

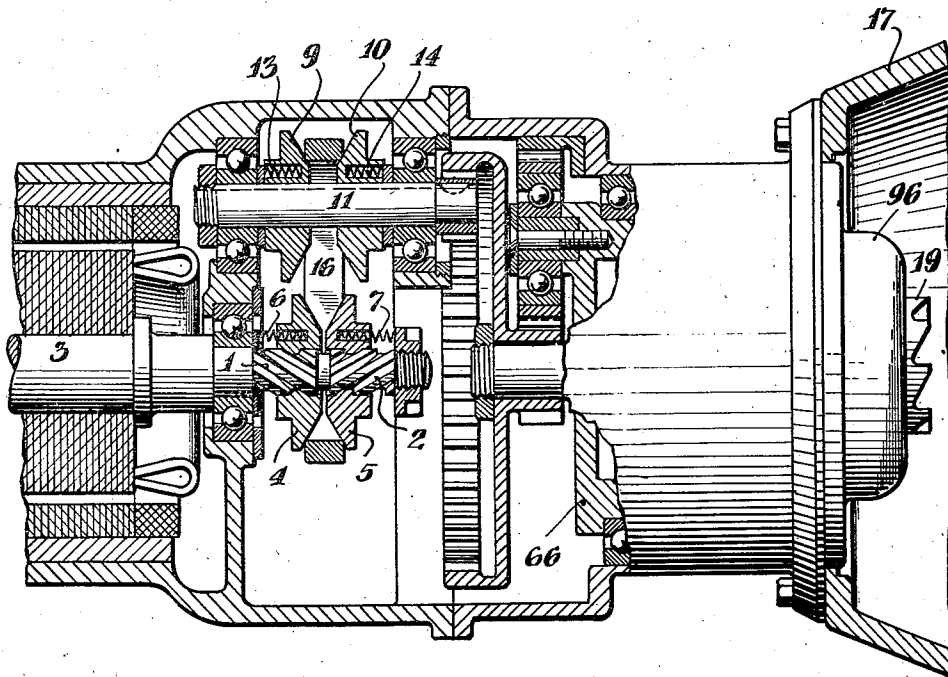
Sept. 21, 1943.

R. M. NARDONE

2,330,136

ENGINE STARTING MECHANISM

Filed Nov. 17, 1941



INVENTOR.

Romeo M. Nardone

BY

Martin J. Finnegan
ATTORNEY

ATTORNEY

UNITED STATES PATENT OFFICE

2,330,136

ENGINE STARTING MECHANISM

Romeo M. Nardone, Westwood, N. J., assignor to
Bendix Aviation Corporation, South Bend,
Ind., a corporation of Delaware

Application November 17, 1941, Serial No. 419,493

2 Claims. (Cl. 74-7)

This invention relates to engine starters, and more particularly to starters of the type wherein the engine-engaging member is rotated at variable speed.

In engine starters of this type, as for example, electrically driven starters wherein the energy of the motor passes through a reduction gear train before being applied to an engine-engaging member for cranking purposes, it is desirable that the gear ratio be varied in accordance with torque requirements. In apparatus of this kind heretofore employed such a condition has not been achieved, since with the usual forms of transmissions between the constant speed driving member and the engine-engaging member, the gear ratio can not be changed (except by manual intervention) during the cycle of operation. Consequently, if the engine offers resistance to being turned over at the predetermined cranking speed, there is necessarily a substantial amount of slippage at the point where the slipping clutch is installed. Energy loss is therefore considerable.

It is therefore one of the objects of the present invention to provide an engine starter wherein the cranking speed is automatically varied throughout the cranking operation.

Another object is to provide novel engine starting mechanism wherein the speed of rotation of an engine-engaging member is constantly varied, independently of changes in speed of the driving motor.

A further object is to provide an engine starter embodying novel transmission means between the driving member and the engine-engaging member, whereby the driving ratio of said means is varied in accordance with the torque load.

These and other objects will appear more fully from a consideration of the detailed description of the invention which follows. Although only one embodiment of the invention is described and illustrated in the accompanying drawing, it is to be expressly understood that the drawing is for the purpose of illustration only and is 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 drawing, the invention is shown embodied in a double screw 1, 2, formed on the extending part of armature shaft 3. These screws 1, 2 engage corresponding threads on cones 4, 5, respectively. These cones are urged together by springs 6, 7. Torque transmitted from armature shaft 3 through the double screw to cones 4, 5 acts to compress springs 6, 7 and separate

the cones. The degree of separation depends on the torque value.

A second pulley has cones 9, 10, which are splined to pinion shaft 11 and pressed together by springs 13, 14. It is these springs that maintain contact pressure between ring 16 and the two pulleys.

Springs 6, 7 are considerably stronger than springs 13, 14 and therefore, at rest conditions, cones 4, 5 are closed up and cones 9, 10 are open. A step-up ratio between shafts 3 and 11 therefore results, the latter rotating faster than the former. This condition is obtained at light torque loads on the motor. As the torque increases, the reaction between the double screw and the cones 4, 5 separates the cones and drops the ring 16 deeper between the cones. Cones 9, 10 simultaneously close up to take up the slack on the ring, springs 13, 14 maintaining proper contact pressure. The ratio now changes such that shaft 11 rotates at a relatively lower speed than the speed of drive shaft 3. The ratio adjusts itself in accordance with the torque on the motor.

In operation, the motor is energized and the engine-engaging jaw clutch element 19 advances to engage with the engine jaw (not shown) located in engine housing 17, to which the starter housing attaches; the automatic advance of the jaw being by screw means well known in the art, and illustrated at 41 and 44 in Lansing Patent No. 1,962,397, granted June 12, 1934. A high torque is required to break the engine "loose" and accelerate it. Pulley cones 4, 5 immediately separate to increase the ratio between motor and jaw. As soon as the engine has been accelerated, the torque required to keep it turning over is reduced and this reduction is transmitted back to the motor. Under the reduced torque, springs 6, 7 overcome the separating force of the screw shaft and the cones are forced closer together, thereby decreasing the ratio between motor and jaw and increasing the speed of the jaw.

The motor may therefore be caused to operate at practically constant torque and at a point of maximum efficiency. A higher cranking speed at the jaw is the result of the variable ratio and the higher operating motor efficiency.

To eliminate the friction effect between the screw threads on the shaft 3 and mating threads on cones 4, 5, anti-friction steel balls may be substituted, as in my Patent No. 2,144,196 granted January 17, 1939.

Element 56 of the accompanying drawing is rotatable with, and in response to the rotation

of, the planetary elements of the gear train, which planetary elements are in turn driven by the "sun" gear of the planetary system, as in the Lansing Patent No. 1,962,397, above referred to; the "sun" gear being shown as integral with an internally toothed annulus gear driven from shaft 11, and corresponding to the gear 24 of the Lansing patent. Member 96 constitutes part of an oil seal assembly, and corresponds to member 48 of the Lansing patent.

I am aware that it is known to employ shiftable cones such as are shown at 4, 5, 8, and 10, in the accompanying drawing; but I believe myself to be the first to suggest that such cones could be made to function in the manner disclosed herein, or that they could be operated by the specific control means shown herein, to cause a shifting of such cones independently of manual intervention and in accordance with load conditions encountered in the "cranking" of an internal combustion engine.

What is claimed is:

1. In an engine starter, a driving member, an engine-engaging member, a variable-ratio transmission therebetween, said transmission including two pairs of axially shiftable friction elements and a friction ring driven there between,

and screw-action means for shifting said friction elements, said screw-action means including oppositely inclined threads on those portions of said driving member which support and drivably engage one pair of said friction elements, said ring constituting the sole means for axially shifting said other pair of friction elements away from one another, and resilient means individual to each friction element to shift each friction element toward said ring.

2. In a driving mechanism, a driving member, a driven member, a variable ratio transmission therebetween, said transmission comprising two pairs of shiftable cones, one pair of which is in threaded engagement with said driving member, while the other pair is in splined engagement with said driven member, said threaded cones being shiftable away from one another by the screw action which occurs between said cones on the one hand and said driving shaft on the other as a result of the resistance to rotation due to the inertia of said driven member, and resilient means yieldably opposing such screw action and operating to restore said cones to their original relationship with respect to said driving member upon reduction of the resistance to rotation.

ROMEO M. NARDONE.