

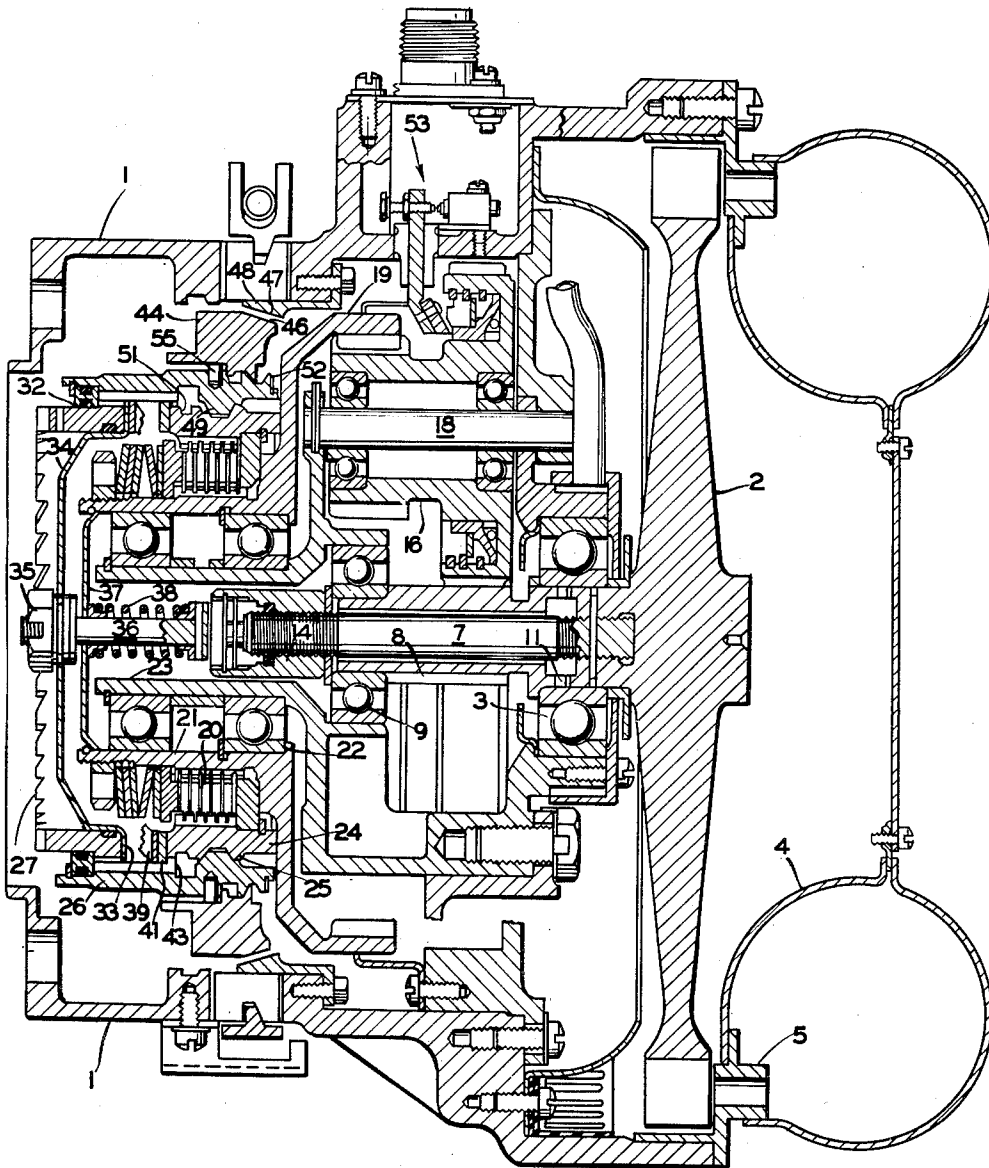
Jan. 1, 1957

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2,775,894

PNEUMATIC ENGINE STARTER

Filed March 7, 1955



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1

2,775,894

PNEUMATIC ENGINE STARTER

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Application March 7, 1955, Serial No. 492,457

8 Claims. (Cl. 74—7)

The present invention relates to pneumatic engine starters. It is particularly concerned with an engine starter that is powered by an air driven turbine, whereby starter jaw mechanism is caused to engage and start an associated engine.

The starter is of a type that finds particular use in association with high speed engines, such as jet engines. With such engines, positive disengagement of the starter jaw from the engine after starting and a quick restoration of the jaw mechanism is desired to avoid jaw ratcheting damage, and wear to the jaws that might otherwise occur.

An object of the invention is, therefore, to avoid ratcheting and damage in engine starters in engine starting operations.

A further object of the invention is to provide an improved pneumatic engine starter that finds particular use in association with high speed engines.

A more particular object of the invention is to provide improved starter jaw advancing and retracting mechanism.

Now, we have designed a pneumatic engine starter that is particularly suited to high speed engines. It is especially characterized by its starter jaw engaging mechanism whereby engagement and disengagement of the starting jaw in engine starting operations is free of ratcheting or danger of damage to the engine starting elements.

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

The drawing is a cross section of a pneumatic engine starter embodying the invention.

In the drawing is disclosed a suitable housing 1 in which is supported an air driven turbine 2 in suitable bearings 3. The turbine is driven by pressure air supplied through a scroll 4 and nozzles 5. The housing is provided with suitable means through which the used air may exhaust. Axially extending from a hub of the turbine is a shaft 7. Slewing the shaft is an elongated pinion gear 8 mounted at its ends in suitable bearings, as 3 and 9. Pinion 8 is clutched at 11 to the hub of the turbine and is held in such engagement by nut means 14 carried on the free end of shaft 7. The pinion gear is engaged with a plurality of gears 16 spaced radially about it, and each of which rotates on bearings carried by separate stub shafts 18 supported in the housing structure. Gears 16, in turn, are in mesh with a surrounding annulus gear 19. Rotation of the turbine drives the pinion gear, which in turn drives the annulus gear through the intermediate gears 16. The annulus gear carries an axially extending hollow hub 21 which is mounted for rotation on the outer races of bearings 22. The inner races of the latter are supported by an elongated hollow axial extension 23 of the interior structure of the housing. Hub 21 of the annulus gear is engaged by a suitable slip clutch 20 with a surrounding

2

short screw shaft 24. The latter is provided with heavy external threads 25 on which is threadedly engaged a travel nut 26. Slidably splined to the upper interior wall of the latter is a starter jaw 27. The latter is prevented from escaping free of the spline nut by a shoulder of the jaw that limits against the underside of a ring 32 retained on an interior shoulder of the spline nut 26. The bottom end wall of jaw member 27 rests upon a step 33 formed about the edge of a crown plate 34.

The latter is bolted as at 35 axially to the end of a short rod 36 which extends axially through a second plate 37 spaced below. The latter is retained in the free open end of hub 20 of the annulus gear. Rod 36 carries a restoring coil spring 38 which limits between the underside of plate 37 and a collar at the end of the rod. A function of the coil spring is to cushion the starter jaw and to aid in its restoration after an engine starting operation. The jaw member is further cushioned beneath step 33 by a spring 39 that rests upon a broad washer 41. The latter limits partially against an end wall of the screw shaft 24 and against a shoulder 43 interiorly of the spline nut 26. It is clear that axial movement of spline nut 26 on the screw shaft 24 will cause washer 41 and spring 39 to advance the jaw member axially outward into engagement with the jaws, not shown, of an opposed associated engine.

Suitable means is provided to apply a restraining torque on the spline nut 26 so that it will be caused to move axially along the screw shaft. This torque is provided by a thickened heavy ring 44 engaged upon the outer surface of the spline nut by internal threads or helical splines. The band of the threads of the ring and of the complementary spline nut is such that initial rotation of the spline nut will cause the heavy ring to move axially to the right. When this happens a conical surface 46 on the ring will engage a complementary surface 47 of another ring 48 fixed to the housing. Rotation of the spline nut occurs briefly as the screw shaft is accelerated, and it causes the heavy ring 44 to move axially to the right to frictionally engage ring 48. With this action, a restraining torque is communicated from the latter engaged elements to the spline nut 26. Whereupon, the latter moves axially leftward. As it moves, it axially advances the jaw member 27 into positive engagement with the jaws of the associated engine. Spline nut 26 continues moving axially to the left as permitted by the compression of spring 39 until the upper end of the threads 49 therein abut a flange 51 of screw shaft 24. Completion of the travel of the spline nut to its leftmost position will result in a lock ring 52 carried at the right end of the spline nut engaging a shoulder of the heavy ring 44 and moving the latter out of contact from housing ring 48, thereby removing the frictional drag on the spline nut and allowing the latter, together with the starter jaw, to rotate at high speed in positive engagement with the associated engine.

As the speed of the starter mechanism increases with the consequent starting of the associated engine, automatic switch means, generally indicated at 53, is centrifugally operable through the rotation of gear 16 to close and cut off the supply of pressure air to the turbine.

With the latter action and the resultant deceleration of the turbine and starter jaw mechanism, restoration of the latter takes place with the aid of the coil spring 38. This causes the heavy ring 44 to tend to move leftward to a position in which surface contact of the ring 44 and ring 48 cannot take place.

Upon disengagement of the starter jaw from the associated engine jaw, the starter jaw is apt to be kicked back against ring 48 when the starter jaw is given an impulse to the right by the engine jaw. To avoid this, a number of plugs 55 which fit loosely in spline nut 26 will, with the increased speed of the starter mechanism in starting the associated engine, be thrown out centrifugally

3

to contact the inner cylindrical surface of ring 44. The resulting friction will prevent the latter from being kicked back during disengagement of the starter jaw from the engine.

By the structure described, a starter mechanism is provided having many desirable advantages. A drag is provided on the starter jaw by the heavy ring 44 whereby the starter jaw is not slammed into engagement with the engine jaw but is first carried into axial positive engagement therewith and then rotated. The drag of the ring element is freed from the starter jaw as the latter is ready to rotate in starting the engine, thus permitting high speed starter jaw rotation at the proper time. On disengagement of the starter and engine jaws, the structure permits the starter jaw to coast to restored position under the influence of the coil spring 38. The drag of the ring element having been removed from the starter jaw in the starting operation, axial advancement leftward of the starter jaw, that would tend to otherwise occur as the turbine power decelerates, is curbed; and, under the strong influence of the coil spring the starter jaw recedes back to normal. In curbing a tendency of the starter jaw to continue moving into engagement with the engine jaw during the coasting back period, ratcheting and consequent wear and damage to the starter mechanism is eliminated.

Although but one embodiment of the invention has 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.

What is claimed is:

1. In a pneumatic engine starter including a screw shaft and air driven turbine means for driving the screw shaft, a travel nut threadedly engaged upon the screw shaft, a spring cushioned starter jaw splined to the travel nut and adapted to be advanced axially by axial travel of the latter, and a ring element having a relatively high polar movement of inertia threadedly engaged upon the travel nut, the ring element adapted to move in a direction opposite to that of the travel nut upon rotation of the latter, the ring element having a conical surface engageable with a complementary surface of fixed ring upon rotation of the travel nut and consequent movement of the ring element causing a drag upon the travel nut whereby the latter is caused to move axially along the screw shaft.

2. In a pneumatic engine starter as in claim 1, wherein the travel nut is limited in the extent of its axial travel and means is provided upon the nut so limiting to free the drag of the ring element from the travel nut.

3. In a pneumatic engine starter as in claim 2 wherein means is provided to lock the ring element to the travel nut in its freed position.

4. A pneumatic engine starter comprising starter jaw advancing mechanism including means for causing a drag upon the starter jaw as it advances, means for re-

4

leasing the drag as the starter jaw approaches the limit of its advance, means within said starter for retracting the starter jaw to normal position, and means for restraining the drag causing means from taking effect during the retraction of the starter jaw by said means for retracting.

5. A pneumatic engine starter, comprising an air driven turbine, a screw shaft powered by the turbine, starter jaw means rotatable with the screw shaft, means for imposing a drag upon the starter jaw means to hinder rotation thereof and to cause axial outward advancement thereof along the screw shaft, means for releasing the drag as the starter jaw mechanism approaches the limit of its advance, means to decelerate the screw shaft, retraction means within said starter for withdrawing said starter jaw means from its advanced position when said shaft is decelerated, and means operable to prevent any axial outward advancement of the starter jaw means and actuation of said drag means during the deceleration of the screw shaft.

6. Starter jaw advancing mechanism including a screw shaft, means for driving the screw shaft, starter jaw means including a travel nut rotatable with turning of said shaft, drag means operable to impose a drag upon the travel nut of the starter jaw means when jaw means is rotating and to cause the starter jaw means to advance axially along the screw shaft, and means operable to release the drag means as the starter jaw means reaches the limit of its axial advance whereby the starter jaw means is free to rotate with further turning of the screw shaft.

7. Starter jaw means as in claim 6 wherein means is provided to decelerate the screw shaft, and wherein spring means is operable to aid in the retraction of the starter jaw means to its inactive position concomitant with the deceleration of the screw shaft, and further including means for preventing operation of said drag means upon deceleration.

8. In engine starter jaw mechanism rotatable with the rotation of a screw drive shaft and axially advanceable along the shaft upon a drag being exerted upon the engine starter jaw mechanism, means for exerting a drag on the jaw mechanism to permit axial advancement thereof along the screw shaft, means for limiting the axial advance of the jaw mechanism and causing rotation thereof with continued rotation of the screw shaft, means operable to release the drag from the jaw mechanism as the latter approaches the limit of its advance, other means operable to prevent operation of the drag means as the jaw rotates with the continued rotation of the shaft and when the jaw is decelerated, means for decelerating the screw shaft to rest position, and means for progressively and continuously moving the jaw means axially toward normal position as the screw shaft decelerates.

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