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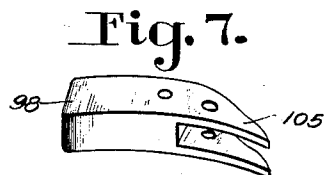
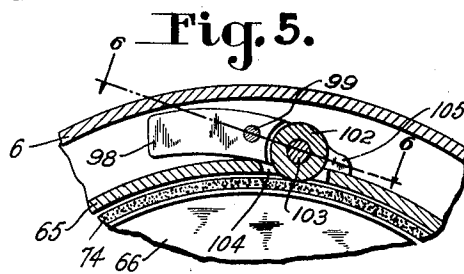
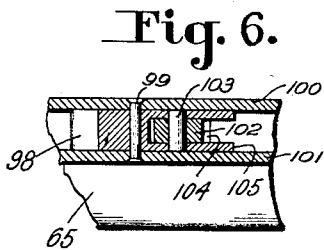
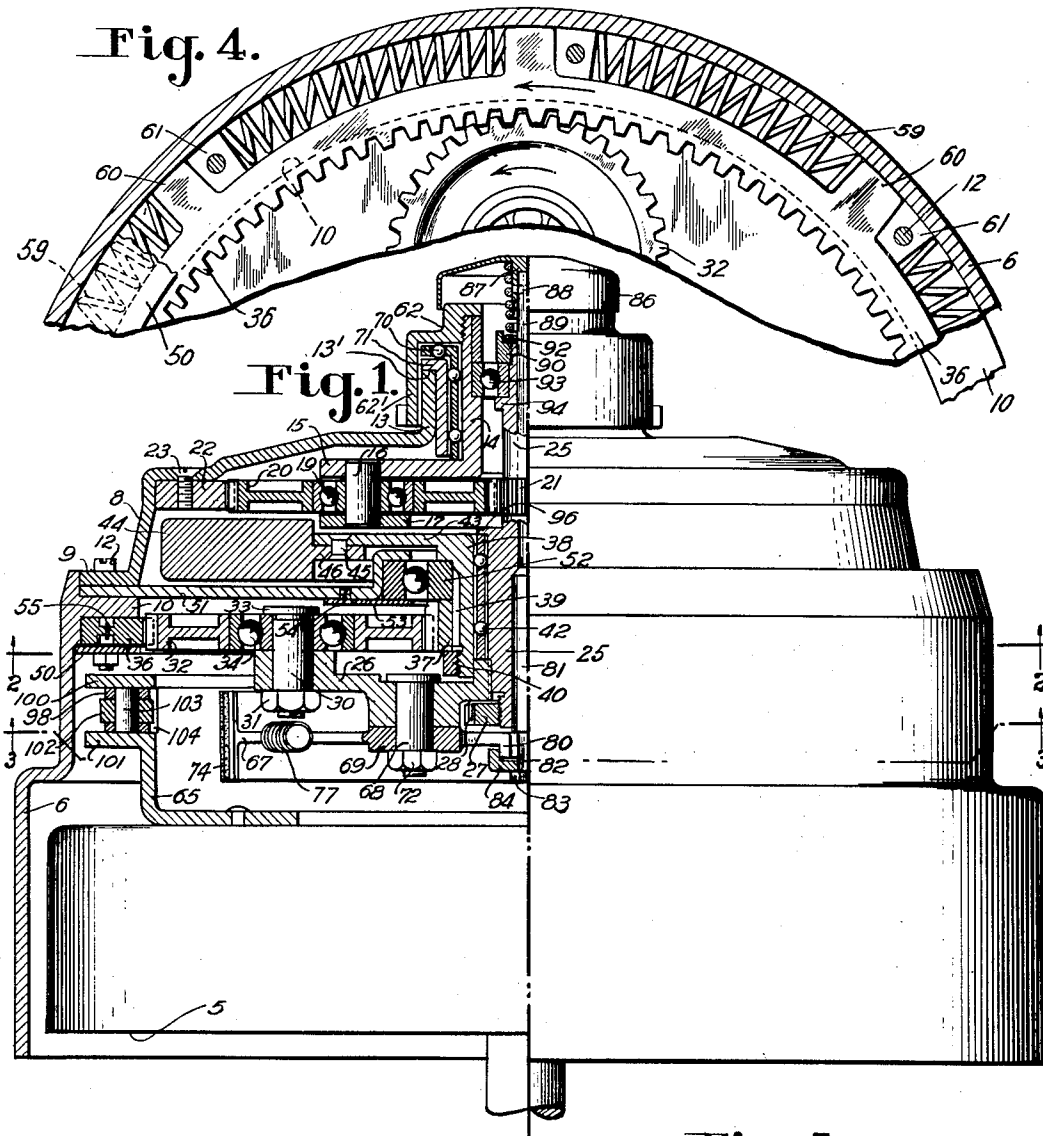
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1,864,256

ENGINE STARTING APPARATUS

Filed June 19, 1931

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 2.

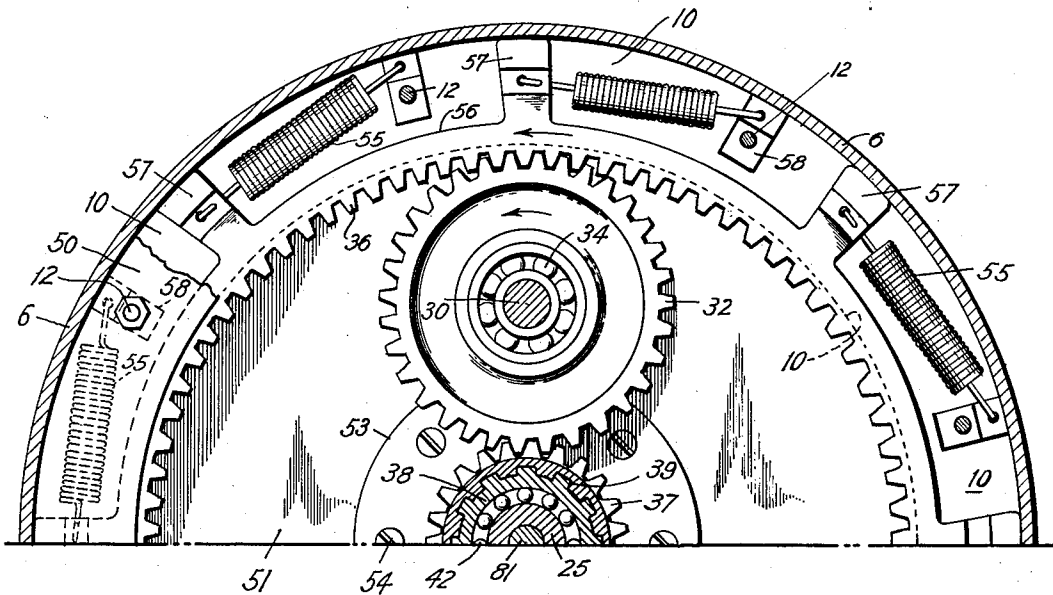
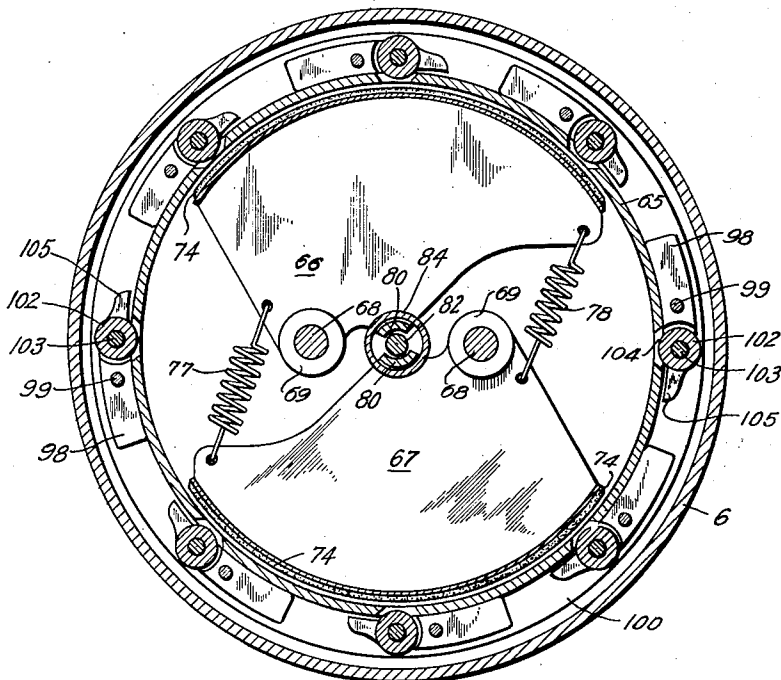


Fig. 3.



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ENGINE STARTING APPARATUS

Application filed June 19, 1931. Serial No. 545,604.

This invention relates to engine starting apparatus, and more particularly to a starter of the type adapted to impart initial rotation to a rotatable member of an engine.

5 An object of the invention is to provide a novel engine starter of the type embodying an engine-engaging member which is radially movable into driving engagement with a member of the engine to be started, and which
10 is drivably connected to a small high speed flywheel through reduction means which convert the high speed of the flywheel into a high torque applicable to rotate the engine member.

15 Another object of the invention is to provide an engine starter embodying novel means for preventing return torque transmission from the engine on starting of the latter under its own power.

20 Another object of the invention is to provide a novel manually operated engine starter of the inertia type, employing multi-stage speed varying mechanism interposed between the manually operated member and
25 the inertia member, and adapted to drive the inertia member at a considerably multiplied speed, a portion of said mechanism being thereafter operable to transmit the energy thus stored in the inertia element to the engine-engaging member at a considerably reduced speed.

30 A further object is to provide novel means for releasing the driving connection between the starter and engine automatically upon self-operation of the latter.

35 Another object is to provide releasing means of the foregoing character so constructed as to respond to the centrifugal force created by the acceleration resulting from starting of the engine under its own power.

40 A further object is to provide novel shock absorbing and vibration damping means interposed between the gearing and the housing of an inertia starter of the foregoing character.

45 These and other objects of the invention will become apparent upon consideration of the following specification, when read with reference to the accompanying drawings wherein is illustrated the preferred embodi-
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ment of the invention. It is to be expressly understood, however, that the drawings are for the purpose of illustration only, and are not designed as a definition of the limits of the invention, reference being had for this purpose of the appended claims.

In the drawings,

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

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

Fig. 3 is a transverse sectional view along the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary transverse sectional view similar to Fig. 2 of another embodiment;

Fig. 5 is a detail view showing certain of the parts shown in Fig. 3, and illustrating the extent of movement thereof;

Fig. 6 is a sectional view taken along the line 6—6 of Fig. 5; and

Fig. 7 is a detail view of one of the parts shown in Figs. 5 and 6.

Referring to the drawings, and particularly to Fig. 1, it will be seen that the engine to be started is provided with a rotatable member 5, which, if desired, may be integral with or secured to the crankshaft of the engine, or a member drivably associated therewith.

The invention is shown embodied in novel starting or cranking means associated with the rotatable member 5 for developing and transmitting a starting torque to said member whereby the engine may be cranked. As shown, such means includes a housing having a section 6 extending upwardly from around the engine member 5, said housing having an upper section 8 with an outwardly turned marginal flange 9 registering with section 6 and adapted to be supported on an inwardly turned flange 10 on the section 6, suitable means such as screws 12 being provided to rigidly secure the flange 9 of section 8 to the flange 10 of section 6. The upper portion of section 8 is preferably provided with a centrally disposed hub 13 having a central opening through which extends the cylindrical hub 14 of a yoke or spider

member 15 provided for a purpose presently to be described.

Suitable means are employed for storing up energy to be subsequently used at the will of the operator for rotating the engine member 5 and thereby starting the engine. As shown, such means is preferably constituted by an inertia member adapted to be rotated at high speed through suitable gearing, drivably connected to a cranking member; the gearing being preferably divided into two or more stages. For this purpose, the spider 15 above referred to is provided with a plurality of supporting posts 16 extending downwardly to retain in place an annular member or ring 17 on which is rotatably supported, with the aid of ball bearings 19, a corresponding number of driving gears 20 adapted to mesh with a sun gear or pinion 21 and also with the teeth of an internal or annular gear 22 which is secured to the housing section 8 by suitable means as indicated at 23. As shown, the gears 20, 21 and 22 constitute a planetary system of gears operating in response to rotation of member 14 to impart rotation at a multiplied speed to the inertia means to be described; the gear 21 being preferably integral with a centrally disposed shaft 25.

Appropriate means are provided for drivably connecting the shaft 25 with the second stage of the gearing which leads to the inertia member 44. As shown, such means preferably involves the provision at the lower end of shaft 25 of a recessed apertured plate or spider 26 rotatable in response to rotation of the sun gear 21 by means above described. The supporting means for spider 26 may be of any suitable form, but, as shown, consists in the provision of a threaded reduced portion at the lower end of shaft 25 to which is secured a nut 27 adapted to hold in place, with the aid of locking washer 28, the aforesaid spider 26. Near the outer periphery of spider 26 are located a plurality of supporting posts or bolts 30 having threaded lower ends for attachment of nuts 31, said bolts being adapted to rotatably receive a corresponding number of gears 32, the bolts being preferably enlarged, as indicated at 33, to form heads resting on bearings 34, the latter being provided to facilitate rotation of said gears. The rotation of these gears about the posts 30 is preferably brought about by providing an internal gear 36 with which is associated shock absorbing means constituting one of the important features of the invention, to be further described hereinafter.

The preferred means for imparting rotation to the inertia member 44 at a greatly multiplied speed, in response to the rotation of the member 14, further includes a second sun gear or pinion 37 having teeth meshing with the teeth of the gears 32 and hence

adapted to be rotated thereby, the gear 37 being rigidly secured to a member 38 by suitable means, which, as illustrated, takes the form of splines 39, a retaining nut 40 being threaded to the lower end of member 38. Member 38 is in turn rotatable relative to the driving shaft 25, the relative rotation between the two being facilitated by the provision of suitable bearing means, as indicated at 42. The member 38 is also provided at its upper end with an inwardly turned flange 43 adapted to be secured to the inertia member 44 by suitable means, which, in the form shown, comprises a plurality of studs or rivets 45 rigidly connecting the flange 43 with an inwardly extending annular flange 46 provided on the inertia member, or flywheel 44.

The bolts 12 also serve to hold in place an annular disc 50 supporting gear 36, together with a transversely disposed plate or partition 51 which is adapted to support a ball bearing 52 representing any suitable means upon which the flywheel 44 and flanged member 38 may be rotatably mounted, the ball bearing member 52 being preferably adapted to rest at its outer edge on the supporting plate 53 rigidly fastened to the partition 51 by suitable means as indicated at 54.

One of the novel features of the invention is the provision of yieldable shock absorbing means permitting a limited degree of rotation between the internally toothed annular gear 36 and the housing of the starter, as a result of which the vibrations which occur in the operation of the starter, particularly during the initiation and continuance of connection with the engine, are absorbed or damped to a considerable degree without interfering with the continuance of the cranking operation.

Referring to the drawings and more particularly to Figs. 1 and 2, it will be seen that the gear 36 is adapted to yield relatively to the housing 6 by virtue of the compression of a torque-reaction and shock-absorbing mechanism which, as shown, takes the form of a plurality of coiled tension springs 55 (Fig. 2) disposed at equal intervals about the periphery of the gear 36 and in recesses 56 provided therein, the springs being secured at one end of the radial projections 57 of the gear and at the opposite ends to blocks 58 rigidly held to housing 6 by bolts 12, the blocks 58 being spaced at a considerable distance from the associated projections 57 on the gear 36, whereby limited relative rotation may occur between the gears 36 and the housing whenever an excessive shock or torque load is placed upon the mechanism; the springs 55 acting to return the gear to the relative position indicated in Fig. 2 following the absorption of such excessive shock or load.

In Fig. 4 a modification of the shock-absorbing means is illustrated. Referring to

this figure it will be seen that compression springs 59 are interposed between the radial projections 60 on gear 36 and the inwardly projecting spacers 61 on the housing. With this construction, the relative motion possible between the gear 36 and the housing depends upon the degree to which the compression springs can be compressed.

Any suitable manually operated means may be provided for rotating the hub 14 to store energy in the inertia member 44 through the speed multiplying mechanism above described. As illustrated in Fig. 1 such means preferably comprises the provision of a threaded upper portion on member 14 for engagement with an internally threaded member 62 having a transversely extending section which at its outer edge turns in a downward direction to form a sleeve 62' to which any suitable crank or other hand turning device (not shown) may be attached, the member 62 being rotatably supported, with the aid of bearing 70, on the spacer 71 and the upper edge 13' of hub 13.

Appropriate means are provided for operatively connecting the flywheel 44, after the desired amount of energy has been stored therein to the engine member 5. Such means preferably comprises the provision of a cylindrical member or drum, such as that indicated at 65, rigidly secured to the flywheel 5, in combination with a plurality of elements such as those indicated at 66 and 67 (Figs. 1 and 3) having convex arcuate surfaces adapted to be moved radially into engagement with the inner surface of the drum 65 by operation of the meshing means to be described.

These radially movable elements 66 and 67 are adapted to rotate with the recessed plate or spider 26 to which said elements are pivotally secured by suitable means, as for example, by providing hubs or bosses 69 having apertures for reception of bolts 68, the bolts being held in place by suitable means, as for example, the nuts 72 (Fig. 1) engaging the lower ends thereof. On the convex arcuate rims of elements 66 and 67 are provided correspondingly shaped bands 74 of suitable friction material; the elements 66 and 67 being so pivoted as to make them self-energizing, that is, cause them to wrap themselves snugly against the inner surfaces of drum 65 upon radial movement from their normal positions shown in Fig. 3.

Suitable means are provided for maintaining the members 66 and 67 in non-engaging position with respect to the drum 65 notwithstanding the tendency of such elements to move outward radially in response to the centrifugal force resulting from rotation of these elements during the cranking operation. As shown, such means comprises, first, a plurality of resilient means so positioned as to oppose the centrifugal action, and secondly, the

provision of suitable locking means also acting to nullify the centrifugal action until released. The resilient means preferably comprises a pair of springs 77 and 78 (Figs. 1 and 3) each being fastened at one end to the element 67 and at its other end to the element 66, the points of attachment being so located with respect to the pivots 68 on which the friction elements are suspended, and with respect to the axis of rotation of these elements, that they exert a resilient force in opposition to the centrifugal force resulting from rotation of the parts.

Novel means are provided to move the elements 66 and 67 outwardly in a radial direction into frictional driving contact with the surface of drum 65, such novel means also permitting the continuance of the manual cranking action through the handcrank, if so desired. For this purpose, the driving shoes are preferably provided with downwardly projecting fingers, as indicated at 80, disposed so as to permit their being engaged by the centrally and vertically disposed rod 81, the lower end 82 of which receives nut 83, adapted to hold in place a locking cup or plate 84 having a circular rim to prevent radial movement of fingers 80.

The operating means for rod 81 comprises preferably a cap 86 having a knob or other suitable member 87 centrally disposed thereon, the said knob 87 being preferably secured as indicated at 88 to the upper end 89 of the rod 81; the rod and knob being normally urged upwardly by suitable means such as the spring 92, which thereby holds the rod normally in the position indicated at Fig. 1. The spring is provided with a seat 90, the latter being threaded to the shaft 25 and supported on a bearing member 93 within which the shaft 25 revolves, the said bearing member being in turn supported on hub 14 and shoulder 94. Shaft 25 is also preferably provided with a second collar 96 resting on bearing 42 previously referred to.

The novel means for releasing the driving connection between the arcuate elements 66 and 67, on the one hand, and the drum 65 on the other, preferably comprises a plurality of pivoted weight members 98 disposed at equal intervals about the circumference of the drum 65 and pivotally secured thereto by suitable means such as the rivets 99 (Figs. 3, 5 and 6) the said pivot pins or rivets being secured at their upper ends to the annular ring or plate 100 and at their lower ends to the marginal flange 101 provided for this purpose on the drum 65. As indicated best in Figs. 1, 5, and 7, these weighted members 98 are recessed to permit insertion of rollers 102 pivotally secured thereto by means of pins 103 and normally disposed so as to protrude into the openings 104 provided at regular intervals in the periphery of the drum 65 and in positions to register with the said rollers.

In this position as indicated in Fig. 3, there is a slight clearance between the smaller ends 105 of the weights 98 and the outer surface of the drum 65, this clearance permitting further inward movement of the rollers 102 into engagement with the surface of the arcuate bands 74 upon movement of the weights to the position indicated in Fig. 5.

Having enumerated the parts entering into the construction illustrated, the operation thereof will now be described. When it is desired to start the engine, the member 62 is rotated by means of a suitable handcrank (which may or may not remain in place at all times) such rotation operating to store energy in the flywheel 44 through the speed multiplying means above described. The path of transmission being from the member 62 to the member 14, thence to the planetary gears 20 to the sun gear 21, thence through shaft 25 to the spider 26, and thence to the planetary gears 32, sun gear 37 and hub 43 to the flywheel 44.

When the flywheel has by the foregoing means been brought up to a speed sufficient to store the desired amount of energy for use in cranking the engine, the operator may press downwardly on button 86 thereby producing a downward pressure on knob 87 to compress spring 92 and move rod 81 downwardly to release fingers 80 and cause a radial movement of the members 66 and 67 into engagement with the inner surface of drum 65 and thereby bring the engine up to a sufficient speed to produce starting thereof under its own power, the springs 55 being effective to ease the shock due to initial application of torque to the engine.

On the occurrence of self-operation of the engine, the resulting suddenly increased speed imparted to the drum 65 by virtue of its connection with the engine flywheel 5, produces a centrifugal force acting on the weights 98 to move them from the positions indicated in Fig. 3 to the positions indicated in Fig. 5 in which latter positions the rollers 102 are caused to engage the surface of the arcuate members 66—67 and move them inwardly away from the inner surface of the drum 65, the rollers being assisted in this return movement by the springs 77 and 78. The operative connection between the starter elements and the drum 65 being thus released, the former come to rest allowing the drum to rotate with the engine and without restraint from the starter elements, the fingers 80 being returned to the restrained position shown in Figs. 1 and 3.

There is thus provided a novel engine starter of the inertia type which is simple and rugged in structure, inexpensive to manufacture and efficient in operation. It is especially adapted for use with small engines because of its compactness and light weight, but since it is a self-contained unit it may be

easily attached to any engine, and requires no external supporting means, the whole unit in the embodiment shown, being mounted within an extension of the engine housing and part of the mechanism being carried by a rotating member of the engine.

If desired, the invention may be embodied in a starter of the reaction type, wherein the entire mechanism is carried by, and rotates with the engine member to be cranked. Such an embodiment involves the upward extension of drum 65 to constitute a housing for the entire starter, thereby eliminating the parts shown at 6 and 8, and also the reduction gearing between the inertia member and the drum.

Likewise, any other known form of cranking and meshing means, either manual or otherwise, may be substituted for that shown in the drawings.

The radially movable friction elements 66 and 67, as well as the means for moving them into driving position, are not claimed herein per se, as they form part of the subject matter of my copending application, Serial No. 507,229, filed January 7, 1931.

It is to be understood that various other changes may be made in the form, details of construction, arrangement of parts and the uses to which they are applied, without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. In an engine starting mechanism having an inertia member in which energy is stored for subsequent transmission to a member connected to the engine to be started, the combination with said inertia member and engine connected member of means for drivably connecting said inertia and said engine connected member to transmit starting torque to said engine, said means comprising a mechanism rotatable with said inertia member and movable radially into engagement with said engine connected member, and means engageable with said radially movable mechanism to effect a disengagement of said mechanism from said engine connected member when the engine becomes self-operating.

2. In an engine starting mechanism having a driving member in which energy is developed for transmission to a member secured to the engine to be started, the combination with said driving member and engine member of means for drivably connecting said driving member with said engine member to transmit starting torque to said engine, said means comprising a mechanism rotatable with said driving member and movable radially into engagement with said engine member, and means engageable with said radially movable mechanism to effect a disengagement between said mechanism and said engine member when the latter tends to overrun the former.

3. In a device of the class described, a

driven member, a driving member normally disengaged from said driven member, means for moving said driving member into engagement with said driven member, and speed responsive means carried by said driven member and engageable with said driving member to return the latter to its normal, disengaged position upon development of a predetermined speed.

4. In an engine starting mechanism having a driving member in which energy is developed for transmission to a member secured to the engine to be started, the combination with said driving member and engine member of means for drivably connecting said driving member with said engine member to transmit starting torque to said engine, and centrifugally operable means for disengaging said mechanism from said engine member.

5. In an engine starting mechanism having an inertia member in which energy is stored for subsequent transmission to a member secured to the engine to be started, the combination with said inertia member and engine member of means for drivably connecting said inertia member and said engine member to transmit starting torque to said engine, and centrifugally operable means for disengaging said mechanism from said engine member, said disengaging means comprising a plurality of members interposed between said mechanism and said engine member and movable radially into engagement with said mechanism when the speed of the engine member exceeds the speed of said mechanism.

6. In an engine starting mechanism of the type employing radially moving mechanism adapted to engage and crank a member of the engine to be started, the combination with said mechanism and engine member of manually operable means for controlling such radial movement of said mechanism, and centrifugally operable means for disengaging said mechanism when the engine starts under its own power.

7. In an engine starting mechanism of the type employing radially moving mechanism adapted to engage and crank a member of the engine to be started, the combination with said mechanism and engine member of manually operable means for controlling such radial movement of said mechanism, and centrifugally operable means for disengaging said mechanism when the latter tends to overrun the former.

8. In an engine starting mechanism of the type employing radially moving mechanism adapted to engage and crank a member of the engine to be started, the combination with said mechanism and engine member of manually operable means for causing such radial movement of said mechanism, by virtue of the centrifugal force developed due to rotation thereof, and means for producing disengagement of said mechanism comprising

ing a plurality of members on which centrifugal force acts in a direction opposite to the direction of its action on said mechanism.

9. In an engine starting mechanism of the type employing radially moving mechanism adapted to engage and crank a member of the engine to be started, the combination with said engine member and mechanism of means normally holding said mechanism against such radial movement, means operable at the will of the operator for rendering such holding means ineffective to prevent such radial movement, and centrifugally operable means for returning said mechanism to its initial position.

10. In an engine starting mechanism of the type employing radially moving mechanism adapted to engage and crank a member of the engine to be started, the combination with said engine member and mechanism of means normally holding said mechanism against such radial movement, means operable at the will of the operator for rendering such holding means ineffective to prevent such radial movement, and means engageable with said radially movable mechanism to effect disengagement between said mechanism and said engine member when the engine becomes self-operating.

11. In an engine starting mechanism of the type employing radially moving mechanism adapted to engage and crank a member of the engine to be started, the combination with said engine member and mechanism of means normally holding said mechanism against such radial movement, means operable at the will of the operator for rendering such holding means ineffective to prevent such radial movement, and means engageable with said radially movable mechanism to effect a disengagement between said mechanism and said engine member when the speed of the latter tends to exceed that of the former.

12. In an engine starting mechanism of the type employing radially moving mechanism adapted to engage and crank a member of the engine to be started, the combination with said engine member and mechanism of means normally holding said mechanism against such radial movement, means operable at the will of the operator for rendering such holding means ineffective to prevent such radial movement, and centrifugally operable means for disengaging said mechanism from said engine member.

13. In an engine starter of the type embodying an inertia member in which energy is stored for transmission to a member of the engine to be started, speed varying mechanism drivably connecting said inertia member with said engine member, means associated with said speed varying mechanism for absorbing the reaction resulting from the transmission of said energy to said engine member, said means comprising a casing en-

- closing said inertia member, a member meshing with said speed varying mechanism and constituting a track about which said mechanism revolves, and resilient metallic means interposed between said casing and track to limit the angular movement of said track. 70
14. In an engine starter of the type embodying an inertia member in which energy is stored for transmission to a member of the engine to be started, speed varying mechanism drivably connecting said inertia member with said engine member, means associated with said speed varying mechanism for absorbing the reaction resulting from the transmission of said energy to said engine member, said means comprising a casing enclosing said inertia member, means meshing with said speed varying mechanism and constituting a track about which said mechanism revolves, and means under tension interposed between said casing and track to limit the angular movement of said track. 75
15. In an engine starter of the type embodying an inertia member in which energy is stored for transmission to a member of the engine to be started, speed varying mechanism drivably connecting said inertia member with said engine member, means associated with said speed varying mechanism for absorbing the reaction resulting from the transmission of said energy to said engine member, and centrifugally operable means for releasing the driving connection between said speed varying mechanism and said engine member when the engine becomes self-operating. 80
16. In an engine starter of the type embodying an inertia member in which energy is stored for subsequent transmission to a member of the engine to be started, speed varying mechanism drivably connecting said inertia member with said engine member, means associated with said speed varying mechanism for absorbing the reaction resulting from the transmission of said energy to said engine member, and centrifugally operable means for releasing the driving connection between said speed varying mechanism and said engine member when the engine becomes self-operating, said last named means comprising a plurality of weighted members rotatable with said engine member but movable radially to engage a member driven by said speed varying mechanism after said driven member has transmitted a starting torque to said engine member. 85
17. In an engine starter of the type embodying an inertia member in which energy is stored for subsequent transmission to a member of the engine to be started, speed varying mechanism drivably connecting said inertia member with said engine member, means associated with said speed varying mechanism for absorbing the reaction resulting from the transmission of said energy to said engine member, and centrifugally operable means for releasing the drivable connection between said speed varying mechanism and said engine member when the engine becomes self-operating, said last named means comprising an engine-engaging member driven by said speed varying mechanism, and a plurality of members rotatable with said engine member and movable to release said engine-engaging member from said engine member when the latter tends to overrun the former. 90
- In testimony whereof I have signed this specification. 95
- ROMEO M. NARDONE. 100
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