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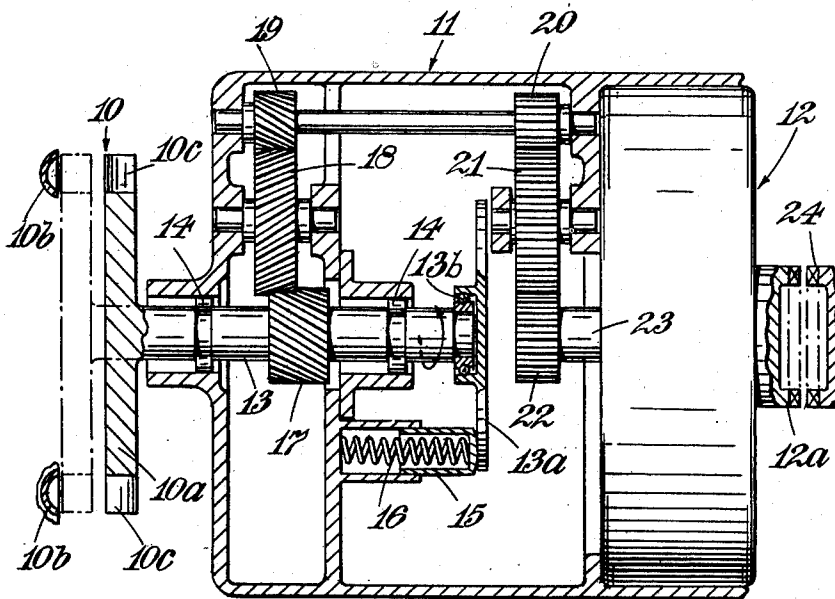
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ENGINE STARTER MECHANISM HAVING A TURBINE AS THE PRIME MOVER

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2 SHEETS—SHEET 1

Fig.1.



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2 SHEETS—SHEET 2

Fig.2.

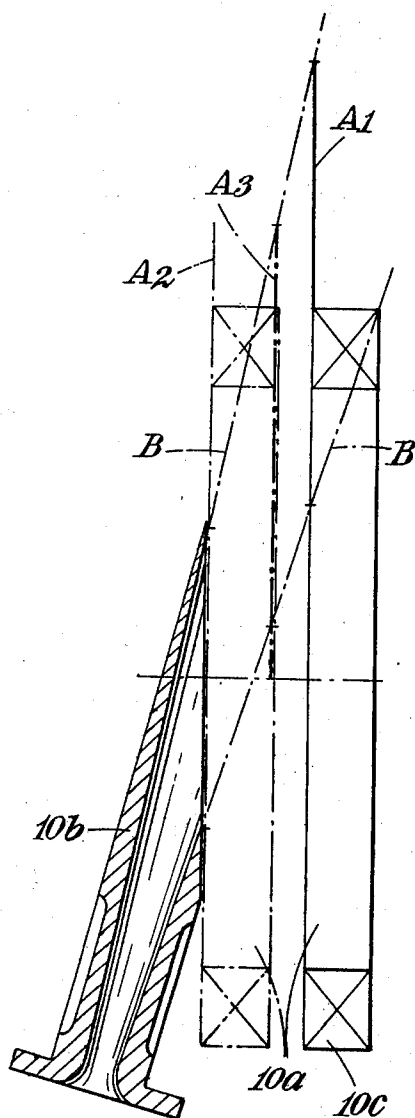
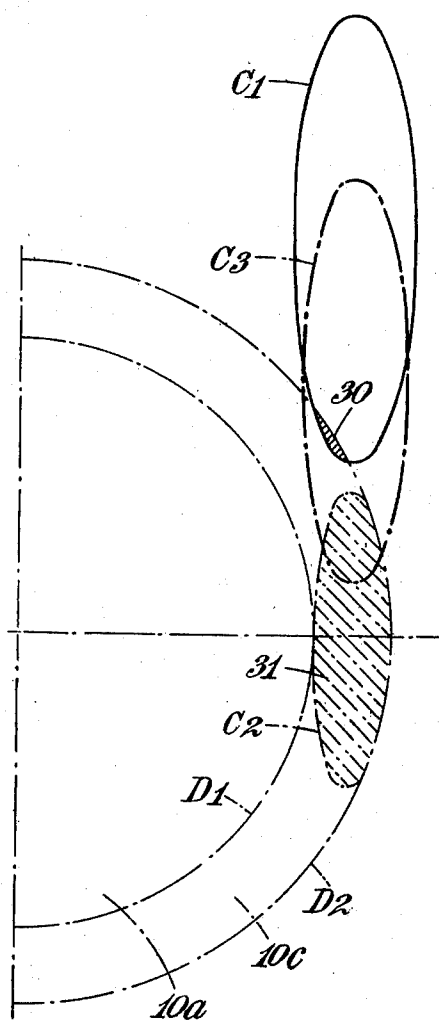


Fig.3.



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ENGINE STARTER MECHANISM HAVING A
TURBINE AS THE PRIME MOVER

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3 Claims. (Cl. 253—59)

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This invention relates to starters for engines having a rotary power shaft, such as gas-turbine engines or reciprocating internal combustion engines.

This invention is more particularly concerned with starters of the type comprising a turbine on to the rotor of which a working fluid is directed to drive the turbine, and a driving coupling for connecting the turbine to the engine to rotate it during starting. The coupling normally includes a clutch between it and the engine which clutch engages automatically when the turbine starts to rotate. The working fluid may for instance be the hot, pressure gases produced by the discharge of a cordite cartridge.

The difficulty has occurred in the use of such starters that the driving coupling between the starting turbine and the engine has failed to transmit the drive so that the starter turbine is driven at an excessive speed and is damaged.

This invention has for an object to avoid this difficulty.

According to this invention, in an engine starter of the kind referred to comprising a starting turbine and a driving coupling to transmit the drive from the turbine to the engine to be started, the turbine rotor and the nozzle means for directing the working fluid on to the turbine rotor are arranged for relative adjustment axially of the turbine rotor into and out from a position in which maximum power can be developed by the turbine and the turbine rotor is shifted into said position by shifting means which is under control of torque-sensitive means, sensitive to the starting torque, so that when the torque transmitted is below a selected value, the turbine rotor is out of said position, and moves into it only when the torque transmitted attains the selected value.

Until the torque transmitted through the coupling reaches the predetermined value the turbine rotor and nozzle means will occupy relative positions such that only a portion of the working fluid will impinge on the turbine rotor to drive it. Thus over-speeding of the turbine cannot occur under these conditions. When the torque exceeds the value indicating that the drive to the engine has been properly taken up, in which circumstances over-speeding of the turbine cannot occur, the turbine rotor and the nozzle means will be moved relatively into the position in which substantially the whole of the working fluid delivered by the nozzle means will impinge on the turbine rotor.

A preferred arrangement of starter device ac-

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cording to this invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic view partly in section of the starter device, and

Figures 2 and 3 are diagrammatic drawings illustrating the effect of moving the turbine rotor relative to a nozzle directing a working medium on to the rotor blades.

Referring to Figure 1, the starter device comprises a turbine 10, a gear-casing 11, and a clutch mechanism 12.

The turbine comprises a turbine rotor disc 10a carried on a shaft 13 mounted in bearings 14 in the gear-casing 11 so as to be slidable in the direction of its axis of rotation. The turbine also comprises nozzles 10b, of which any desired number may be employed, through which a working fluid is directed on to the blading 10c carried on the periphery of the turbine rotor 10a. The nozzles 10b form part of the turbine stator casing which is not otherwise shown.

At the end of shaft 13 opposite to that on which the turbine rotor is carried, there is mounted a plate 13a on a thrust bearing 13b. Against this plate 13a bears one or more spring-loaded plungers 15 such as that indicated, the springs 16 for loading the plungers having a fixed abutment in the gear casing. The resilient load applied to the shaft by this means tends to hold the shaft 13 and turbine rotor 10a to the right, as viewed in the drawings, in a position in which the jets of working medium issuing from the nozzles 10b only partially impinge on the blading 10c.

The shaft 13 has secured on it a helical gear 17 which meshes with a second helical gear 18 from which a drive is taken through gearing 19, 20, 21, 22 to the input shaft 23 of the clutch device 12. It will be clear that when a torque is being transmitted from the turbine rotor 10a through the helical gears 17, 18 to the clutch device 12, an axial thrust will be developed tending to displace the shaft 13 and turbine rotor 10a axially of itself and by suitably selecting the angle of the teeth of gears 17, 18 this axial thrust may be arranged to oppose the resilient load applied by the spring-loaded plungers 15, so that as the torque transmitted increases the rotor 10a moves towards the nozzles 10b.

The strength of the springs 16 is selected so that the turbine rotor 10a reaches a position (indicated in chain lines) relative to the nozzles 10b corresponding to the full development of power by the turbine only when the clutch mem-

ber 12a of the clutch device 12 is properly engaged with the clutch member 24 formed on a shaft of the engine (not shown) being started, that is only when a proper drive to the engine is completed.

The clutch device 12 may be of any convenient form and is preferably of the kind having a telescopic clutch member which when the turbine starts to rotate is moved axially towards a co-operating clutch member carried by the engine to engage therewith. With a clutch device 12 of this form, as soon as the turbine rotor 10a starts to rotate, the clutch member 12a telescopes into engagement with the co-operating clutch member 24 on the engine and it is not until the clutch members 12a, 24 are properly engaged and a substantial torque is being transmitted to the engine that the turbine rotor 10a is moved into the chain line position.

Referring now to Figures 2 and 3, there is diagrammatically illustrated the effect of moving a turbine rotor, such as the rotor 10a carrying blading 10c, towards a nozzle 10b arranged to direct a working fluid, such as hot pressure gases produced by the discharge of a cordite cartridge, across the path of the blades. The axis of the nozzle 10b may for instance make a small angle, say 15°, with the plane of the rotor so that the jet of working fluid from the nozzle cuts across the path of the blades at this angle and has a large component of velocity tangentially of the rotor and only a small component of velocity at right angles to the plane of the rotor.

In Figure 2, the full line outline of the rotor 10a corresponds to the position in which only a small proportion of the working medium issuing from the nozzle impinges on the blade and the chain line outline corresponds to the position in which substantially the whole of the jet acts on the blades and in which maximum power is developed in the turbine.

In Figure 2, the line A₁ indicates the plane of the leading edges of the blades in the first position, A₂ indicates the plane of the leading edges of the full-power position, and the line A₃ the plane of the leading edges of the blades in an intermediate position. The lines B indicate the jet issuing from the nozzle 10b.

In Figure 3, the curves C₁, C₂, C₃ indicate respectively the intersections of the planes A₁, A₂, A₃ with the jet and the chain lines D₁ and D₂ indicate parts of the paths swept out by the roots and tips of the blades 10c during rotation of the rotor 10a.

It will be seen clearly from this figure that when the leading edges of the blades are in plane A₁ only a small proportion of the working medium issuing from the nozzle impinges on the blades, the proportion being represented by the ratio of the hatched area 30 to the area within the curve C₁, so the turbine will develop only a small proportion of its maximum power, and that the proportion will increase as the rotor moves axially of itself towards the nozzle until the leading edges of the blades reach a position in plane A₂. In this position, the hatched area 31 covering the whole of the space within the curve C₂ lies within the annulus between the paths D₁, D₂ of the blade roots and tips so that substantially the whole of the working medium impinges on the blades and the turbine can develop its full power.

The adjustment of the relative positions of the turbine rotor and nozzles need not be effected in the manner above described. For instance, the telescoping member of the clutch device may be

arranged to control by its movement an electrical or hydraulic mechanism for displacing the turbine rotor.

I claim:

1. A starter mechanism for an engine comprising a driving clutch member adapted to engage a co-operating clutch member of said engine, a casing, a rotor shaft extending in said casing, bearing means to support said rotor shaft in said casing, a turbine rotor on said shaft, turbine blades on the periphery of said rotor, turbine nozzle means through which working fluid is supplied towards said turbine rotor at an angle to the axis thereof, the shaft and rotor being axially movable relative to the casing into and out of a position in which substantially the whole of said working fluid passing through said nozzle means impinges on said turbine blades, a plate, thrust bearing means between said plate and said shaft so that said plate is axially fixed with respect to and rotatable relative to said shaft, a spring between said casing and said plate to urge said rotor out of said position, a first helical gear secured on said rotor shaft, a second helical gear non-slidably journaled in the casing and meshing with said first gear, said first helical gear having a helix sense such that the torque reaction on it when it transmits torque to said second helical gear has a component urging said turbine rotor towards said position, and driving connection between said second gear and said driving clutch member whereby, on attainment of a pre-selected value of the torque transmitted through said helical gears, the turbine rotor is constrained to move into the position in which substantially the whole of said working fluid jet impinges on said turbine blades.

2. A starter mechanism for an engine comprising a driving clutch member adapted to engage a co-operating clutch member of said engine, a casing, a rotor shaft, extending in said casing, bearing means to support said rotor shaft in said casing, a turbine rotor on said shaft, turbine blades on the periphery of said rotor, turbine nozzle means through which working fluid is supplied towards said turbine rotor at an angle to the axis thereof, the shaft and rotor being axially movable relative to the casing into and out of a position in which substantially the whole of said working fluid passing through said nozzle means impinges on said turbine blades, resilient means acting between said rotor and said casing to urge said rotor out of said position, and a gear connection between said turbine rotor and said driving clutch member including a first helical gear on said rotor shaft, a second helical gear meshing with said first helical gear and means to restrain said second helical gear against axial movement relative to said casing, said first helical gear having a helix sense such that the torque reaction on it when it transmits torque to said second helical gear has a component urging said turbine rotor towards said position, whereby, on attainment of a preselected value of the torque transmitted through said helical gears, the turbine rotor is constrained to move into the said position in which substantially the whole of said working fluid impinges on said turbine blades.

3. A starter mechanism for an engine comprising a driving clutch member adapted to engage a co-operating clutch member of said engine, a casing, a rotor shaft extending in said casing, bearing means to support said rotor shaft in said casing, a turbine rotor on said shaft, turbine

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blades on the periphery of said rotor, turbine nozzle means through which working fluid is supplied towards said turbine rotor at an angle to the axis thereof, the shaft and rotor being axially movable relative to the casing into and out of a position in which substantially the whole of said working fluid impinges on said turbine blades, a driving connection between said turbine rotor and said driving clutch member, torque-responsive means responsive to the torque transmitted through the said driving connection and shifting means connected to said rotor to shift it into and out of said position, said shifting means being connected with said torque means to be controlled thereby so as to shift said rotor into said position on attainment of a

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preselected value of the torque transmitted through the driving connection.

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