April 18, 1939. H. BAER ET AL 2,154,555

ENGINE STARTING APPARATUS

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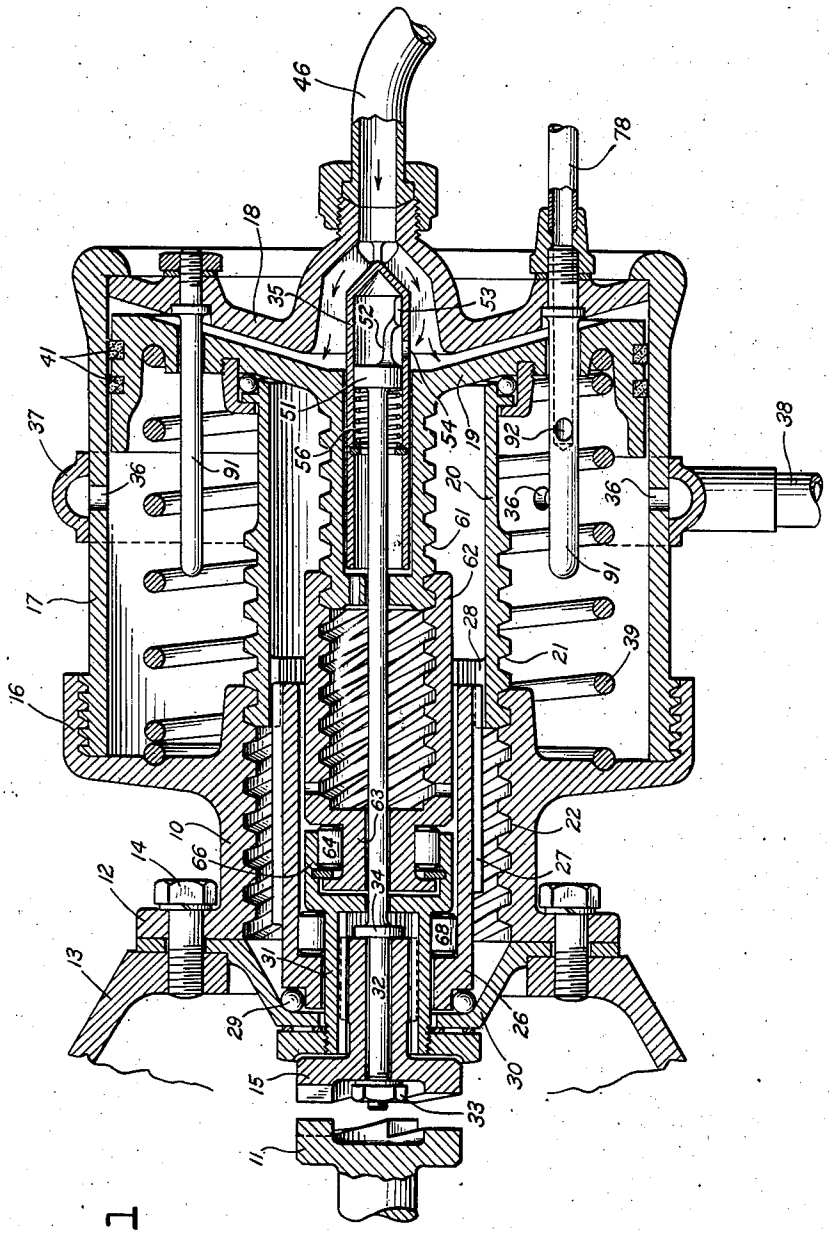


Fig. 1

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Fig. 2

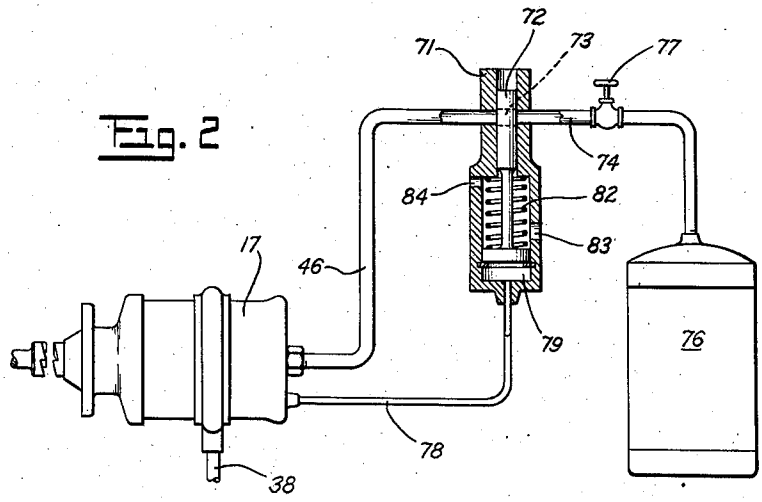
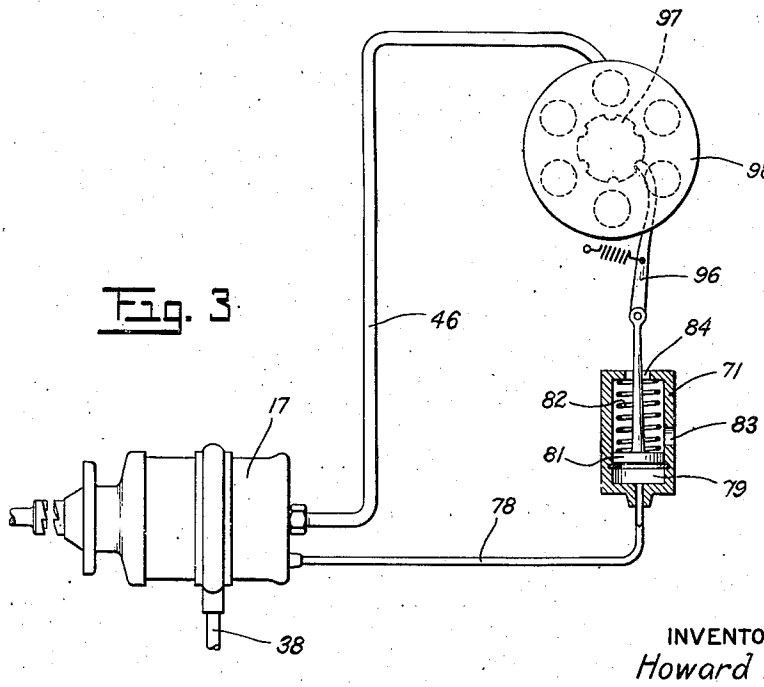


Fig. 3



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Fig. 4

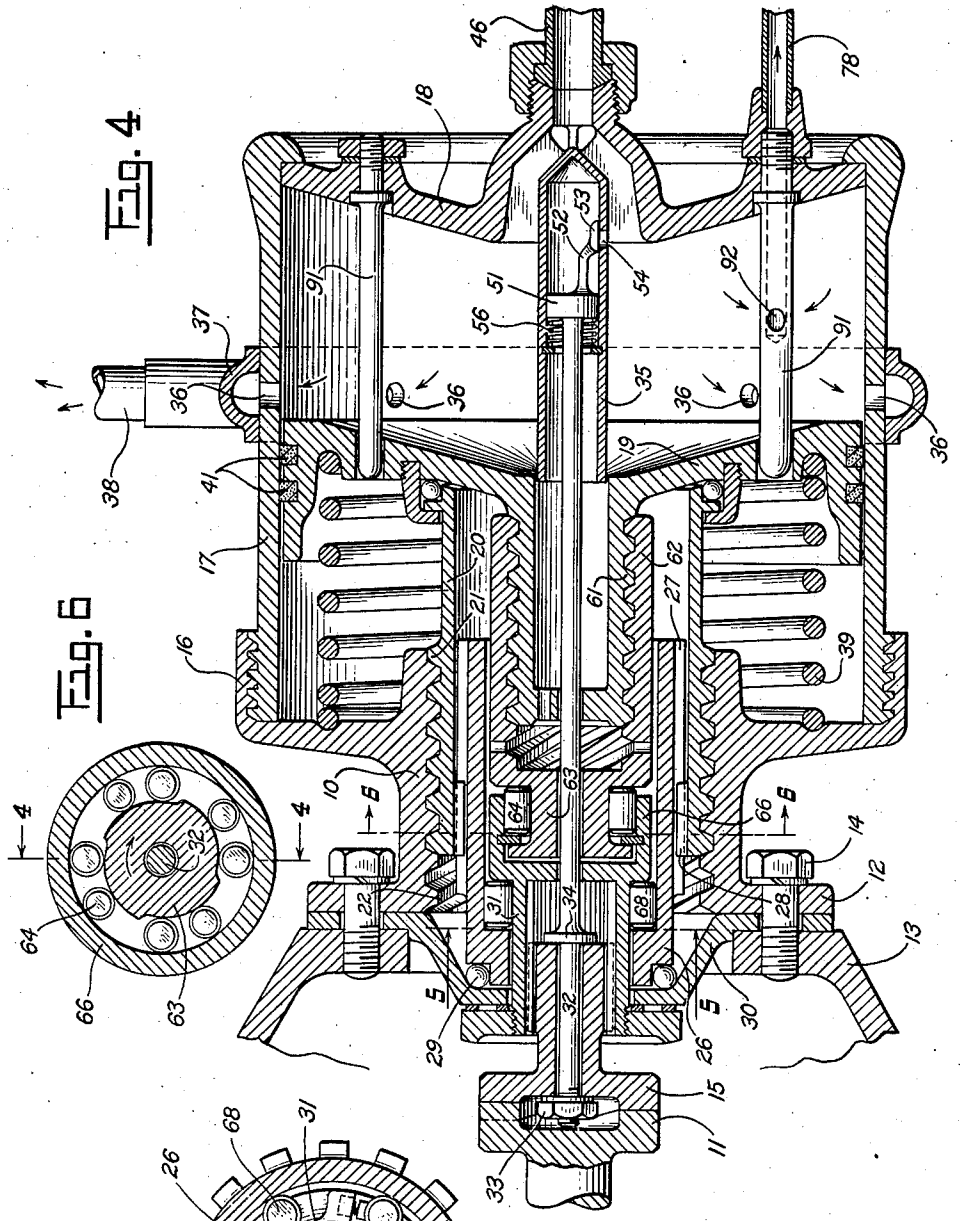
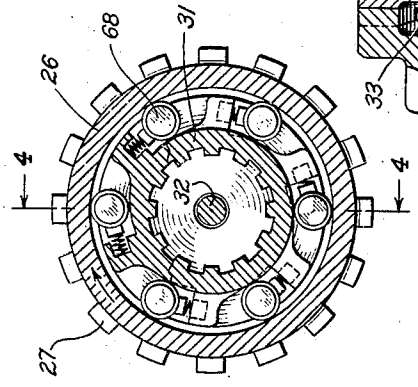


Fig. 6

Fig. 5



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UNITED STATES PATENT OFFICE

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ENGINE STARTING APPARATUS

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Application August 1, 1935, Serial No. 34,286

5 Claims. (Cl. 123—179)

This invention relates to engine starters, and particularly to those of the type having an engine engaging member which is movable to engaging position to impart initial rotary movement to the engine crankshaft, and subsequently retracted, or "demeshed" when the cranking effort is discontinued.

An object of the invention is to provide means for holding the engine engaging member in engine engaging position until the engaged engine member has attained a speed greater than that of the engine engaging member, such holding being effected by a novel method of operation which includes the step of utilizing energy derived from the same source as that which supplies the cranking force.

When the source of energy is a fluid under pressure, as in the embodiment illustrated in the accompanying drawings, the holding means for the engine engaging member preferably takes the form of a mesh controlling piston movable in response to application of the fluid pressure, and having pressure trapping means associated therewith to hold the piston (and hence the engine engaging member) in the effective position until the engaged element of the engine runs ahead of i. e., "over-runs"—the engine member of the starter.

In the illustrated embodiment the starter is shown as of the type including a piston (distinct from the mesh controlling piston above described) reciprocable within a fluid receiving chamber, the motion of the piston being converted into rotation of the engine engaging member by suitable translating mechanism; but it is to be understood that these drawings are for the purposes of illustration only and are not to be construed as a limitation of the scope of the invention, reference being had for this purpose to the appended claims.

In the drawings:

Fig. 1 is a longitudinal sectional view of a device embodying the invention;

Fig. 2 is a diagrammatic view showing one form of pressure generating and control means;

Fig. 3 is a view of a second form of pressure generating and control means;

Fig. 4 is another longitudinal sectional view, but showing the piston in an extreme operative position; and

Figs. 5 and 6 are transverse sectional views through the overrunning clutches.

With reference to the drawings, and more particularly to Fig. 1, the piston and engine starting gear unit comprises a body member 10 having a flange 12 by which it is secured to the engine crankcase 13 as by bolts 14, the flange being conveniently of a size standardized for aircraft engine starters. The engine crankshaft, or other drive shaft (not shown) is provided with an engine jaw 11 engageable by the starter jaw 15 as will be later more fully described.

Screw threaded in a quickly detachable manner to an annular flange 16 integral with the body 10 is a cylinder 17 having a closed head 18, and slidably fitted within the cylinder is a piston comprising the head 19 secured to the rotatable cylindrical piston body 20, the piston body 20 and the main starter body 10 being provided with co-operating helical grooves 21 and 22. A sleeve 26 is internally drivably connected with the piston body 20 by splines 27 and 28 which permit the axial travel of the piston body relative to the sleeve, but restrain these two parts to unitary rotation. An anti-friction thrust bearing 29 is preferably interposed between the end of the sleeve 26 and a nose piece 30.

The starter jaw 15 is splined for limited axial travel within a second sleeve 31 and is normally retained in the position shown by a central rod 32 which is connected to the jaw 15 as by the nut 33 and shoulder 34.

This rod has a piston fit within the bore of a sleeve 35 which is integral with the cylinder head 18, the head 51 of the rod being exposed to the gas pressure within the cylinder 17. Trailing from the head 51 is a tail piece 52 having a portion 53 constituting a slide valve adapted to close the port 54 in cylinder 18 when the piston moves forward to a sufficient extent to mesh the parts 15 and 11, such forward movement being yieldedly opposed by the spring 56. As shown the cylinder 18 is received within the bore of the externally threaded extension 61 formed centrally of the piston head 19 and engageable with a correspondingly internally threaded sleeve 62 terminating in a portion 63 of reduced diameter constituting the inner race of an overrunning clutch 64, the outer race being constituted by the extending socket 66 of an internally splined sleeve 31 previously described. This sleeve 31 constitutes the inner race of a second overrunning clutch 68, the outer race of which is constituted by the previously described sleeve 26.

Exhaust ports 36 are uncovered by the piston at the left-hand end of its stroke and an exhaust ring 37 preferably collects the discharge so that it may be led away to any desired point by a suitable pipe 38. A spring 39 normally maintains the piston at the right-hand end of its travel as shown, and the piston is preferably equipped

with a pair of piston rings 41. The cylinder head 18 is provided with a pipe 46 which may be connected to the breech of a cartridge firing mechanism, as in Fig. 3, or to a pressure chamber, as in Fig. 2.

Referring first to Fig. 2 it will be seen that the pipe 46 terminates in a valve housing 71 enclosing a pressure operated tubular valve member 72 which is apertured, as indicated at 73, to permit the establishment of communication between pipes 74 and 46, the former being in turn connected with a tank 76 constituting a source of fluid under pressure, the initiation of the flow of fluid being under the control of a manually operable valve 77. A second pipe 78 leads from the cylinder head 18 to the lower chamber 79 of the valve housing 71 and operates to convey fluid to the said chamber 79 to move the piston 81 against the yielding opposition of the spring 82 and thereby eventually open the chamber 79 to the atmosphere by way of the vent 83, a second vent being shown at 84 for the purpose of preventing creation of undue pressure on the upper side of the piston. The corresponding piston 81 of Fig. 3 actuates a pawl 96 engageable with an indexing member 97 to rotate the cartridge container 98 step by step, for successive firing of the cartridges in any suitable manner, as indicated, for example in the application of Romeo M. Nardone, Serial No. 457,301 filed May 29, 1930.

In order to hold the piston head 19 against rotation, a plurality of rods 91 are caused to extend through apertures in the piston head, the outer end of the rod being fixedly secured in the stationary head 18. One of these rods 91 is apertured as indicated at 92 and is also longitudinally bored to permit passage of fluid into the pipe 78 from the space to the right of the piston head 19 when the latter has advanced to the left to a sufficient extent to uncover the said port 92.

The operation of the mechanism so far described is as follows:

Upon valve 77 being opened, the high pressure fluid is conveyed from tank 76 by way of the open port 73 and pipe 46 to the cylinder 17, and acts both upon the piston head and the central rod 32. There being practically no resistance other than the spring 56 to the movement of the rod, it is instantly advanced to the left thus engaging the engine jaw 11. At the same time the piston 19 advances, and enforces a rotary motion on the starter jaw 15 due to the helical grooves 21 and 22, causing rotation of sleeve 26, and likewise sleeve 31 through overrunning clutch 68. The engine is accordingly turned over and when the piston reaches a point where the exhaust ports 36 are uncovered the fluid pressure will escape and the spring 39 can return the piston to the normal position shown in the drawings. At whatever point of the piston travel the engine starts under its own power, it is free to overrun the jaws 15 due to their sloped or angular formation, and the spline connection of the jaw with the sleeve 31.

Should the engine fail to so start, there will be no overrunning at the point 11, 15, and hence no demeshing of the jaws, for the spring 56 is not strong enough, per se, to return rod 32 against the opposing force of the fluid trapped under pressure in the small cylinder 18. The large cylinder 17, on the other hand, is exhausted of all pressure fluid due to the openings 36 and therefore spring 39 returns piston head 19 and its threaded extension 61, the return stroke of the latter being translated into a turning of sleeve 62 and a corresponding additional rotational impulse on sleeve 31 and jaw 15, the roller clutch 64 now being effective to drive while clutch 68 overruns. Meanwhile chamber 79 and pipe 78 release the pressure fluid to the atmosphere, through the port 83 and the resulting descent of plunger 81 restores communication between tank 76 and pipe 46. As a result a second charge of pressure fluid acts upon piston head 18 and thus continues the reciprocating movement of threaded sleeves 20 and 61, and produces a corresponding continuation of the drive to engine member 11, the cycle being repeated without demeshment of jaw 15, and the process continuing until the trapped fluid in small cylinder 35 is released by reason of the overrunning of the jaw 11, which overrunning can occur only when the engine "fires"—that is, develops its own motive power. The firing means of Fig. 3 will produce a similar multiplication of driving impulses, until the cartridge supply is exhausted, or the operator may intervene to stop the firing mechanism before all cartridges are discharged. Likewise, with the system of Fig. 2, it is also intended that the operator intervene to re-close valve 77 to prevent needless expenditure of fluid pressure after demeshment of the jaws 11 and 15.

What is claimed is:

1. In a device of the class described, the combination with an engine engaging member of means operating successively to drive said engine engaging member, rectilineally moving means for controlling the effectiveness of said successively operating means and means carried by one of said heretofore recited means to cause movement of said engine engaging member to engine engaging position.

2. In a device of the class described, the combination with an engine engaging member of means operating successively to drive said engine engaging member, rectilineally moving means for controlling the effectiveness of said successively operating means, means carried by one of said heretofore recited means to cause movement of said engine engaging member to engine engaging position, means for energizing said rectilineally moving means, and means responsive to a demeshing of said engine engaging member to discontinue the energization of said rectilineally moving means.

3. In a device of the class described, the combination with an engine engaging member, of means including a pair of torque transmitting clutches alternately effective to drive said engine engaging member, means including a common rectilineally moving member for actuating said clutches, the effectiveness of said clutches being dependent upon the direction of rectilineal movement of said last named member, and means carried by said rectilineally moving member to cause movement of said engine engaging member to engine engaging position.

4. In a device of the class described, the combination with an engine engaging member, of means including a pair of torque transmitting concentrically disposed screws alternately effective to drive said engine engaging member, means including a common rectilineally moving member for actuating said concentrically disposed screws, the effectiveness of said concentrically disposed screws being dependent upon the direction of rectilineal movement of said last named member, and means carried by said rectilineally moving member to cause movement of said engine engaging member to engine engaging position.

5. In a device of the class described, the combination with an engine engaging member, of means including a pair of torque transmitting elements alternately effective to drive said engine engaging member, means including a common rectilineally moving member for actuating said elements, the effectiveness of said elements being dependent upon the direction of rectilineal movement of said last named member, and means carried by said rectilineally moving member to cause movement of said engine engaging member to engine engaging position.

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