March 13, 1934. R. M. NARDONE 1,951,030

ENGINE STARTING MECHANISM

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Fig. 1

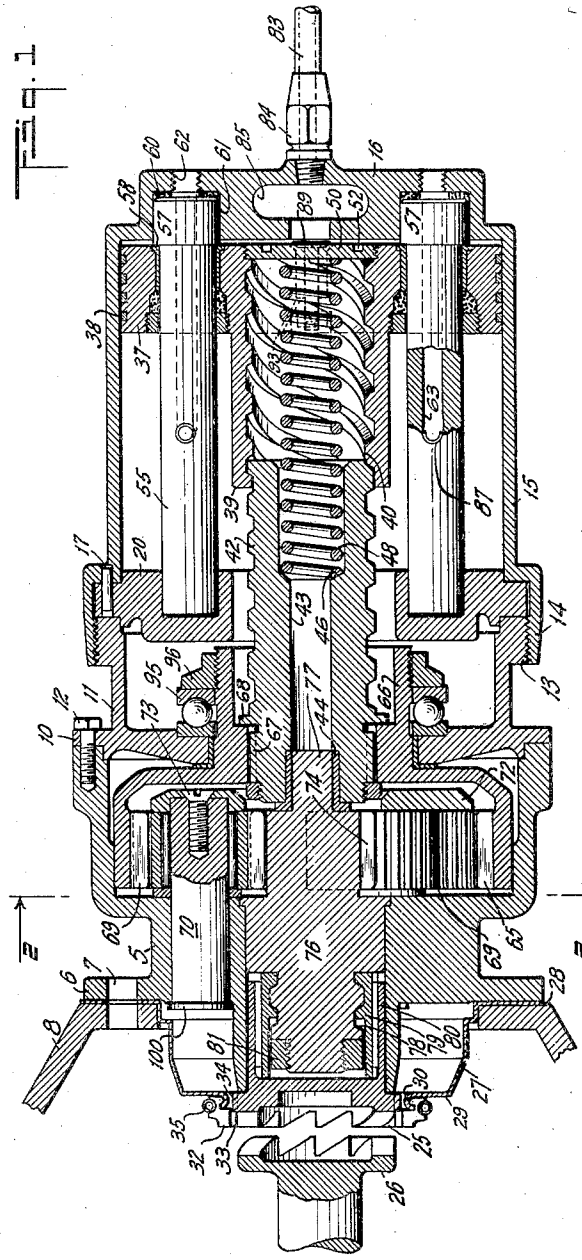


Fig. 3

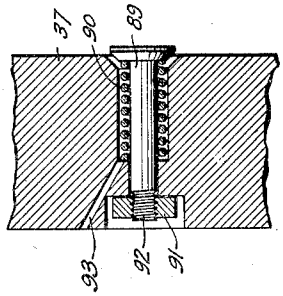
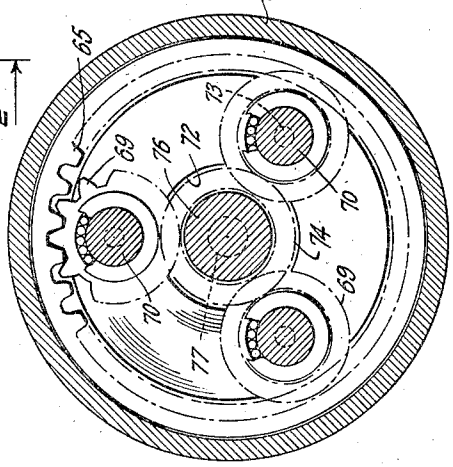


Fig. 2



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## ENGINE STARTING MECHANISM

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4 Claims. (Cl. 121—37)

This invention relates to starting devices for internal combustion engines.

An object of the invention is to provide in a power actuated starter of the character above referred to, novel driving connections between the driving member and engine engaging member, which novel connections are operative to transmit axial motion to said engine engaging member in response to axial motion of said driving member, and are also operative after a predetermined extent of axial motion to transmit a rotary motion to said engaging member in response to continued axial motion of said driving member.

Another object of the invention is to provide novel operating connections between a driving member and engaging member of the foregoing character, which novel means are so constructed and inter-related that the initial rectilinear motion of the driving member is converted into a rotary motion of certain of the parts which rotary motion is in turn reconverted into a rectilinear motion imparted to the engine engaging member.

Another object of the invention is to provide in a power actuated starting mechanism of the foregoing character, novel means for holding the driving member against rotary movement and at the same time insuring transmission of rotary movement to the engine engaging member and the intermediate transmission means.

A further object of the invention is to provide in a power actuated starting mechanism of the foregoing character, novel means for controlling the release of the applied power.

A further object of the invention is to provide means supplementing the release means above referred to, and operative to relieve any residual power remaining after return of the parts to the inoperative position.

Another object of the invention is to provide in a piston actuated starter of the foregoing character, novel means for limiting the stroke of the piston and returning it to its initial position at the completion of the cranking operation.

Other objects and advantages to be derived from the use of the invention reside in the specific construction, combination and inter relation of parts whereby a compact, efficient, and easily operated and maintained unit is produced, all of which objects and advantages will appear more clearly upon an inspection of the following specification, with reference to the accompanying drawing illustrating the preferred embodiment of the invention. It is to be expressly understood, however, that the said drawing is for the purpose of illustration only and is not to be construed as a definition of the limits of the invention, reference being had to the appended claims for this purpose.

In the drawing, wherein like reference characters refer to like parts throughout the several views:

Fig. 1 is a longitudinal axial section through a device embodying the invention;

Fig. 2 is a transverse sectional view taken along the line 2—2 of Fig. 1; and

Fig. 3 is a sectional view of a portion of the actuating piston, the view being taken so as to show the novel pressure release means.

Referring to the drawing, and particularly to Fig. 1, the invention is shown embodied in a substantially cylindrical self-contained unit, the casing of which is composed of a plurality of interlocked casing sections, the first section 5 being provided with a flange 6 having an aperture 7 through which may be inserted suitable fastening means engaging a corresponding flange 8 on the engine crankcase. At its outer end, the section 5 is formed to provide a suitable surface for reception of the end plate 10 in which the intermediate casing section 11 terminates, the said plate 10 being secured to the section 5 by suitable means 12. The outer end of section 11 is threaded, as indicated at 13, for reception of the correspondingly threaded end portion 14 of the outer casing section 15, the latter constituting in addition a head or cap 16 for the mechanism, and being properly positioned with respect to the remaining sections of the mechanism by the provision of suitable means such as dowel pins 17 registering with cylindrical openings in the end portion 14 of the head 15 and a similar opening in an annular plate 20 interposed between the opposing shoulders on the members 11 and 15 for a purpose to be further explained hereinafter.

In order to seal the starting mechanism against entry of oil from the crankcase 8 and at the same time provide means for insuring movement of the engine engaging member 25 into cranking relation with the rotatable engine member 26, the latter being either the engine crankshaft or shaft connecting therewith, a baffle member 27 having a combined cylindrical and frusto-conical shape is provided between the crankcase 8 and the said engine engaging member 25. As shown, this baffle member 27 has an outwardly directed flange 28 adapted to be held in place between the flanges 6 and 8 by the fastening means passing through

the apertures 7, and is further provided with an inwardly directed rim or flange 29, the inner circular edge of which is turned to point outwardly, thus forming a semi-circular concave ledge or lip 30. Into the annular depression thus produced is inserted a split guide ring 32 having inwardly projecting teeth 33 adapted to engage correspondingly disposed longitudinal grooves or splines 34 provided at the proper intervals about the periphery of the engine engaging member 25. The guide ring 32 is provided on its outer periphery with a semi-circular groove into which is pressed a coil spring 35 in the form of a toroid, the action of which will be further explained in tracing the operation of the mechanism hereinafter.

The novel fluid pressure actuated mechanism for moving the engine engaging member 25 into operative position and thereafter cranking the engine, comprises a piston 37 fitting the interior cylindrical surface of the casing section 15 and preferably provided with piston rings 38 insuring fluid tight registry with said surface. As shown, the piston has a centrally disposed extension or hub 39, the bore of which is threaded, as indicated at 40, for cooperation with a correspondingly externally threaded shaft 42, the latter also having a central bore 43 and counter-bores of larger diameter at either end, one of said counter-bores being adapted to receive a flanged bearing sleeve 44 and the other providing a shoulder or annular ledge 46 constituting an abutment for a coiled compression spring 48, the opposite end of which abuts a stop nut 50 threaded to the piston 37, the latter being preferably provided with recesses 52 affording means for insertion of a wrench or other means by which the parts may be positioned or removed. The coil spring 48 thus serves to normally maintain the piston 37 in the position shown in Fig. 1, from which position it is adapted to be moved in response to admission of pressure fluid in the manner to be described.

The novel means for holding the piston 37 from rotation and thus causing positive rotation of the screw shaft 42 in response to axial motion of the piston, preferably comprises a plurality of (as shown, two) guide shafts 55 having their inner ends supported in suitable openings in the plate 20, and provided near their outer ends with portions 57 of enlarged diameter, the shoulders 58 thus formed affording a limiting means for the rearward movement of the piston 37 and thus operating to take the reaction produced by the normal stress of the spring 48, the reaction being in turn transmitted by the shafts 55 to the cylinder head 16 in which the end portions 57 of the shafts are held. If desired, buffer discs 60 may be interposed between the ends of the shafts 55 and the seat of the sockets 61 in which the shafts are held. In line with the sockets 61 is a corresponding number of openings 62 extending through the remaining thickness of the head 16 and thus registering with longitudinally disposed passages 63 provided centrally of each of the shafts 55, for a purpose to be further explained hereinafter.

The novel means for producing, first, an axial movement of the engine engaging member 25, and thereafter a rotary movement thereof in response to the rotation of screw shaft 42, comprises an annular gear 65 having a hub 66 splined to the screw shaft 42, as indicated at 67, and adapted to mesh with a plurality of (as shown, three) idler gears 69, the latter being mounted on stud shafts 70 held in position in the housing section 5 in bored holes, shaft 70 having shoulders 100 to prevent them from inward movement. The idler gears 69 are held to the shaft 70 by suitable means including preferably a ring 72 and screws 73, and each of the gears is adapted to mesh with a centrally disposed pinion 74 which, as shown, is integral with a shaft 76 having a reduced end 77 rotatably mounted in the above described bearing sleeve 44 and provided at its opposite end with a threaded portion 78 adapted to cooperate with a correspondingly internally threaded nut 79, the outer surface of which is splined to the hub 80 of the engine engaging member 25. A nut 81 is threaded to the outer end of shaft 76, and thus limits longitudinal movement of member 79.

The pressure fluid for actuating the piston 37 is conducted through a pipe 83 leading from any suitable reservoir or pressure generating chamber (not shown), such as the explosion chamber of a cartridge firing gun. This pipe 83 has a suitable connection 84 with a centrally disposed chamber 85 in the cylinder head 16, from which chamber the fluid enters the cylinder and exerts its pressure over the entire exposed area of the piston, thus forcing the piston to the left, as viewed in Fig. 1. Since the piston is held from rotating by virtue of the provision of the guide shafts 55, the screw action resulting between the thread 40 of the piston hub 39 and the threads of screw shaft 42, imparts a rotary movement to the latter member, which rotary movement is communicated to the gear 65 by virtue of the splined connection between the screw shaft and the gear hub 66. The gear 65 in turn drives the pinion 74 through the idler gears 69, and the resulting rotation of shaft 76, in conjunction with the resistance to rotation exerted upon the engine engaging member 25 and the nut 79 by the spring pressed guide ring 32, causes a threading action between the threads 78 of the shaft 76, and the cooperating threads on nut 79, such threading action resulting in a forward movement of the said nut 79 and the engine engaging member 25, causing the latter to slide along the surfaces of the teeth 33, and into driving relation with the engine member 26. When the latter member prevents further forward movement of the driving member 25, the continued pressure of the torque being applied through shaft 76 and nut 79 overcomes the frictional pressure of the spring 35, and the separate sections of the guide ring 32 are accordingly caused to rotate with the member 25 and the engine member 26.

When the piston 37 has reached substantially the end of its stroke, the motor fluid is automatically exhausted to the atmosphere by way of the previously described passages 63, whose connecting ports 87 are presented to the pressure side of the piston as the latter approaches the stop member 20. Upon such exhaust of the pressure fluid, the spring 48, having become compressed by the advancing nut 50 on the piston, operates to return the piston to the position shown in Fig. 1; the jaw member 25 being returned by the cam action of the inclined surfaces of member 26, as soon as the latter accelerates, due to starting of the engine under its own power.

The means for releasing any residual pressure which may result from the trapping of a portion of the pressure fluid in the cylinder 15 on the return of the piston, comprises a valve member 89 (shown best in Fig. 3) of the poppet type, the said valve being mounted in a recess provided in the piston 37, and being normally held in the

open position by the action of a compression spring 90, the force of which is adjustable by suitable means 91 cooperating with the threaded end 92 of the valve stem. Although the spring 90 normally holds the valve 89 open, it is not of sufficient force to maintain it open against the working pressure of the motor fluid, and it is accordingly moved promptly to its seat upon entry of the operating charge of the fluid into the cylinder. As soon as the ports 87 are passed by the piston, however, the fall in pressure behind the piston permits spring 90 to open the valve, thus establishing communication between the two chambers of the cylinder by way of the space surrounding the valve stem and the connecting passage 93.

The thrust bearing 95, held in position between the plate 10 and a retaining nut 96 threaded to the outer end of gear hub 66, absorbs the axial thrust created by the relatively high pressure exerted upon the piston. The line of thrust transmission is from the piston hub 39 to the screw shaft 42, thence by way of shoulder to the gear hub 66, and retaining nut 96, and thus upon the bearing 95.

It is to be understood that any desired changes which suggest themselves to those skilled in the art, may be made in the form, details of construction and arrangement of the parts without departing from the scope of the invention as disclosed herein, and reference is therefore to be had to the appended claims for a definition of such scope.

What is claimed is:

1. In a device of the class described, in combination, a normally withdrawn engine-engaging member, a driving member operative when held against rotation to move said member into engine-engaging position and then rotate both said member and said engine, and a fluid conduit extending through said driving member for preventing rotation thereof during either forward or rotary movement of said member, said conduit also serving to govern the release of fluid pressure from said device.

2. In a device of the class described, in combination, a driving member, a member automatically engageable with the engine to be started and rotatable in response to application of power to said driving member, and means for preventing rotation of said driving member as it advances toward said engine engaging member, said last named means also serving to effect the release of the pressure applied to said driving member.

3. In a device of the class described, in combination, a driving member a member automatically engageable with the engine to be started and rotatable in response to application of pressure to said driving member, and a member extending through said driving member for preventing rotation thereof as it advances toward said engine engaging member, said member also being adapted to permit the release of the pressure.

4. In a device of the class described, in combination, a driver, a housing surrounding said driver, a member automatically engageable with the engine to be started and rotatable in response to application of power to said driver, a member extending through said driver for preventing rotation of said driver as it advances toward said engine-engaging member in response to said power application, and means including a passage through said member adapted to cause the release of the applied power as the driver approaches said first named member.

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