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JET ENGINE STARTER CLUTCH WITH TEETH SYNCHRONIZING MEANS

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Fig. 1.

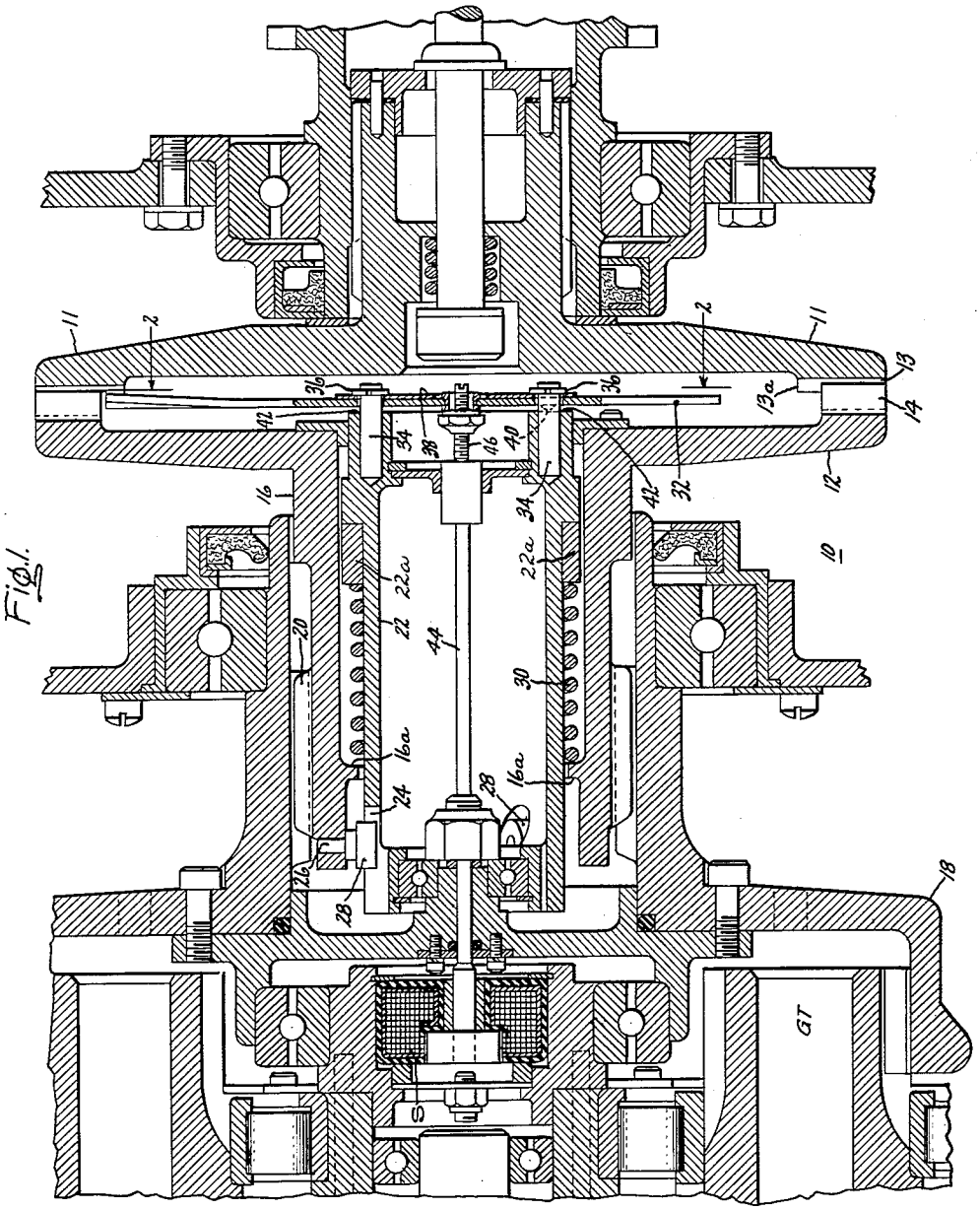
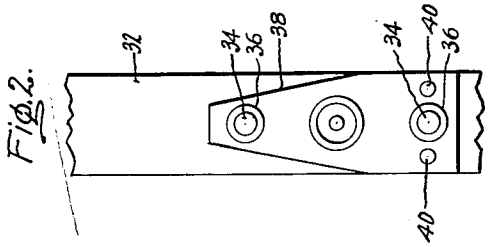


Fig. 2.



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JET ENGINE STARTER CLUTCH WITH TEETH SYNCHRONIZING MEANS

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This invention relates generally to a starter clutch mechanism for jet engines and in particular to a synchronizing means for positive engagement of a jaw type clutch before application of a load.

The substantial increases in size and weight of the latest type jet engines require the application of considerable force to overcome starting inertia, with resulting high torque loads which must be carried by starters of reasonable weight. Coincident with this weight problem is that of clutch engagement with a running engine, as when coasting, and the problem of disengagement of the clutch from the started engine rotating at high operating speeds.

Accordingly, it is an object of this invention to provide an improved starter clutch for jet engines.

Another object of invention is to provide a lightweight starter clutch for use with the latest type jet engines.

Still another object of invention is to provide a jet engine starter clutch for use with an engine which may be either stationary or rotating.

A further object of invention is to provide an improved jet engine starter clutch which is automatically disengageable from the engine which it has started.

These and various other objects, features and advantages of our invention will be apparent from the following particular description, and from an inspection of the accompanying drawings in which:

Fig. 1 is a longitudinal sectional view of a preferred embodiment of our improved clutch in engaged position and;

Fig. 2 is a partial view of the synchronizing finger structure taken along line 2—2 of Fig. 1.

The objects of our invention may be accomplished by the provision of synchronizing means carried by the driving clutch member for contacting the driven clutch member initially so as to index and bring the load carrying teeth into full depth engagement without gnashing.

In the drawing, the automatic clutch arrangement is disclosed generally at 10, comprising the torque transmitting members 11 and 12, the former consisting of a rotatable engine dog which is restrained against axial movement, and the latter consisting of a starter dog which is movable axially for engagement with the engine dog 11. Both dogs have conventional type cantilever mounted teeth 13, 14 on their respective contacting faces, tapered along one edge and straight along their contact edges, with the teeth 13 on engine dog 11 having extensions indicated at 13*a*.

The starter dog 12 has a tubular portion or member 16 which extends away from the contacting face backward toward the gear train indicated generally at GT by which power is transmitted from a starter motor (not shown), with the output gear 18, carrying the tubular member 16 by the spline construction indicated at 20. A second tubular member, indicated at 22, is located within tubular member 16 and, though free to rotate, is fixed axially, and provided with helical slots 24, three being shown as used at the end distant from the contacting face of the starter dog 12. Inwardly extending radial pins 26, equal in number to the disclosed slots, are secured to the end of the tubular member 16 corresponding to the helical slots and are provided at their ends with rollers 28, which contact the walls of the respective helical slots in the inner tubular member 22.

A compression spring 30 is positioned in the annular space between the outer and inner tubular members 16 and 22, and reacts against flanges 16*a* and 22*a*.

Since the inner tubular member 22 is restrained against axial movement, the effect of spring 30 is to exert an axial force on tubular member 16 which tends to hold starter dog 12 in a disengaged position.

A synchronizing finger 32 is located in the cylindrical space between the faces of the starter and engine dogs 11 and 12, and is carried by the inner tubular member 22 by means of axially extending pins 34 fastened thereto, so that the synchronizing finger will rotate with the inner tubular member but is free to move axially along the pins, its outward movement into engagement with the engine dog teeth being limited by spring type fastening means indicated at 36.

Between the outer face of the synchronizing finger 32 and the fastening means 36, there is interposed a spring member 38, joined at one end to finger 32 by rivets as at 40, while the other end is free to react against the upper fastening means 36. The inner heads of rivets 40 are in contact with the front face of the inner tubular member 22 as shown at 42 and act to keep the synchronizing finger 32 in contact with the lower fastening means 36.

The synchronizing finger 32 is moved into engagement with the teeth extensions 13*a* by means of an electrical solenoid, indicated at S, the axial movement being transmitted from the solenoid to the synchronizing finger by means of rod 44 extending from the solenoid armature through the inner tubular member 22 against the adjustable spacing structure 46 carried by the synchronizing finger 32, which moves axially with respect to the upper pin 34 and because of the rivet head contacts at 42, pivots on the lower pin 34, the rivet heads serving to prevent wobbling of the finger.

When the clutch members are in a disengaged position, the output torque transmitted from gear 18 will be transferred to the tubular member 16 of the starter dog 12 through the spline 20. This torque will in turn be transmitted through the radially extending pins 26 and rollers 28 to the wall surfaces of the helical slots in the rotatable inner tubular member 22. The transmission of the torque to the helical wall surfaces results in an axial component of force which is proportional to the amount of the torque transmitted and the helix angle of the slots. Since the tubular member 22 is not free to move axially, a reaction force will result tending to move starter dog 12 into engagement with engine dog 11. If the synchronizing finger is not engaged, the amount of torque transmitted to the inner tubular member 22 will be only enough to keep the latter rotating at the speed of the starter dog 12. The compression spring 30 is designed to overcome the axial force developed under such conditions so that no axial movement of the starter dog 12 takes place.

In the process of starting, solenoid S is energized, which throws the upper end of synchronizing finger 32 against the face of engine dog 11 into the region of teeth extensions 13*a*. Assuming the engine dog 11 to be at a standstill, when starter dog 12 begins to rotate as driven by the starter motor, it carries with it the synchronizing finger 32 until the synchronizing finger engages with the first tooth extension 13*a* that it contacts. Thereafter the synchronizing finger 32 is held back by engine dog 11, while starter dog 12 continues to rotate ahead. This

relative retardation of the synchronizing finger 32 with respect to starter dog 12, greatly increases the torque transmitted to the inner tubular member 22 to develop sufficient axial force to overcome the force exerted by spring 30, so that the rollers 28 will move along the helical wall surfaces and carry the tubular member 16 and starter dog 12 into engaged position with engine dog 11, the movement being in some fixed proportion to the amount of relative motion between the starter dog 12 and the inner tubular member 22. The axial motion of starter dog 12 in conjunction with its rotational advancement ahead of engine dog 11, results in a screw-like action of starter dog 12 as it comes into engagement with engine dog 11. By proper design for the location of the synchronizing finger 32, this screw-like action of starter dog 12 is indexed to bring the dog teeth into load carrying contact in the position of full engagement, the design being such that only a relative motion of one tooth pitch can occur before the clutch members become fully engaged and rotational advancement of starter dog 12 with respect to engine dog 11 stopped. The amount of relative motion necessary to bring the clutch members into engagement will be the same regardless of the individual absolute velocities of the two clutch dogs 11 and 12.

In the event that the engine dog is rotating at the beginning of the engaging cycle, the synchronizing finger 32 will undergo a ratchet action over the teeth 13*a* until the starter dog reaches a speed equal to that of the engine dog. Thereafter the engagement continues as in the standstill condition above.

The disengagement process begins when the engine begins to run ahead of the starter or when the starter effort is discontinued. The action of disengagement is opposite that of the engagement, the action of the synchronizing finger permitting spring 30 to withdraw the starter dog 12 into disengaged position, in a screw-like fashion, without the back sides of the teeth on either starter dog 12 or engine dog 11 making contact with each other.

The synchronizing finger 32 will remain in tooth engaging position so that a ratchet action will take place if the engine speed increases greatly, until such time as the solenoid is used to retract the finger.

The compression spring which disengages the starter dog and holds it in that position when the synchronizing finger is not engaged, must be strong enough to hold the starter dog in the disengaged position under the acceleration and deceleration conditions when the clutch unit is airborne.

It will be obvious to those skilled in the art that our objects of invention are accomplished by using a pawl or finger to synchronize the starter means with the engine before full engagement of the jaw teeth on the clutch members is possible and that the process is reversed when the engine begins to run ahead of the starter; should the engine be at a standstill, the clutch engages immediately when the starter begins to turn over.

Although many changes can be made in the disclosed apparatus without departing from the scope of the claims, it is intended that all matter contained in the preceding description or shown in the accompanying drawings shall be interpreted as illustrative and not limitative.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In a mechanism for starting engines, a clutch assembly for transmitting torque from a starter motor and adapted to engage with a clutch member carried by the engine to be started comprising, a first clutch element mounted for rotary and axial movement and having a contacting face with teeth thereon and a tubular body portion for connection to said starter motor, a second clutch element mounted for rotary movement only and interconnected concentrically within said first clutch element, means for causing said first clutch element to move axially upon relative rotation between said first and second clutch elements, and synchronizing means for ensuring toothed engagement between said clutch assembly and said engine clutch member mounted on said second clutch element for rotation therewith and means for moving said synchronizing means axially for contact with said teeth on said engine clutch member.

2. A starting mechanism, in combination with a motor, for starting an engine having a clutch member with teeth on its engaging face, comprising a first clutch member adapted to move in rotation and translation and having teeth on a contacting face for engagement with said teeth on said engine clutch member and having a tubular body portion for mounting on said motor, a second clutch member adapted to move in rotation only and mounted interconnectedly and coaxially within said first clutch member, means for causing said first clutch member to move axially upon relative rotation between said first and second clutch elements, means for synchronizing the rotation of said starting mechanism clutch members with said engine clutch member comprising a fingerlike extension mounted on said second clutch member for rotation therewith and adapted to contact said teeth on said engine clutch member, and means for moving said extension axially into engagement with said teeth on said engine clutch member.

3. In combination with an engine having a clutch face with teeth thereon, a starting mechanism therefor comprising a starter motor having a drive shaft, a first clutch member mounted coaxially thereon for rotation therewith and adapted to have axial motion, said first clutch member having a tubular body and a contacting face with teeth thereon adapted to contact corresponding teeth on the engine to be started, a second clutch member having a tubular body portion mounted concentrically and internally of said first clutch member and adapted to have rotary motion only, connecting means between said first and second clutch members to provide axial movement of said first clutch element upon relative rotation between said first and second clutch members, a synchronizing finger-like extension mounted on said second clutch member and adapted to make contact with said teeth on said engine clutch face, and means for axially moving said extension into operative engagement with said teeth of said engine clutch face for synchronizing the rotation of said starting mechanism clutch members with said engine clutch member.

4. Torque transmitting means between a starter motor and an engine to be started having a toothed clutch member comprising a rotatable driving member, a sleeve member carried by said driving member and having a helical slot, means interconnecting said members comprising a radial projection on one of said members extending into said slot to insure rotation of said members and axial movement of said driving member into and out of engagement with said engine clutch member.

5. In combination, a releasable coupling for a starter mechanism for an engine comprising a first element having a cylindrical body mounted coaxially with a starter motor for rotation therewith and a contacting face with teeth thereon adapted to contact similar teeth on a contacting clutch face of said engine, a second element having a cylindrical body mounted concentrically within said cylindrical body of said first element and adapted to rotate therewith, means to insure rotation therebetween comprising a projection on one of said elements and a helical slot on the other of said elements into which said projection extends substantially radially, means for synchronizing engagement with said toothed engine clutch face comprising a finger-like extension carried by said second element adapted to engage said teeth on said engine contacting face, and means for axially moving said last-mentioned means into operative engagement with said last-mentioned teeth.

6. In a starter, torque transmitting means comprising a driving member having a first element having a cylindrical sleeve section and a face having teeth adapted to

engage with corresponding teeth on a member adapted to be driven, a second element having a cylindrical sleeve section for concentric mounting within said first element and having a finger-like extension adapted to contact said teeth on said driven member, means for placing said extension into contact with said teeth, and means for moving said teeth on said driving member into contact with said teeth on said driven member.

7. In a starter as set forth in claim 6, said last-mentioned means comprising a substantially radial projection on one of said sleeve sections and a helical slot in the other of said sleeve sections, said projection extending into said slot.

8. In a starting mechanism, means for transmitting torque comprising a first member having a sleevelike body and a toothed face adapted to engage a similar toothed face on an engine to be started, a second member having a sleeve-like body with a helical slot and mounted internally concentric with said first member for rotation therewith, interconnecting means for rotating said members together comprising a substantially radial projection carried by said first member extending into said helical slot carried by said second member, means located between said sleeve-like bodies of said members for restraining axial movement of one of said members, means for placing said toothed faces into engagement with each other comprising a finger-like extension mounted on said second member adapted to contact said toothed face of said engine, and means for axially moving said extension comprising a rod extending coaxially with said first member.

9. Means for coupling driving and driven parts and comprising a pair of elements carried by the driving part, said elements having concentric cylindrical parts and arranged to rotate together, one of said elements having a toothed face portion adapted to engage with a corresponding toothed face portion carried by said driven part, the other of said pair of elements having a finger-like extension for contacting said toothed face portion of said driven part, means for moving axially said extension on said other of said pair of elements into contact with said toothed face portion of said driven part, and means for placing said toothed face portions into engagement with each other comprising a substantially radial projection on said one of said elements and a helical slot carried by the other of said elements into which said projection extends.

10. In combination with a driven member, a driving member engageable with said driven member and adapted to move in rotation and translation and having a sleeve-like body for mounting on a drive shaft of a starter motor and a toothed face for contacting a similar face on said driven member, a second member mounted coaxially therewith and adapted to move in rotation only and having a helical slot in a sleeve-like body, a projection carried by said first sleeve-like body extending into said slot and contacting the periphery thereof for moving said driving member in translation, spring means between said sleeve-like bodies for opposing translational motion for engagement between driving and driven members, and means for insuring synchronization between said members before engagement of their toothed faces comprising a finger-like extension carried by said second member and engageable with the toothed face of the driven member.

11. Means for transmitting torque between a driving and a driven member comprising a pair of telescoping members carried by said driving member, the first of

said members having a sleeve-like body with a helical opening therein and adapted to move in rotation only and the other of said members being concentrically mounted with respect to said first member and having a substantially radial projection extending into said opening in contact with the walls thereof and adapted to move in rotation and translation and having a face with teeth thereon adapted to match with corresponding teeth on the face of said driven member, said first member having a finger-like extension for contacting said teeth on said driven member for synchronizing the speed with that of said driving member, and means for placing said extension in contact with said teeth on said driven member.

12. In a clutch mechanism for starting an engine having a contacting face with teeth thereon by means of a starter motor, a first clutch element adapted to move axially and having a tubular body portion and a face portion with teeth thereon adapted to match corresponding teeth on said engine contacting face, a second clutch element mounted concentrically within said first clutch element for rotation therewith and defining an annular chamber therebetween, one of said clutch elements having a helical slot and the other of said clutch elements having a substantially radial projection extending into said slot and in contact with the wall surface thereof thereby to assure rotation of said elements and providing for axial movement of said first clutch element into engagement with said contacting face of said engine, a synchronizing finger carried by said second clutch element adapted to contact said teeth on said engine contacting face prior to toothed engagement between said contacting faces, means for axially moving said finger into contact with said engine contacting face teeth comprising a rod extending coaxially with said elements, and spring means in said annular chamber restraining said first element from engagement with said engine contacting face.

13. In combination with an engine and a starter motor, said engine having a clutch face with teeth thereon, a clutch assembly comprising a first clutch element having a tubular body and mounted coaxially on said starter motor for rotation therewith and a clutch face with teeth thereon, said element being adapted to move axially, a second clutch element having a tubular body and mounted concentrically within said first clutch element and interconnected for rotation therewith, means interconnecting said elements comprising a substantially radial projection in one of said members and a helical slot in the other of said members into which said projection extends and contacts the walls thereof whereby rotation and axial motion of said first clutch element is assured, spring means located between said clutch elements for restraining axial movement of said first clutch element into teeth engaging position with said engine member contacting face teeth, means for synchronizing the position of said teeth on said clutch faces comprising a finger-like extension carried by said second clutch member and adapted to move axially into tooth engagement position with said engine clutch face, and means for axially moving said extension into tooth engaging position comprising a rod mounted coaxially with said clutch members.

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