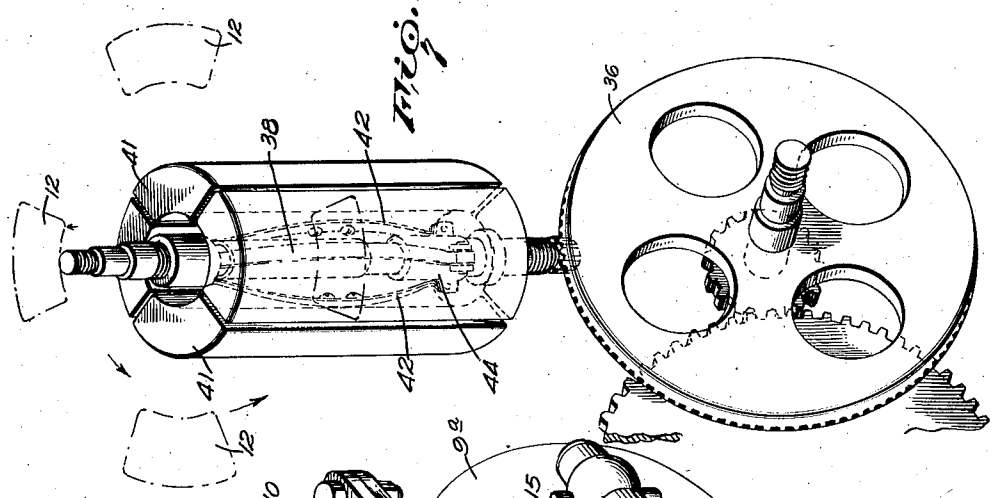
Dec. 15, 1936. R. P. LANSING 2,064,669

STARTING MECHANISM

Original Filed Sept. 5, 1930

Fig. 2.



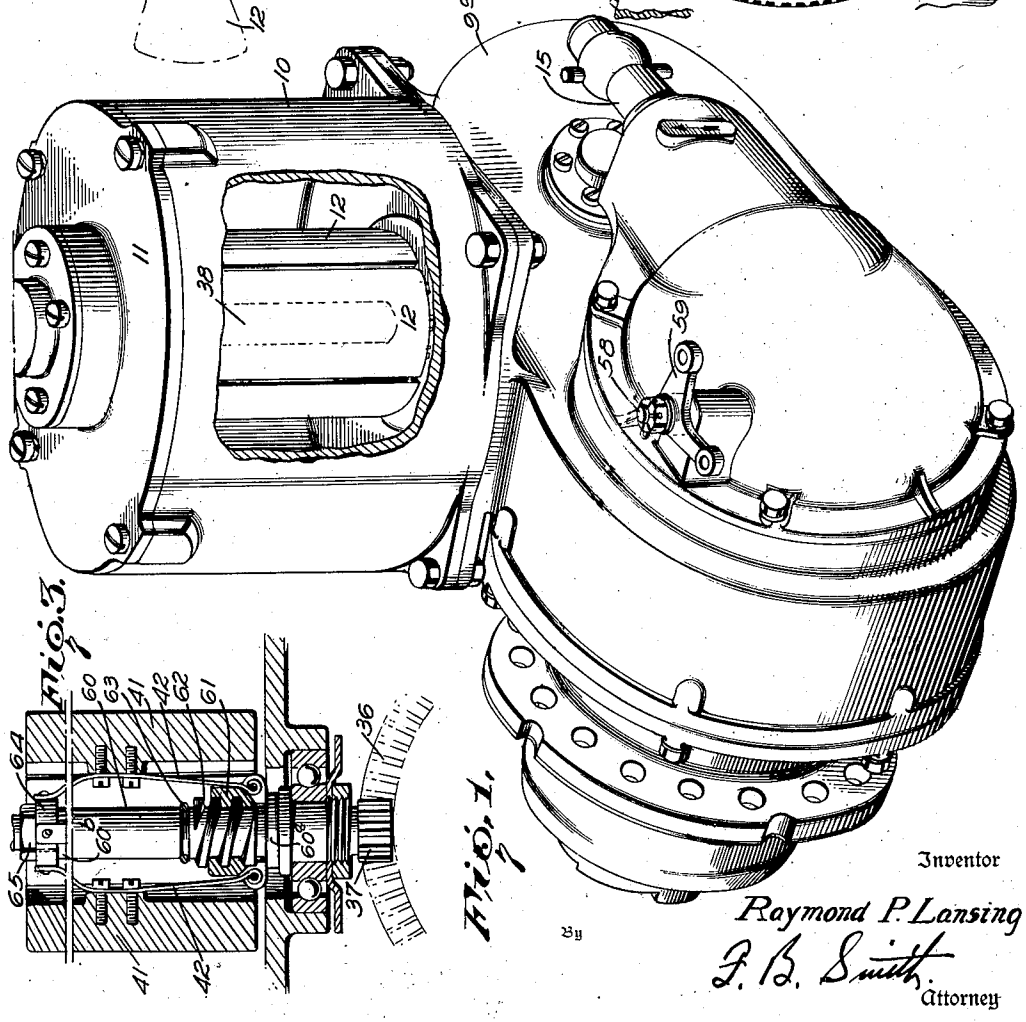


Fig. 3.

Fig. 1.

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STARTING MECHANISM

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8 Claims. (Cl. 74—572)

This invention relates to starting mechanism, and more particularly to inertia apparatus for starting internal combustion engines.

In inertia starters heretofore provided the inertia member has been constituted by a solid mass which may be automatically or manually rotated at high speed by means of a cranking shaft and suitable gearing. In actuating starters of this type a constant torque should be applied to the cranking shaft in order to secure constant acceleration of the inertia member. In view of the step-up gear train employed for rotating the inertia member the latter offers considerable resistance to rotation and when the same is manually operated the operator must exert an unusually large amount of energy on the cranking shaft when initiating the rotation of said member. His ability to continue to exert the required effort to bring the inertia mass to the desired speed is materially lessened due to his initial efforts.

An object of the present invention is to provide starting apparatus of the inertia type which is so constituted that the inertia member may be more easily brought up to the desired speed of rotation.

Another object of the invention is to provide, in an inertia starter, an inertia mass having a variable moment of inertia.

Another object of this invention is to provide a manually operable inertia starter which is so constructed that the operator will find it comparatively easy to initiate the rotation of the inertia member and bring it up to a reasonable speed.

A further object is to provide an inertia member for use in starters composed of a plurality of centrifugally actuated members constituting a mass having a variable moment of inertia. The above and other objects will appear more fully hereafter in the detailed description.

One embodiment of the present invention is illustrated in the accompanying drawing, but it is to be expressly understood that the drawing is for the purposes of illustration only and is not designed 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 perspective view, with parts broken away, of a structure embodying the present invention;

Fig. 2 is an enlarged detail perspective view of one form of a novel inertia mass, such as is shown in Fig. 1; and

Fig. 3 is a detail sectional view illustrating additional control means for the inertia member which may be employed in accordance with the present invention.

Referring more particularly to Fig. 1, the starting mechanism of the present invention includes a housing constituted by an inner flanged portion adapted to be secured in any suitable manner to the crank case, not shown, of an internal combustion engine. For example, the flange of housing section may be provided with openings to receive suitable bolts or screws (not shown) for securing the starter to the rear of the engine crank case. Attached to the outer face of the inner housing section, is an outer housing section provided with a laterally extending portion on which is mounted a casing 10 provided with a cover 11 constituting a housing for an inertia mass 12.

Energy may be stored in the inertia mass 12 by rotating the same at high speed, in a manner to be described hereafter, and this stored energy is then effective to rotate a jaw adapted to be moved into driving engagement with the engine crank shaft or an extension thereof, whereby the crank shaft will be rotated and the engine started.

Means are provided for manually rotating the inertia member 12 at high speed. For this purpose there is provided a cranking shaft 15 adapted to be rotated by a hand crank (not shown).

Rotation of the shaft 15 is effective to produce rotation of the inertia mass 12 at a substantially increased speed due to the provision of a suitable gear train, a portion of which is indicated in Fig. 2 wherein it is shown as including a crown gear 36 which drivably engages a pinion 37 drivably secured to a shaft 38 that carries the inertia mass 12. The upper and lower ends of shaft 38 are rotatably mounted in the housing 10 by means of ball bearings (not shown) of any suitable design, whereby the inertia mass to be described more fully hereafter is maintained supported in operative position.

Rotation of cranking shaft 15 is transmitted as above indicated, to the crown gear 36 and pinion 37 to rotate shaft 38. In view of this step-up train of gearing it will be apparent that one revolution of the cranking shaft 15 will result in a very large number of revolutions of the shaft 38 and if the latter offers any substantial resistance to rotation it will be extremely difficult for the operator to actuate the cranking shaft 15.

In starters of the inertia type heretofore provided the inertia member has been constituted by a solid mass having a constant moment of inertia,

or radius of gyration, and while relatively small in weight, this mass offers a considerable amount of resistance to rotation due to the step-up gear train employed. In accordance with the present invention there is provided an inertia mass having a variable moment of inertia, the moment of inertia being relatively low when shaft **38** is rotated at low speed and increasing as the speed of rotation of shaft **38** is increased, whereby less effort is required to place said mass in rotation.

In the form shown, the inertia mass is constituted by four, substantially parallel segments **41**, which in normal position constitute a substantially hollow thick walled cylinder of small diameter. Intermediate the ends of the inner face of each segment is secured a resilient member **42** which may be constituted by a piece of clock-spring that is disposed parallel to shaft **38** and is secured at its upper end in any convenient manner, as by means of a suitable sleeve **43**, to said shaft. The lower end of each of the resilient members **42** is secured to a sleeve **44** which slidably surrounds the lower reduced portion of shaft **38**. A shoulder **38***a* formed on said shaft constitutes a stop for limiting upward movement of sleeve **44** relative to the shaft.

When slow speed rotation is imparted to shaft **38** through the train of gearing described above, the segments **41** are retained by springs **42** closely adjacent and surrounding the shaft **38**. Consequently the moment of inertia of the mass constituted by the segments **41** is low and the resistance to rotation is relatively small. As the operator increases the speed of rotation of shaft **38**, the segments **41** move radially under centrifugal force until they assume a position closely adjacent the inner walls of housing **10** as indicated in dotted lines in Fig. 2. As the segments move outwardly the moment of inertia increases and consequently the effort on the part of the operator must be increased, but since the cranking shaft is now revolving and since he has not greatly exerted himself in bringing the cranking shaft to this speed of rotation, he is enabled to readily exert the extra effort required to increase the speed of rotation of shaft **38**. When the cranking shaft is rotated at approximately 80 R. P. M. for example, sufficient energy will be stored in the inertia member or flywheel constituted by elements **41** to start the engine.

It will be apparent that when the operator ceases to exert a force on the cranking shaft after bringing the flywheel up to the desired speed of rotation, the latter is effective to rotate the engine engaging element through the gear train and barrel **21** previously described.

The operation of the device is as follows: The operator engages the hand crank with the cranking shaft **15** and with comparatively little effort is enabled to rotate the flywheel through the train of gearing, since the moment of inertia of the mass **12** is small and hence offers only a small amount of resistance to rotation. As the speed of rotation of shaft **38** is increased, the sectors **41** move radially as diagrammatically shown in Fig. 2, sleeve **44** sliding up shaft **38** until it abuts against shoulder **38***a*. The radial movement of the sectors **41** increases the moment of inertia of the mass **12** and hence the effort that must be exerted by the operator, but the parts are now moving and the additional work is easily performed in view of the fact that he has been able to bring the flywheel to a reasonable speed without an unusual amount of effort. As soon as the flywheel has been brought up to the desired speed of rotation, i. e., when sufficient energy has been stored in the flywheel, the operator actuates bell crank lever **59** to move the engine engaging element into driving engagement with the engine and the energy of the flywheel is now effective to crank the engine.

In Fig. 3 there is illustrated another embodiment of the invention wherein the crown gear **36** drivably engages pinion **37** mounted on the lower end of a shaft **60** on which are mounted the inertia segments **41** through the medium of resilient members **42**. The lower ends of said resilient members are secured to an interiorly threaded sleeve **61** having engagement with threads **62** provided on shaft **60** adjacent the lower end thereof.

The movement of sleeve **61** downwardly relative to shaft **60** is positively limited by means of a shoulder **60***a* formed on said shaft and the movement of the sleeve upwardly relative to shaft **60** is positively limited by means of a shoulder **63** which may be formed by a split ring suitably mounted in a groove formed in the shaft immediately above the threads **62**. The upper ends of the resilient members are rigidly secured to a sleeve **64** which is mounted on, and rotatable, relative to shaft **60**, but which is held against longitudinal movement thereon by means of a nut **65** and a suitable shoulder **60***b*.

When torque is applied to the cranking shaft **15** the engagement of threaded sleeve **61** with the threads **62** results in sleeve **61** being jammed against shoulder **60***a* whereby the sleeve and shaft **60** rotate in unison, the segments **41** being rotated through the resilient members **42**. The latter prevent radial movement of the segments due to the fact that sleeves **61** and **64** cannot have relative movement toward each other. The operator can now bring the speed of rotation of the inertia mass or flywheel up to the desired speed with a minimum of effort, due to the low moment of inertia of said flywheel.

If the rotative effort on the crank shaft **15** is momentarily removed, the inertia mass will now become the driving means and will tend to rotate at a greater rate of speed than shaft **60**. The relative rotary movement between shaft **60** and the segments **41** will cause sleeve **61** to move upwardly relative to said shaft until it is jammed against the shoulder **63**. During this movement of sleeve **61**, sleeve **64** rotates relative to shaft **60** and the segments move radially under centrifugal force relative to said shaft.

As the segments move away from shaft **60**, their angular velocity will decrease. This results from the fact that the energy of rotation stored in the inertia mass is substantially the same with the segments in expanded position as when they are in retracted position closely adjacent the shaft. Since the stored energy of rotation depends on the radius of gyration and the angular velocity, and since the former is increased as the segments move radially, the angular velocity must decrease to maintain the total amount of energy substantially constant.

The operator now exerts rotative effort on shaft **15** at this lower speed and continues to accelerate the fly-wheel until the cranking shaft is brought up to a speed of approximately 80 R. P. M. for example, whereupon sufficient energy will be stored in the flywheel to start the engine.

There is thus provided novel starting apparatus embodying an inertia mass having a variable moment of inertia. The structure is so constituted that energy may be more readily stored

therein than in starters embodying an inertia mass having a constant moment of inertia. The apparatus is compact and may be readily installed on the rear portion of an engine crank case. It is particularly adapted for starting aeroplane engines, but it will be expressly understood that its use is not limited thereto.

The parts are so assembled and constructed as to be light in weight and positive in action. Yielding means are interposed between the starter jaw and the gearing whereby said gearing is protected against injury due to backfires or unusual operating conditions. In the form illustrated the device is adapted to be manually actuated only, but it will be readily understood by those skilled in the art that electrical actuating means may be combined with the mechanism illustrated where desirable.

Various changes may be made in the details of construction and arrangement of parts as will be readily apparent to those skilled in the art. Reference will therefore be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. The combination with a shaft to be rotated, of a plurality of radially movable segments for rotating said shaft, means connecting said segments to said shaft, said means including a pair of cooperating helically slotted members adapted to prevent movement of said segments radially during the actuation of said shaft, but permitting radial movement of said segments when the segments rotate said shaft, and means for rotating said shaft to store energy in said segments for subsequent use in imparting rotation to said shaft.

2. In an inertia starter, a rotatably mounted shaft, means for rotating said shaft, a plurality of radially movable segments rotatable with said shaft, and means for securing said segments to said shaft, said last named means comprising a threaded portion on said shaft, and a sleeve threaded to said portion, said shaft and sleeve cooperating to prevent movement of said segments radially during the actuation of said first named means but permitting radial movement of said segments thereafter.

3. The combination with a shaft to be rotated, of a plurality of radially movable segments for rotating said shaft, means connecting said segments to said shaft, said means including a pair of cooperating members adapted to prevent movement of said segments radially during the actuation of said shaft, but permitting radial movement of said segments when the segments rotate said shaft, and means for rotating said shaft to store energy in said segments for subsequent use in imparting rotation to said shaft.

4. The combination with a shaft to be rotated, of a plurality of radially movable segments for rotating said shaft, means connecting said segments to said shaft, said means including a pair of cooperating helically slotted members adapted to prevent movement of said segments radially during the actuation of said shaft, but permitting radial movement of said segments when the segments rotate said shaft.

5. The combination with a shaft to be rotated, of a plurality of radially movable segments for rotating said shaft, means connecting said segments to said shaft, said means including a pair of cooperating members adapted to prevent movement of said segments radially during the actuation of said shaft, and means responsive to discontinuance of the actuation of said shaft to permit radial movements of said segments.

6. In an inertia starter, a rotatably mounted shaft, means for rotating said shaft, a plurality of radially movable segments rotatable with said shaft, and means for securing said segments to said shaft, said last named means comprising a slotted portion on said shaft, and a sleeve engaging said portion, said shaft and sleeve cooperating to prevent movement of said segments radially during the actuation of said first named means but permitting radial movement of said segments thereafter.

7. In combination, a rotatably mounted shaft, means for rotating said shaft, a plurality of radially movable segments rotatable with said shaft, and means for securing said segments to said shaft, said last named means comprising a slotted portion on said shaft, and a sleeve engaging said portion, said shaft and sleeve cooperating to prevent movement of said segments radially during the actuation of said first named means but permitting radial movement of said segments thereafter.

8. The method of utilizing an inertia mass as an engine starting agency, which comprises accelerating the mass and at the same time maintaining its moment of inertia at a constant minimum, then permitting its moment of inertia to increase to a maximum as it begins to deliver its stored energy to the engine to be started.

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