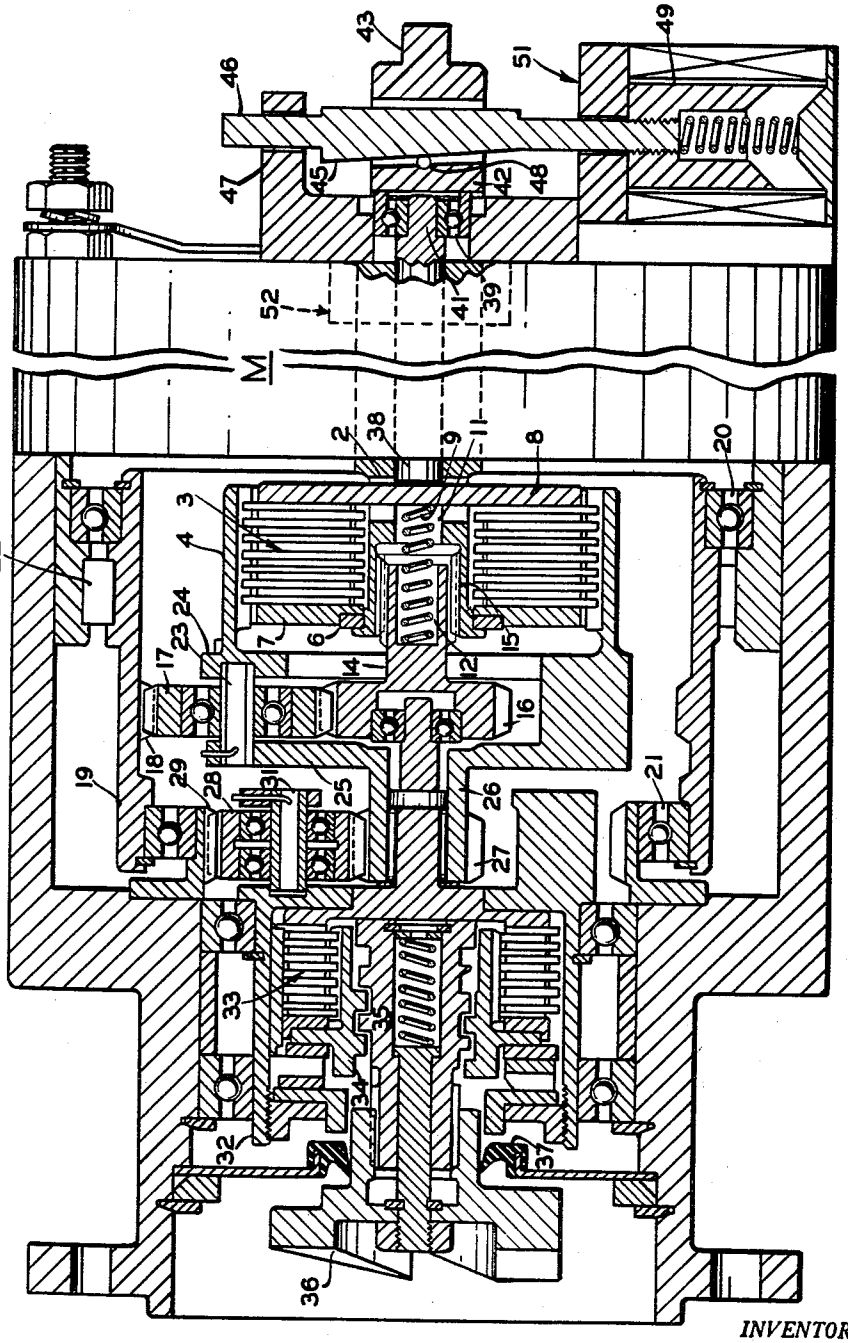
June 7, 1960 S. GILBERT ET AL 2,939,324

ENGINE STARTER MECHANISM

Filed Feb. 23, 1956 2 Sheets-Sheet 1

FIG. 1



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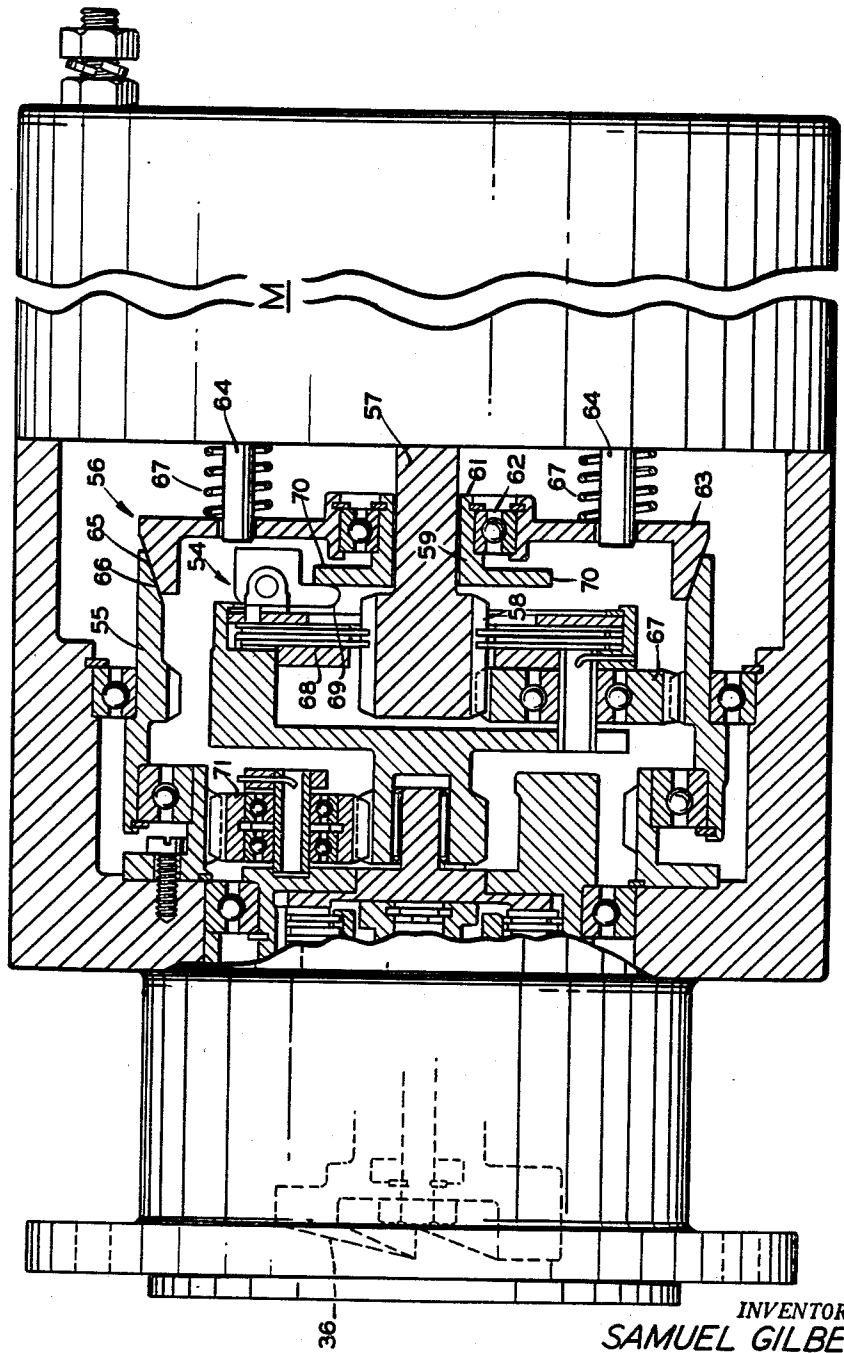
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FIG. 2



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ENGINE STARTER MECHANISM

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8 Claims. (Cl. 74—7)

This invention relates to dual speed starter mechanism for operating a turbine power plant, such as might be incorporated in jet aircraft engines.

The general object of the invention is to provide dual speed engine starter mechanism whereby a low speed operation of the mechanism will effect engagement of the starter jaw with the associated engine jaw and will iniatiate cranking of the latter; and, upon the starter mechanism attaining a predetermined speed, the starter mechanism will operate at a relatively higher speed to complete the starting operation of the associated engine.

The purpose of associating dual speed starter mechanism with the heavy load of a jet engine is to gradually raise the speed of the latter to a high cranking speed. This avoids damage to the engine mechanism as well as damage to the starter mechanism, such as snapping of shafts, breaking of jaw teeth, and overloading of the starter motor, all of which might otherwise happen were the high speed of a jet engine starter motor immediately applied to the heavy load of an associated jet engine.

The invention further lies in particular structures, and in their general organization and cooperative association to effect the purposes intended.

The foregoing and other objects and advantages of this invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings wherein an embodiment of the invention is illustrated. It is to be expressly understood, however, that the drawings are for purposes of illustration and description, and are not to be construed as defining the limits of the invention.

In the drawings:

Fig. 1 is a longitudinal section through dual speed starter mechanism embodying the invention; and

Fig. 2 is a similar section through a further form of the invention.

In describing the invention in further detail, reference is directed to the drawings, and now, particularly to Fig. 1, wherein there is disclosed starter mechanism including a high speed motor powered main drive shaft 2. On the latter is mounted a set of discs of a clutch pack 3, which are interleaved with complementary discs carried by a barrel member 4.

Retained by a snap ring 6 in the inner end of the barrel is a clutch disc pressure ring plate 7. The pressure plate is normally relaxed, whereby the clutch discs of the drive shaft are carried about with the latter, free of those carried by the barrel member. A key member 8 projecting radially through a slot in the drive shaft is axially slidable to pressurize the discs of the clutch pack into engagement with one another. This key is normally restrained from so acting upon the pressure plate by the tension of a coil spring 9. The latter is retained at one end in an axial cup 11 in the end of shaft, and at the other end, in a pocekt 12 formed in the end of stub pinion shaft 14.

Pinion shaft 14 is splined at 15 in the hub end of the drive shaft, and it carries a pinion or sun gear 16. The

latter is meshed with a plurality of planetary gears 17, representing a first planetary stage. The planetary gears are engaged with a ring gear 18 formed internally of a reaction barrel member 19. The latter is supported for rotation in bearings 20 at one end, and is further supported for rotation on bearings 21. The barrel member is normally restrained against rotation by an overrunning clutch 22. The planetary gears are rotatably supported on trunnions 23 retained between an end flange 24 of the clutch barrel and an opposed plate 25.

Unitary with plate 25 is a stub shaft 26 carrying at its end a pinion or sun gear 27. The latter is in mesh with planetary gears 28, representing a second planetary stage, which in turn are engaged with a stationary ring gear 29.

Planetary gears 28 are mounted on trunnions 31 carried in the end wall of a barrel member 32 of a disc clutch 33. Rotation of planetary gears 28 is transmitted through clutch 33 to an internally, helically splined member 34 of the latter. Clutch 33 is comprised of multiple disc elements carried by the barrel member interleaved for frictional engagement with multiple disc elements carried by the driven shaft. A helically splined travel nut 35 engaged in splined member 34 carries on its end a starter jaw or driven element 36. Suitable mechanism, as indicated by the friction ring 37, is arranged to normally effect a dragging action upon the travel nut; whereby, upon rotation of spline member 34, nut 35 is caused to travel axially to the left and to carry the starter jaw into axial engagement with the associated jaw, not shown, of a jet engine.

In the operation of the device, energization of the motor M causes rotation of the planetary gears 17. Due to the restraining action of the overrunning clutch 22 upon the barrel ring gear 18, the planetary gears 17 rotate internally of the latter. Rotation of the planetary gears of the first stage 17 is transmitted through the sun gear 27 to the second stage planetary gears 28. The latter effect axially movement of the starter jaw and its engagement with the associated engine jaw. By this arrangement, an initial low speed of operation is transmitted to the starter jaw mechanism to initiate engagement of the opposed jaws and initial safe low speed cranking of the associated engine.

Upon the starter mechanism and the associated engine reaching a predetermined speed, suitable mechanism is provided to increase the cranking speed of the starter mechanism. This is accomplished by effecting frictional engagement of the interleaved clutch discs of clutch pack 3, so that the rotation of the first planetary stage is replaced by rotation as a unit of the barrel ring gear 18 together with the clutch pack 3 and the first planetary stage. By this arrangement the rotational speed of the motor is transmitted to the starter jaw mechanism directly through the second planetary stage.

The mechanism to effect this change of speeds and torque transmission includes an elongated push-rod 38 suitably supported in bearings 39 for axial slidable movement in the hollow interior of the main drive shaft.

The left end of the push-rod abuts against the clutch pressure-key member 8. A reduced right end 41 of the rod projects through the support bearing 39 and abuts against a ramming-block 42. The latter is carried on the end of a shaft 43 slidably supported in housing, not shown. Movable in a slot through the ram block is a wedge cam piece 45, which is guided in its movements by a projecting finger 46 thereof and a cooperating guide hole member 47. The wedge piece is adapted to ride over a roller pin 48, carried by the ram-block. The lower end of the wedge piece is unitary with the plunger 49 of an actuating solenoid 51. A suitable governor 52, which may be of the fly-weight type, is adapted, upon

sensing a predetermined speed of the main drive shaft, to close an associated spring switch to effect energization of the solenoid. The combined governor and switch is indicated symbolically at **52**, inasmuch as any conventional structure of this nature might be employed.

Now, it is clear in the operation of the device, that upon the governor **52** sensing a predetermined speed of the main drive shaft **2**, the solenoid is actuated, whereby wedge **45** is pulled down into the ram-block **42** causing the latter to shift to the left so as to pressurize the push-rod **38** against the key member **8** and the associated clutch pack. Whereupon, the discs of the clutch are pressurized. The high torque carried by the engaged clutch pack overrides the clutch **22**, whereupon the reaction of barrel ring **19** is to rotate together with the clutch barrel as a unit, and the power of the motor is transmitted directly through the second stage to increase the cranking speed of the starter mechanism.

In Fig. 2, representing a further form of the invention, the means for pressurizing the clutch, indicated in Fig. 1 at **52**, is provided by fly-weight camming means **54**; and the means for retarding the barrel ring gear **55** is provided by a slip clutch **56**.

In this structure of Fig. 2, there is mounted on the main drive shaft **57**, just before the pinion or sun gear **58**, a slidable collar **59**. A stud shaft **61** of the collar is rotatably contained in a bearing **62**. Axially mounted on the bearing is a non-rotatable clutch slip disc plate **63**, which is axially slidable on fixed guide pins **64**. The clutch plate has a beveled periphery **65** which engages with a complementary beveled portion **66** in the end of the barrel ring gear **55**. Springs **67** normally pressurize the clutch plate **65** into frictional engagement with the barrel ring **55** so as to restrain movement of the latter relative to the planetary gears **67** of the first planetary stage.

In Fig. 2 a clutch **68**, corresponding in function to that shown at **3** in Fig. 1, has a relatively smaller disc pack. Pivoted in ears carried on the outer face of the pressure plate of the pack are a plurality of the fly-weights **54**. These have depending ears **69** which abut against the face of a radial flange **70** of the slide collar **59**.

In the operation of the device in Fig. 2, as the speed of the main drive shaft reaches a predetermined speed, the fly-weights **54** swing out centrifugally, whereupon the collar **59** is cammed to the right and caused to carry the clutch plate **56** free of the barrel ring gear **55**. Whereupon, the barrel ring gear and clutch pack **68** rotate as a unit with the main drive shaft, and as a consequence the high speed of the motor is transmitted directly through the second planetary stage **71** as in Fig. 1.

While embodiments of the invention have been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes can be made in the design and arrangement of the parts without departing from the spirit and scope of the invention, as the same will now be understood by those skilled in the art; and it is our intent, therefore, to claim the invention not only in the form shown and described, but also in all such forms and modifications thereof as may reasonably be construed to be within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In engine starter mechanism the combination of a drive shaft, a barrel member surrounding the drive shaft in spaced relation thereto, a clutch unit comprising multiple disc elements carried by the barrel member interleaved for frictional engagement with multiple disc elements carried by the drive shaft, pressure transmission means arranged to frictionally engage the interleaved disc elements with each other, resilient means normally disabling the latter means from effecting such engagement, a pinion on the drive shaft, first stage planetary gears carried by the barrel member and engaging the pinion, a rotatable reaction barrel ring gear surrounding the barrel member in spaced relation thereto and engaging the first stage planetary gears, friction slip means cooperating with the rotatable reaction barrel ring gear to normally restrain rotation thereof consequent upon rotation of the first stage planetary gears, a sun gear carried by the barrel member, second stage planetary gears engaging the sun gear and engaging a surrounding stationary ring gear, engine starter jaw advancing mechanism operatively connected to the second stage planetary gears, and means arranged to overcome the resilient means and to cause the pressure transmission means to effect frictional engagement of the disc elements and release of the reaction ring gear from the friction slip means upon reaction of the reaction ring gear to rotation of the frictionally engaged barrel member.

2. In engine starter mechanism as in claim 1, wherein the pressure transmission comprises a pressure transmission plate contained in the barrel member for forcing the disc elements into frictional engagement, a pressure transmission member projecting radially through a slot in the drive shaft and axially slidable to press said disc elements against the pressure plate, a spring representing the resilient means tensioning the member away from the discs and the pressure plate, and an actuating rod, actuable to slide the transmission member against the tension of the spring to press said disc elements against the pressure plate for transmission of torque to the engine starter jaw advancing mechanism.

3. In a clutch disc pack having a plurality of interleaved discs and means for pressurizing the interleaved discs including a key member and a slidable horizontally disposed push rod for pressurizing the key member against the interleaved discs, a block member axially movable against an end of the ram rod to effect pressurizing action of the rod, means supporting the block for axially slidable movement, a wedge member vertically slidable in a complementary slot in the block and cooperable with opposed walls of the slot to cam the block axially against the ram rod, a finger projecting vertically from the thickened end of the wedge cooperable with a fixed guide to limit the wedge to an up and down movement in the slot.

4. The structure defined in claim 3 wherein a bearing roller is provided in the slot for bearing the wedge in its movements.

5. A dual speed engine starter for initiating the operation of an associated engine at a low speed and for following such low speed operation as it increases beyond a predetermined speed with a relatively higher speed comprised of a high speed motor having a drive shaft which has a drive pinion, a first planetary gear stage rotatable by said drive pinion, a second planetary gear stage drivingly-connected to said first planetary gear stage, engine engaging means including a starter jaw and jaw advancing mechanism operably connected to said second planetary gear shage, a device responsive to a predetermined low speed of the starter, means operable by said speed device to cause said first planetary gear stage to rotate as a unit at said low speed whereby said starter jaw is driven at relatively higher speed since only said second planetary gear stage is operative.

6. A dual speed engine starter for a jet engine comprised of a high speed motor having a drive shaft, a first planetary gear stage having a rotatably-mounted ring gear, said first planetary stage being drivingly-connected to said motor drive shaft, clutch means normally restraining said ring gear from rotation, a second planetary gear stage having a fixed ring gear drivingly-connected to said first planetary stage, engine connection means drivingly-connected to said second planetary gear stage, control means responsive to a predetermined low speed of said motor, said control means being arranged

to disengage said clutch means at said speed so that said first planetary gear stage rotates as a unit whereby the starter initially transmits a low-speed high torque and then a high-speed low torque.

7. A dual speed engine starter for a jet engine comprised of a high speed motor having a drive shaft, a first planetary gear stage having a rotatably-mounted ring gear, said first planetary stage being drivingly-connected to said motor drive shaft, clutch means normally restraining said ring gear from rotation, a second planetary gear stage having a fixed ring gear drivingly-connected to said first planetary stage, engine connection means drivingly-connected to said second planetary gear stage, control means responsive to a predetermined low speed of said motor, said control means being arranged to disengage said clutch means at said speed so that said first planetary gear stage rotates as a unit whereby the starter initially transmits a low-speed high torque and then a high-speed low torque, said clutch means including an overrunning clutch, said control means including a multiple disc pack arranged to be compressed and then to cause a reaction on the first planetary stage so that said clutch is disengaged.

8. A dual speed engine starter for a jet engine comprised of a high speed motor having a drive shaft, a first planetary gear stage having a rotatably-mounted ring gear, said first planetary stage being drivingly-connected to said motor drive shaft, clutch means normally restraining said ring gear from rotation, a second planetary gear stage having a fixed ring gear drivingly-connected to said first planetary stage, engine connection means drivingly-connected to said second planetary gear stage, control means responsive to a predetermined low speed of said motor, said control means being arranged to disengage said clutch means at said speed so that said first planetary gear stage rotates as a unit whereby the starter initially transmits a low-speed high torque and then a high-speed low torque, said control means including flyweights carried by the planet gear support of said first planetary stage and arranged to cam said disc plate at said speed so that said disc plate is moved out of contact with said ring gear.

References Cited in the file of this patent

UNITED STATES PATENTS

1,632,865	Wright	June 21, 1927
2,330,136	Nardone	Sept. 21, 1943
2,398,716	Ojutkangas	Apr. 16, 1946
2,548,269	Ochtman	Apr. 10, 1951
2,625,247	Shurts	Jan. 13, 1953
2,651,493	Volk	Sept. 8, 1953
2,804,748	Hutchinson	Sept. 3, 1957
2,816,449	Troeger	Dec. 17, 1957