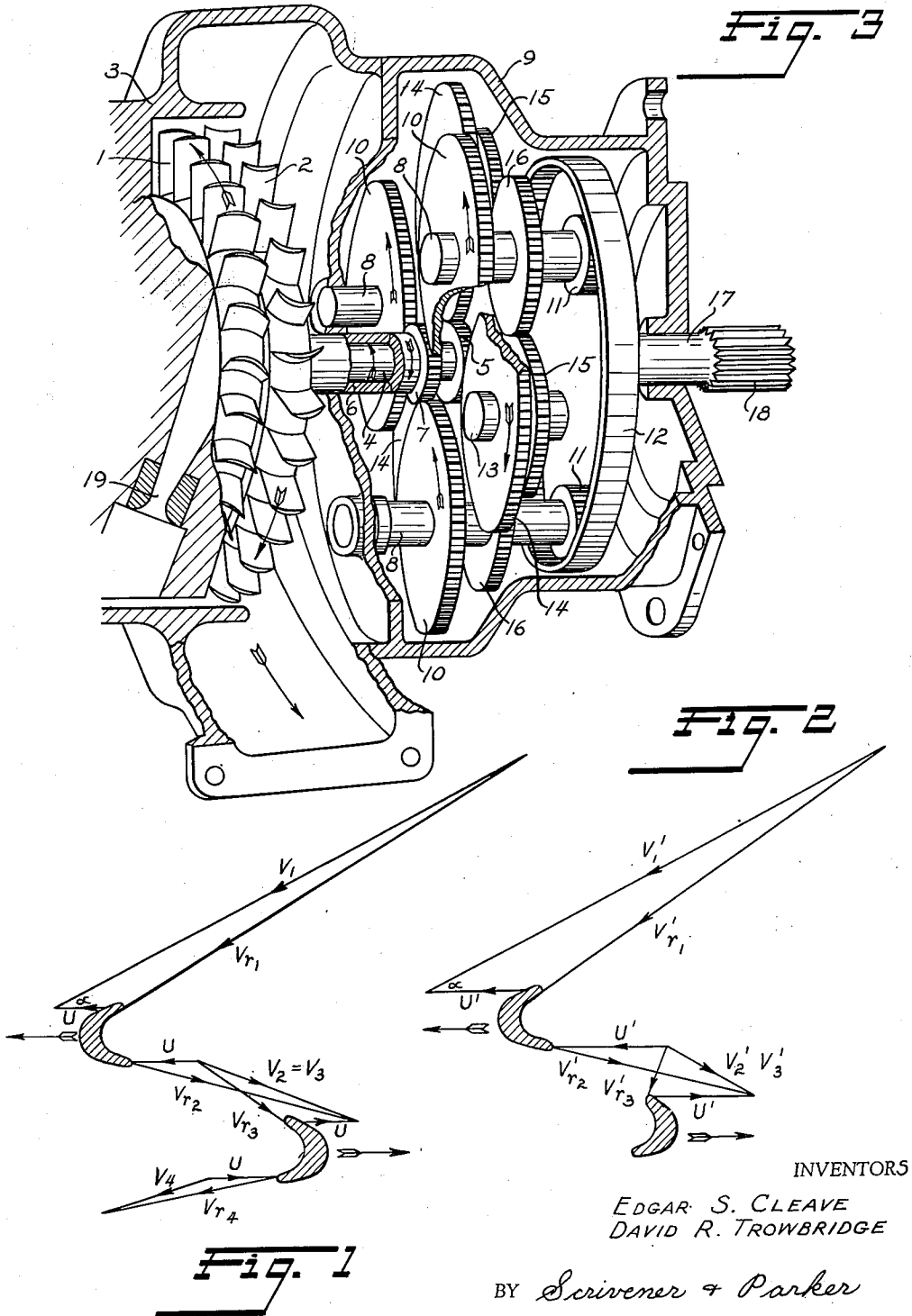
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E. S. CLEAVE ET AL

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SPEED CONTROL MEANS FOR GAS TURBINES USED AS STARTING TURBINES

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INVENTORS

EDGAR S. CLEAVE
DAVID R. TROWBRIDGE

BY *Scrivener & Parker*

ATTORNEYS

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SPEED CONTROL MEANS FOR GAS TURBINES USED AS STARTING TURBINES

Edgar Sherville Cleave, Chigwell, and David Roy Trowbridge, Hornchurch, England, assignors to The Plessey Company Limited, Ilford, England, a British company

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1 Claim. (Cl. 253—16.5)

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This invention relates to a speed control means for a cordite operated starting turbine which is used for starting up gas turbines.

The invention is concerned with oppositely rotating turbines of the type having contra-rotating shafts which are connected to a transmission gearing to enable power to be transmitted between a shaft rotating in one direction only and two co-axial contra-rotational turbine shafts.

It has previously been proposed to provide a steam turbine with contra-rotating turbine wheels without any guide wheel therebetween and by means of suitable gearing the contra-rotational movement of the two turbine wheel shafts are transmitted to a common shaft for rotation in one direction.

In designing turbine wheels, it is a general practice to arrange the blades in such a manner that the axial flow of gas therethrough will generate the maximum rotational power. In arranging the blades it is well known that if they are not set correctly, there is the liability of the gaseous fluid striking upon the back of the blades which may result in a retardation effect upon the turbine.

We have found that when a cordite operated starting turbine fitted with contra-rotating blades and a gearing of the type referred to has the load removed therefrom, there is a danger of overspeeding which may cause the turbine motors to burst, thus causing serious damage.

According to this invention the blades of one or both contra-rotating turbine wheels are set at an angle whereby in the event of said wheels rotating above a predetermined speed, a portion of the flow of cordite gases will strike upon the backs of the blades thereby creating a braking effect which is introduced to control the speed.

An advantage of this arrangement is that the angular position of the blades on the both rotors can be set at an optimum value so that the maximum rotational speed of the turbine can be pre-designed so that it will not exceed the pre-set speed irrespective of removal of load.

This feature is extremely valuable, as one of the chief drawbacks of cordite operated turbines is the danger of over-speeding and bursting of turbine rotor in the event of any removal of the load before expiry of cartridge burning time.

The gearing may consist of a multiple train of gear wheels arranged on a suitable carrier or support which engage with separate pinions fixed to the concentric shafts of the respective rotors and the combined drive of the two contra-rotors is transmitted through said multiple train to a common shaft as herein set forth.

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In order to obtain the desired effect it may be necessary so to arrange proportions of gearing and blading shapes and angles that the turbine develops its best efficiency at a speed somewhat below this limiting speed, which is itself well below the maximum safe rotational speed of the turbine rotor.

The invention will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a schematic diagram of gases flowing through contra-rotating turbine blades at maximum efficiency.

Fig. 2 is a similar diagram to Fig. 1 showing a condition of overspeeding.

Fig. 3 is a perspective view of a complete starter turbine with certain parts broken away for clarity.

Referring to the schematic diagrams, Fig. 1 is at maximum efficiency, that is to say, smooth or shockless entry of the gases to both stages. In the event of the speed rising there is shock at entry to the first stage, at the second stage on the blades of the second turbine this effect is magnified due to the relative blade speed being doubled so that shock on entry of the gases to this stage is much more critical to increase of speed.

With regard to overspeeding conditions shown in Fig. 2 it will be readily seen that the gas on entering the second stage is actually impinging on the back of the blade thus creating a braking effect on the second stage rotor, as these two turbine wheels are positively geared together this retardation is also applied to the first turbine wheel and together with turbulence sets up a limit to the speed of the two turbine wheels.

The following data illustrate an example of how gas velocities and directions change with increase of speed of the turbine wheels.

- 40 V_1 —Gas velocity leaving nozzle.
- V_{R1} —relative gas velocity entering first stage.
- V_{R2} —relative gas velocity leaving first stage.
- V_2 —actual gas velocity leaving first stage.
- V_3 —actual gas velocity entering second stage.
- 45 V_{R3} —relative gas velocity entering second stage.
- V_{R4} —relative gas velocity leaving second stage.
- V_4 —actual gas velocity leaving second stage.

Referring to Fig. 3 a first and second stage turbine wheel 1, 2 each fitted with blades shaped at an angle to control at a desired speed are arranged face to face within a casing 3.

A solid shaft 4 passing through the centre of the turbine wheel 2 is connected to first stage turbine wheel 1 and the outer end of this shaft 4 is fitted with a pinion 5. A hollow shaft 6 sur-

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rounding the solid shaft 4 is fixed at one end to the second stage turbine wheel 2 and at the opposite end carries a pinion 7. Three lay shafts 8 mounted in a gear box 9 (only partly shown) each have a gear wheel 10 fixed thereto which in turn mesh with the pinion 7 fixed to the hollow shaft 6. A pinion 11 is fixed to the end of each lay shaft 8 which drive a ring gear 12, from the second stage turbine wheel 2.

Three countershafts 13 (only one shown) intermediately spaced in the gear box 9 are each fitted with a gear wheel 14 which mesh with the pinion 5 on the end of the solid centre shaft 4. A second gear wheel 15 is fixed to each of the countershafts 13 which engage with an intermediate gear wheel 16 whereby the drive from the first stage turbine 1 is transmitted to the countershafts 8 but in a reversed direction to the turbine wheel 2, thus the gear wheels 15 and 16 serve as a reversing gear.

A common shaft 17 formed with splines 18 is fixed to the centre of the ring gear 12 which enables the composite drive to be transmitted in one direction.

From the above, it will be seen that the gearing of Fig. 3 is of a planetary type wherein the countershafts 13 are free moving and the gear wheels 14 and 15 function as planetary gears.

In operation the gases are fed through a number of nozzles 19 (only one shown) on to the blades of the first stage turbine 1 and then through the blades of the second stage turbine 2 to exhaust whereby the two blades are driven in opposite directions, the composite drive from the wheels 1 and 2 is transmitted through the gearing to the shaft 17 in one direction.

In this construction the blades are shaped so that the turbine wheels 1 and 2 will rotate at a pre-set speed; overspeeding cannot occur due to the effect of the retarding action upon the second stage wheel 2 as herein set forth.

We claim:

A cordite gas operated starting turbine comprising a casing, a pair of concentrically arranged blade turbine wheels in the casing, means for conducting cordite gases to one of said turbine wheels and from the latter to the other turbine wheel to rotate the wheels in opposite directions, a driven member arranged for connection with a load, means connecting said turbine wheels with the driven member for combining the torques de-

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veloped by the oppositely rotating turbine members and for rotating the driven member in one direction, the blades of at least one of said turbine wheels being constructed and arranged at an angle so that during opposite rotation of said turbine wheels above a predetermined speed when the load is decreased, the gases exhausted from said one turbine wheel will strike the backs of the blades of said other turbine wheel to exert a braking effect on both turbine wheels through said connecting means to prevent overspeeding of said turbine, said connecting means comprising concentric shafts respectively connected to the turbine wheels, a gear pinion fixed to the end of each concentric shaft, a gear box, three lay shafts mounted in said gear box, a gear wheel fixed to each lay shaft engaging with the gear pinion fixed to the outer concentric shaft, a pinion fixed to one end of each lay shaft, a ring gear meshing with the pinions fixed to said lay shafts, three countershafts spaced about said concentric shafts and positioned in said gear box, a gear wheel fixed to each said countershaft engaging with the pinion fixed to the inner concentric shaft, a second gear wheel fixed to each countershaft, an intermediate gear wheel fixed to each respective lay shaft between the first named gear wheel and the pinion on each respective lay shaft and engaging with the respective second gear wheels for reversing the drive from the countershafts to the lay shafts, and said driven member comprising a common splined shaft fixed to the outer face of said ring gear whereby said ring gear transmits the composite drive from the oppositely rotating turbine wheels to the common shaft in one direction, all of said shafts being parallel with each other.

EDGAR SHERVILLE CLEAVE.
DAVID ROY TROWBRIDGE.

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