May 25, 1937. R. M. NARDONE 2,081,761

ENGINE STARTING MECHANISM

Filed Jan. 7, 1931 2 Sheets-Sheet 1

Fig. 1.

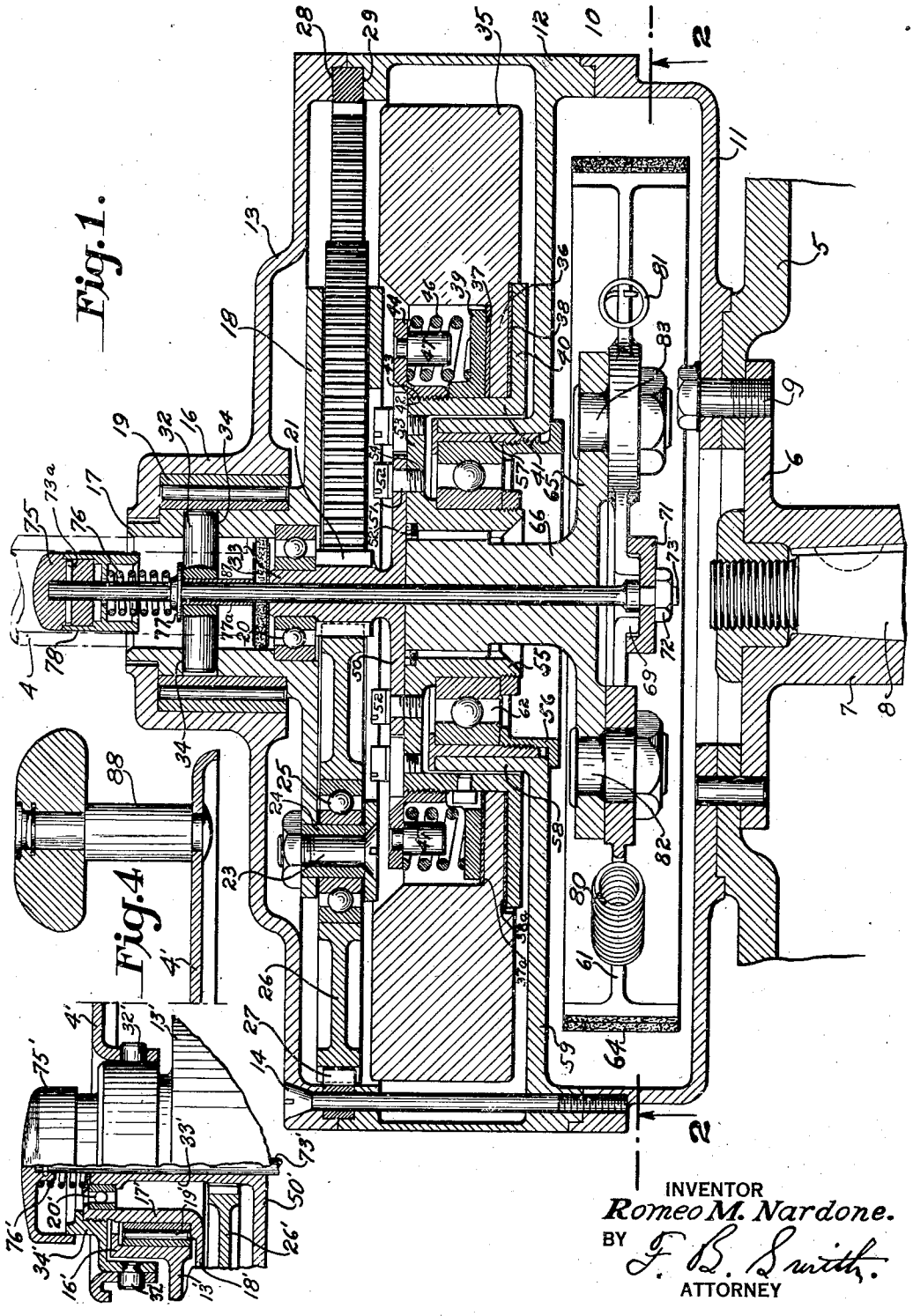

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Fig. 2.

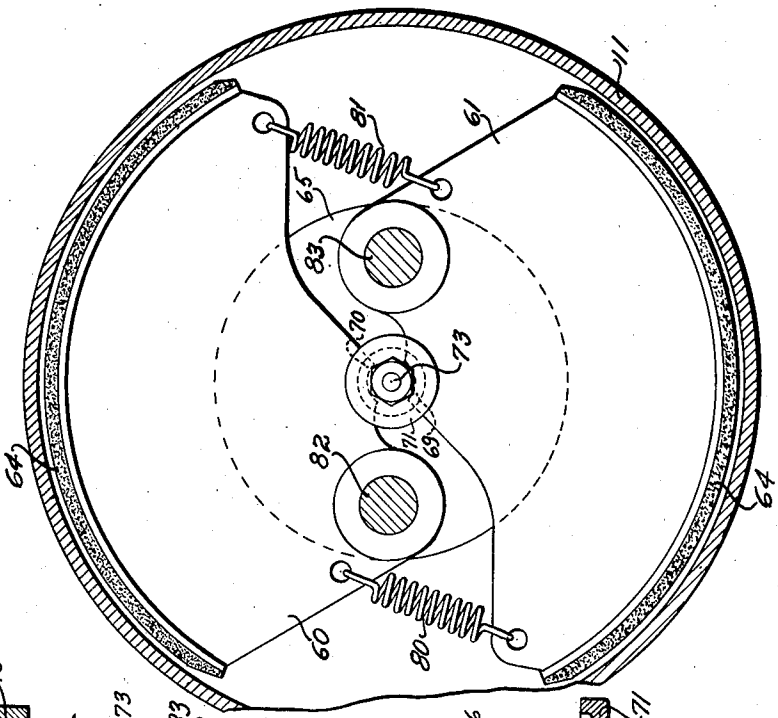
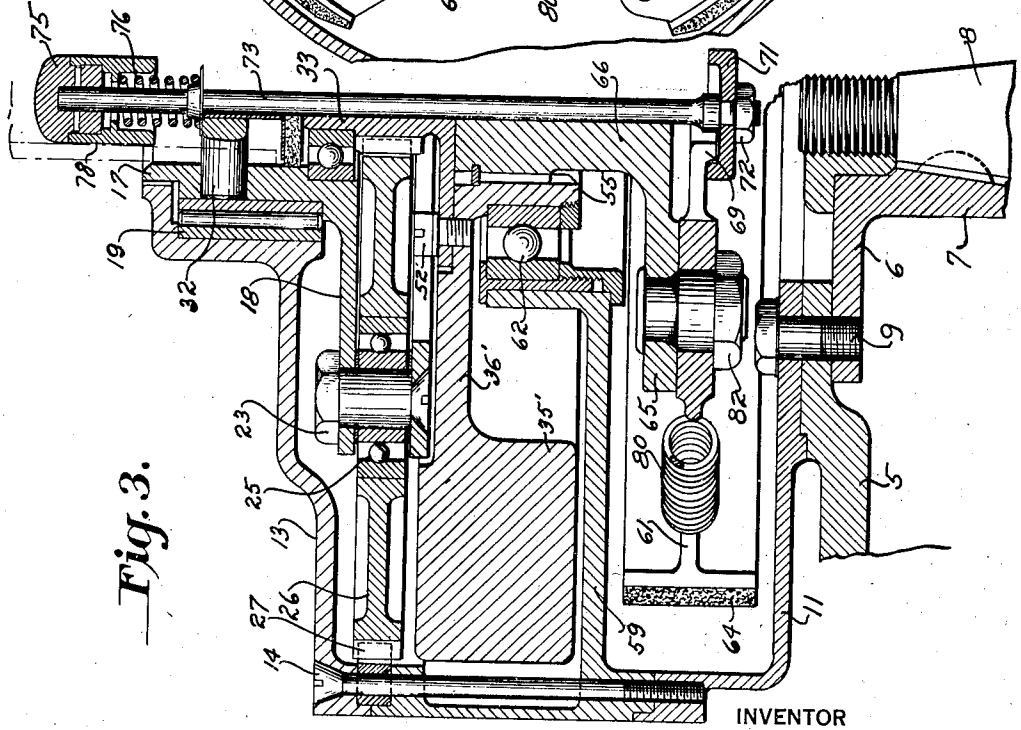


Fig. 3.



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ENGINE STARTING MECHANISM

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5 Claims. (Cl. 123—179)

This invention relates to starting devices for internal combustion engines, and more particularly to a starter of the inertia type.

One of the objects of the present invention is to provide a novel engine starter, of the type embodying a high speed flywheel, which is compact and symmetrical in form and one which is inexpensive to manufacture.

Another object is to provide a novel inertia starter which is so constituted that the inertia member is adapted to rotate with the engine during the normal operation of the latter.

Another object is to provide a novel starter of the inertia type which is completely self-contained and every element of which is mounted on and carried by a rotatable member of the engine to be started.

Another object is to provide a novel engine starter wherein the kinetic energy remaining in the flywheel after the engine has ceased to operate, may be utilized without further manual rotation of the inertia member.

A still further object is to provide a novel inertia type engine starter which is especially well adapted for use with engines of the outboard type above referred to because of its size and low manufacturing cost and the fact that it may be mounted as a unit on such an engine without requiring a change in the design thereof.

Another object is to provide a novel engine starter wherein the energy stored in a rapidly rotating inertia member may be transferred to a member of the engine to be started through a novel arrangement of parts which eliminates the usual requirement of this type of starter for a fixed member for absorbing the reaction due to the starting.

A further object is to provide an inertia starter embodying novel clutch means for operatively connecting the flywheel with the engine member to be rotated whereby the energy stored in the flywheel may be imparted to said engine member at the desired time and in an amount such that damage to the starter elements is avoided.

Another object is to provide novel clutch or brake means of general application, which embody the use of centrifugally actuated members to produce the initial operative connection between the two principal elements of said means.

A further object is to provide novel centrifugally actuated driving means in combination with means for rendering said driving means ineffective until the desired time, at which time driving engagement may be effected by a manual act of the operator, upon the performance of which manual act the centrifugal force created by the rotation of the said driving means, causes their movement into driving relation with the driven member.

Still another object is to provide a novel engine starter of the inertia type which is characterized by the fact that after the engine has been started under its own power, the inertia elements of the starting mechanism are caused to rotate with the engine member and thereby act as a flywheel for said engine.

Another object is to provide an engine starter having novel yielding driving means for preventing excessive stress and breakage of parts of the starter and preventing opposite rotation of the starter drive, in the event of a sudden reversal of the direction of rotation of the engine.

Another object is to provide an engine starter of the inertia type in which the inertia member may slip relative to the remaining parts when the resistance of the remaining parts becomes excessive, or when, after starting the engine, the speed thereof becomes excessive. The above and other objects will become more apparent from the following description of the drawings.

Two embodiments of the present invention are illustrated in the accompanying drawings, but it is to be expressly understood 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 to the appended claims.

The embodiment of the invention illustrated is particularly well adapted for use in starting outboard motors, but is not limited to such use, as above noted and when so used or adapted, comprises an inertia member, together with means for actuating and storing energy therein, mounted on a member of the engine to be started, said inertia member being adapted for rotation independently of said engine member prior to the starting thereof, but also designed for rotation with said member after the engine has been started and so long as the engine continues to run at or above a predetermined speed.

Referring to the drawings,

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

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

Figs. 3 and 4 are central vertical sections through one side of devices representing other embodiments of the invention.

Referring more particularly to the embodiment

shown in Figs. 1 and 2, it will be seen that the engine to be started is provided with a rotatable member 5, which, if desired, may be in the form of a flywheel drivably secured to a flange member 6 keyed or otherwise rigidly secured to the crankshaft (as shown) and held by nut 7, which, as shown, is adapted to threadedly engage the member 8 which may be part of the crankshaft of the engine or an extension thereof.

Rigidly attached to the members 5 and 6, by means of screws 9, is a casing member 10, which is designed to house and support the inertia actuating means. As shown, the casing is composed of three sections, 11, 12, and 13, secured together by suitable means such as screws 14, passing from the horizontally disposed surface of the upper section 13 through the cylindrical wall of the central section 12, and threadedly engaging the upper circumferential edge of the lower section 11. The upper section 13 is provided with a centrally disposed hub portion 16 having a central opening through which extends the cylindrical sleeve or shaft 17 having its lower end flanged, as indicated at 18. A roller or needle bearing 19, is mounted on shaft 17 for rotatably guiding hollow shaft 17, and a ball bearing 20 is mounted in a recess formed in the inner bore of the member 17 for rotatably supporting the pinion 21.

Member 17 constitutes the driving or cranking member of the means for actuating and storing energy in the inertia member. To this end, the flange 18 on said member is provided with a plurality of supporting bolts 23 located at equal angular distances about a circle near the outer edge thereof, said bolts having enlarged heads retaining members 24 adapted to rotatably support, with the assistance of ball bearing 25, a corresponding number of driving gears 26 adapted to mesh with the sun gear or pinion 21 and also with the teeth of the internal gear 27, mounted in the recesses 28 and 29 formed in the abutting edges of sections 12 and 13, the gears 21, 26, and 27, thus constituting a planetary system of gears operable in response to manual rotation of the member 17, produced by inserting a suitable hand crank 4 into the bore of said member and into engagement with the transversely disposed cranking pin 32 secured in sockets 34 formed in the member 17. The shaft 33 formed integral with the sun gear 21 will be caused to rotate at much higher speed than that of the shaft 17. The inertia member of the starting mechanism is adapted to be operatively connected to shaft 33 and driven thereby through novel friction clutch means. As shown, said inertia member comprises an annular rim 35 of suitable weight and mass having near its lower edge a flanged portion 36 presenting the upper and lower flat annular surfaces 37 and 38 for the reception of friction discs 37a and 38a associated with clutch members 39 and 40 respectively, the member 40 having a cylindrical hub or boss 41 extending upwardly at right angles thereto but integral therewith and provided near its upper edge with portion 42 adapted to engage a correspondingly threaded portion 43 formed on the flange ring 44.

Means for regulating the frictional pressure brought to bear on the flywheel 35 through the medium of the members 39 and 40 preferably consist of a nest of coiled springs 46 properly spaced and held in position by the provision of studs 47 riveted or otherwise suitably secured in suitable openings in the ring 44, the upper ends of the springs 46 bearing against the under surface of the ring 44 which is vertically movable to vary the tension of the springs by virtue of the provision of the threaded connection with the member 40.

The means for causing the clutch members 39 and 40 to rotate in response to rotation of shaft 33, and thereby store energy in the flywheel 35 to be subsequently used in starting the engine, preferably comprises the provision of a flanged formation at the lower end of the shaft 33 as indicated at 50, the said flange being provided with a plurality of openings 51 for the reception of screws 52, to the lower threaded ends of which is secured the clutch member 40, the said member having an inwardly extending flanged section 53 provided with threaded openings 54 for the reception of the said screws 52. The member 40 is further provided with a depending hub or boss 55 which together with the co-operating threaded cylinder members 56 and 57, supported on the upwardly projecting flange 58 formed on transversely disposed plate 59, form a pocket for the reception of ball bearing 62, on which the members 50, 55, and 40, and hence the flywheel 35 are rotatably supported.

The mechanism described above constitutes means for storing up energy to be subsequently used at the will of the operator, for cranking and starting the engine. Novel means are provided for operatively connecting the flywheel 35, after the desired amount of energy has been stored therein, to the member of the engine to be started. Generically speaking, said means comprises, first, a mechanism constantly tending to effect operative driving engagement with the casing 11 in response to the transmission of torque through the rotating flywheel; secondly, means normally preventing said mechanism from following such tendency; and thirdly, a manually operable device for rendering said second named means ineffective and thereby permitting said engaging mechanism to effect driving connection with the member 11. The engaging mechanism normally tending to effect driving connection, comprises a plurality of (as shown two) speed responsive elements 60 and 61 pivotally mounted on studs 62 and 63, respectively, these studs being located in openings provided on flange 65 formed at the lower end of shaft 66, the latter being splined or otherwise secured to member 55, for rotation therewith and locked against longitudinal movement relative thereto by suitable keying and supporting means, as shown at 52'.

The sector shaped elements 60 and 61 are provided at their outer arcuate rims with correspondingly shaped friction plates 64, formed along the outer edges thereof and having a curvature corresponding to the curvature of drum 11, the elements 60 and 61 being normally restrained from following the tendency to move radially outward into engagement with the inner surface of drum 11 in response to centrifugal force, set up by the rotation of member 65 and corresponding rotation of the sectors 60 and 61, the restraining means constituting one of the novel features of the present invention now to be described.

Still referring to Figs. 1 and 2, it will be seen that the members 60 and 61 are provided, along the surface passing near the center of rotation, with downwardly extending lugs or fingers 69 and 70 adjacent which fingers there is provided a cup shaped member 71 the upper cylindrical wall of which is adapted to surround and enclose the fingers 69 and 70 thereby preventing radial movement of the members 60 and 61 to effect driving contact with the surface of drum 11 so long as the cup member 71 remains in the position shown

in Fig. 1. The latter is normally held in this position by means of the provision of a nut 72 threaded to the lower end of the rod 73, the purpose of which rod will now be described.

The rod 73 constitutes part of the means whereby the operator may, when desired, release the members 60 and 61 from the restraining influence of the cup member 71 and thereby permit driving engagement to be effected between the rotating elements of the starter mechanism and the engine to be started. When such engagement is desired, the operator, after removing the hand crank 4, presses downwardly upon knob 75 thereby overcoming the force of spring 76, which, resting on a stationary collar 77 normally presses upwardly against the thimble 78 in which the rod 73 is held by suitable means, such as pin 73a. As a result of the downward pressure on knob 75 thus manually exerted, the rod 73 descends to a sufficient extent to permit withdrawal of cup member 71 from the path of fingers 69 and 70 and thereby permits the sector elements 60 and 61 to move outwardly into driving engagement with the drum 11 in response to the centrifugal force created by the rotation of flywheel 35 and the members driven therefrom including the friction clutch member 40 and shaft 66. The collar 77 is preferably supported on shaft 33 by suitable means including the spacer sleeve 77a and sealing gland 87.

In operation, the hand crank is engaged with pin 32, and shaft 17 is rotated until the flywheel is brought up to a speed sufficient to store the desired amount of energy for use in starting the engine, the storing of energy in the flywheel being effected through the transmission of torque from shaft 17 to the planetary gears 26 and 27 and thence through a pinion 21 to the friction clutch members 40 and 39. It will be noted that rod 73 is inaccessible when the hand crank is engaged with cranking shaft 17 and that the rotating starter elements, including the members 40, 35, 66, 60, and 61, are out of engagement with the member 11 during the time that energy is being stored in the inertia member. When the hand crank has been brought to a speed of approximately 100 R. P. M., for example, the crank is disengaged from pin 32 and meshing rod 73 is moved downwardly by hand whereupon sector elements 60 and 61 engage by action of centrifugal force, and the resultant reaction due to the tendency to stop elements 60 and 61, and hence shaft 66, and flywheel 35 from rotating, is exerted upon members 5 and 6, whereby shaft 8 is rotated and the engine started.

A further novel feature of the invention is the provision of means whereby, should the engine, as a result of a backfire or for any other reason during starting operation suddenly reverse its direction of rotation, the starter parts are fully protected against damage by the nature of the structure, shape and method of mounting and operating the elements 60 and 61, which, under such conditions would "slip", that is, rotate at a different speed from that of the casing, although still in engagement with the member 11. Slippage will also occur between the friction discs 39 and 40 and the flywheel surfaces. Springs 80 and 81, fastened at their ends to the members 60 and 61, respectively, as shown in Fig. 2, have points of attachment so located with respect to the pivot points 82 and 83 and center of rotation 73 that they exert a constant pull in opposition to the centrifugal force resulting from the rotation of the members 60 and 61, the purpose of which arrangement will presently appear.

It will be noted that during cranking of the engine, the starter elements 64 remain drivably connected to the engine crankshaft. This is due to the nature of the engagement between the members 60 and 61, on the one hand, and drum 11, on the other hand, and also the shape and tendency of these members which is to maintain driving contact so long as clutch members 60 and 61 are rotating at a speed sufficiently high to overbalance the opposing effects of springs 80 and 81. When the engine is started under its own power, or reversed suddenly, (as by a backfire), the springs 80 and 81 will of course act to withdraw the elements 60 and 61 and return the fingers 69 and 70 to the position shown in Fig. 1, thereby permitting the spring 76 to return cup member 71 into locking relation with respect to the fingers 69 and 70, such return having theretofore been prevented by the centrifugal action of the elements 60 and 61 as they continued to rotate with drum 11, being driven by the flywheel until the latter's energy is spent. In fact, the shape and method of mounting these sector elements are such as to render them "self-energizing", that is, cause them to grip the drum with a force which increases from the initial engaging force to a much greater maximum, which force is a cumulative resultant of the centrifugal force due to rotation, plus the force tending to turn the sector elements about their pivots 82 and 83, respectively. The latter force, by reason of the placing of the pivots eccentrically, as shown, is exerted directly against the surface of the drum 11.

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 well 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 being carried by a rotating member of the engine. A further feature of the present invention is that the mechanism performs the dual function of starter and engine fly-wheel, while a re-starting can be effected by utilizing the energy remaining in the flywheel, which will continue to rotate for a considerable period after the engine power has been cut off.

Another important advantage to be derived from the use of the present invention resides in the fact that the operator may choose the time for effecting driving engagement with the engine and can at such time effect such engagement by release of a lock mechanism, upon the release of which driving engagement results through the radial movement of centrifugally actuated elements, thereby eliminating the necessity of employing longitudinally movable jaw or clutch members, which, because of the necessity of rotating and moving longitudinally at the same time, are subject to breakage or injury or undue strain, besides being more complicated in construction and expensive to manufacture and install.

A further feature of the invention resides in the method of transmitting torque to and from the flywheel as a result of which method and construction, upon excessive load, the clutch members 40 and 39, as well as the members 64 are caused to slip, thereby preventing undue strain or injury to the parts. However, if it is desired to maintain a non-slipping drive between the

shaft **66** and the flywheel **35**, the friction clutch construction shown at **39**, **40**, and **46** in Fig. 1 may be revised, as indicated in the embodiment shown in Fig. 3, wherein the springs **46** have been eliminated and the flywheel **35'** is provided with an inwardly extending portion **36'** near its upper edge and adapted to be directly engaged by screws **52'** which correspond in function to the screws **52** described with reference to Fig. 1, it being understood that the other elements shown in Fig. 3 have functions and methods of operation similar to the corresponding elements in the embodiment shown in Figs. 1 and 2.

It will be obvious that the invention is not limited in form to either of the embodiments above described nor is it limited to the specific use described, but is capable of a variety of mechanical embodiments and uses. For example, any suitable arrangement of gears may be substituted for the specific gear train shown and described and other clutch locking and lock releasing means may be employed in place of the means shown and described for these purposes. Hence it is within the scope of the invention to actuate the lock releasing rod **73** automatically or by power, instead of manually. The same is true of the means for initially energizing the inertia element. Also the invention may be used in internal combustion engines other than those of the outboard type, while certain sub-combinations may be applied to devices other than internal combustion engines, as above noted. Thus for example, the novel clutch and driving means illustrated in Fig. 2, because of the advantages which it possesses as hereinabove explained, is capable of application and use wherever it is desirable to employ frictional engaging means possessing the qualities above pointed out, particularly the inherent characteristic of tending to increase the initial gripping force to a degree proportionate to the speed of rotation of the parts. Such qualities render this sub-combination of elements useful and advantageous in a variety of applications not only as a driving means but also as a speed retarding or braking means. In the latter application the shaft 66 may be connected for rotation with the wheels of the vehicle or other member in which rotation is to be retarded, the drum 11 being supported on some other part of the vehicle or other member not normally rotating with the shaft 66, but free to rotate relatively thereto during the period of application of the brakes.

If desired, as a substitute for the protecting gland 87, a tightly fitting cap **75'**, as shown in Fig. 4, may be employed to protect the gears and other parts in the assembly from moisture or foreign substances, in which event the protecting cap may serve also as a means for actuating the releasing rod. A suitable construction for this purpose, as shown, comprises a cylindrical member **17'** having a flange **18'** connecting with the planetary gears **26'** in a manner similar to that shown and described with reference to Fig. 1, the member **17'** being threaded along its upper portion to another cylindrical member **34'** provided with pins **32'** for engagement by a suitably disposed groove in the cylindrical portion of the crank **4'**, the latter being adapted to removably engage said pins and having a handle **88** by means of which the members **34'** and **17'** may be rotated about the casing **13'**, the bearings **19'** and **20'** permitting easy rotative movement with respect to the casing **13'** and the centrally disposed shaft **33'**, through the center of which passes the releasing rod **73'**, the upper end of the rod being secured to a central extension of the interior of cap **75'** as indicated. The spring **76'**, resting on a suitable seat bearing against the upper end of shaft **33'**, normally holds the rod **73'** in the locking position, from which position it may be moved by downward pressure exerted on the top of cap **75'**.

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.

1. An engine starting mechanism comprising in combination, a high speed shaft, actuating means for said shaft, a casing enclosing said shaft and actuating means, speed responsive mechanism driven by said shaft and tending to move radially into engine engaging position, means normally locking said speed responsive mechanism against such radial movement comprising a projecting lug on said speed responsive mechanism near its center of rotation, a holding member engageable with said lug, and means operable at the will of the operator for rendering said locking means ineffective to prevent said radial movement, said means comprising a rod connected to said holding member and extending through said shaft and casing in co-axial relation thereto.

2. An engine starting mechanism comprising in combination, an engine member, a high speed shaft, actuating means for said shaft, a casing enclosing said shaft and rotatable with said engine member, speed responsive mechanism driven by said shaft and tending to move into engagement with said casing to cause rotation of said casing and engine member, means normally restraining said speed responsive mechanism from effecting said engagement, and means operable at the will of the operator for rendering said restraining means ineffective to prevent said engagement, said last named means extending through said casing at its axis of rotation.

3. In combination with a rotatable member of an engine to be started, a supporting member rigidly attached to said engine member, a high speed shaft mounted on said supporting member and adapted for rotation relative to the supporting member during starting operation, centrifugally actuated means driven by said shaft and adapted to move into driving engagement with said supporting member to cause a transmission of starting torque through said supporting member to said rotatable engine member, and manually controlled means for establishing driving engagement between said centrifugally operated means and said supporting means.

4. An engine starting mechanism comprising in combination, a rotatable engine member, a high speed actuating means, a casing enclosing said actuating means, speed responsive mechanism driven by said actuating means, said speed responsive mechanism including a plurality of torque transmitting members tending to move radially into engagement with said casing to cause rotation of said casing and engine member, means normally locking said speed responsive mechanism against radial movement, and means for rendering said locking means ineffective to prevent said radial movement.

5. An engine starting mechanism comprising

in combination, a rotatable engine member, speed responsive mechanism tending to move radially into engagement with said rotatable engine member to cause rotation of said casing and engine member, means normally locking said speed responsive mechanism against such radial movement, means for rendering said locking means ineffective to prevent said radial movement, and means for disengaging said speed responsive mechanism when said engine starts under its own power.

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