

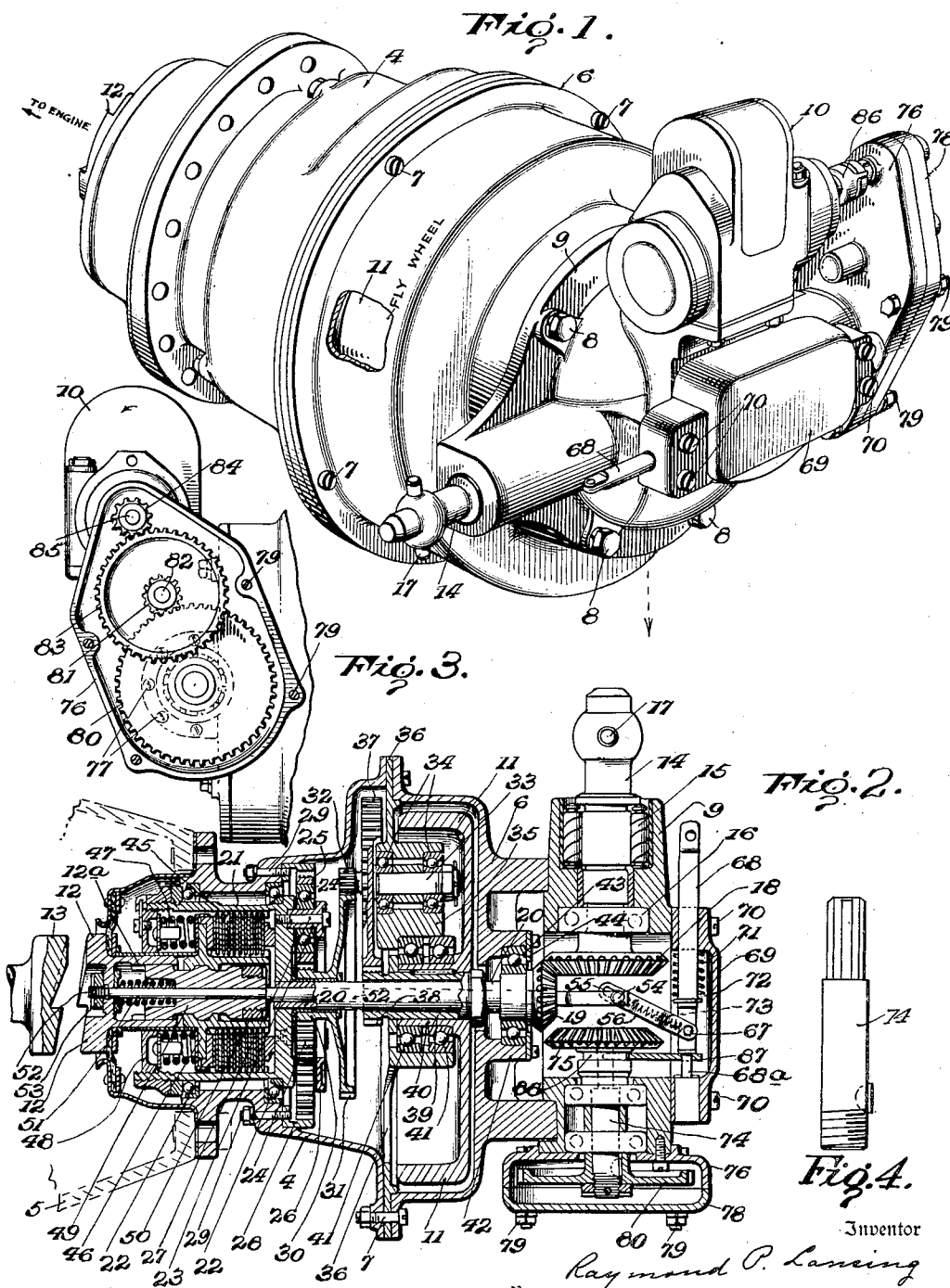
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ENGINE STARTING MECHANISM

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ENGINE STARTING MECHANISM

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This invention relates to engine starting apparatus and more particularly to combined starting and ignition mechanism for internal combustion engines.

It has heretofore been proposed to employ inertia mechanism for starting internal combustion engines. Inertia devices of this character embody, in certain instances, a small flywheel which rotates a driven member that is adapted to engage, but is normally out of engagement with, a member provided on the engine crank shaft or an extension of the latter, whereby the crank shaft may be rotated and the engine started. In order to effectively employ a small flywheel, the same must be rotated at a very high speed. The driven member, however, must be rotated at a relatively low speed. Accordingly, means including reduction gearing are interposed between the flywheel and the engine engaging or driven member.

Manually operable means are employed in certain instances for bringing the flywheel to the desired speed of rotation, and in this event the gearing referred to is employed as a part of said manually operable means, whereby one revolution of a member, such as a hand crank, is effective to rotate the flywheel a large number of times.

When sufficient energy has been stored in the inertia element of the starter, i. e., when the flywheel has been brought to a very high speed of rotation, the engine engaging member is moved by suitable mechanism into driving engagement with the engine crank shaft member, whereby the crank shaft is rotated and the engine started.

In many instances it is desirable to supply the ignition current for an internal combustion engine from a magneto that is mounted on and driven by the engine. During the starting operation, however, this magneto is frequently driven at such a low speed as to be ineffective to supply the desired current.

An object of the present invention is to provide novel starting and ignition mechanism for internal combustion engines, which mechanism includes, in combination, an inertia starter and a booster magneto adapted to be driven by the flywheel of said starter, whereby said magneto is actuated to supply ignition current during the starting operation.

Another object is to provide, in combination, an engine inertia starter embodying novel means for driving a booster magneto at high speed, thereby permitting the use of a relatively small magneto.

Another object is to provide, in combination

with an inertia starter, a booster magneto adapted to be driven by the starter, and novel means for drivably connecting the magneto with the inertia element of the starter.

Another object is to provide, in combination with starting mechanism of the type embodying a flywheel and a member driven thereby that is movable into driving engagement with the engine to be started, a magneto mounted in novel driving relation with the flywheel and adapted to be connected therewith by novel means for moving said engine engaging member into driving engagement with the engine.

A further object is to provide a booster magneto in combination with an inertia starter mechanism and novel manually operable means for engaging the booster magneto with said mechanism after energy has been stored in the latter.

A still further object is to provide, in combination with an inertia starter, a booster magneto mounted thereon and adapted to be drivably connected with the gearing of the starter, the driving connection being made with an element of said gearing which is rotated at low speed.

Another object is to provide, in combination with an inertia starter of the type embodying a flywheel adapted to be manually rotated, a booster magneto adapted to be driven by said flywheel and novel means for drivably connecting the magneto and flywheel, the driving connection being made with a part which rotates at the hand cranking speed, whereby engagement of the parts is readily effected. The above and other objects will appear more fully in the detail description.

One embodiment of the present invention is illustrated in the accompanying drawing, wherein like reference characters refer to like parts throughout the several views. It is to be expressly understood, however, that the drawing is for purposes of illustration only and is not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawing—

Fig. 1 is a perspective view illustrating one embodiment of the present invention;

Fig. 2 is a top plan view in axial section of the parts shown in Fig. 1 with the hand crank shaft adjusted to a different position from that shown in Fig. 1;

Fig. 3 is a detail view, with parts removed and broken away, illustrating one form of means which may be employed for transmitting the motion of the flywheel to the booster magneto; and

Fig. 4 is a view in elevation of one end of the

magneto driving shaft constituting part of the assembly shown in Fig. 2.

In the form shown, the starter comprises a housing constituted by an inner section 4 adapted to be bolted or otherwise suitably secured to the rear end of an engine crank case diagrammatically indicated at 5, and an outer section 6 that is secured to section 4 by suitable bolts 7. To the outer end of housing section 6 there is attached, as by means of screws 8, a starter cranking shaft housing 9. A booster magneto 10 is removably secured in any suitable manner to the outer surface of housing 9.

The starter includes a flywheel 11 rotatably mounted in the housing portion 6 and adapted to drive the armature of the magneto 10 and an engine engaging member 12 which is normally out of engagement with, but is adapted to be moved into driving engagement with a member 13 formed on the engine crank shaft, or on an extension thereof.

Means, which in the form shown are adapted to be manually actuated, are provided for rotating the flywheel 11 at high speed. In the illustrated embodiment, said means comprise a hand cranking shaft 14 which extends substantially at right angles to the axis of rotation of flywheel 11 and is rotatably mounted in housing 9, as by means of roller bearing 15 and ball bearings 16. The end of shaft 14 which extends outwardly of housing 9 is provided with a suitable pin or pins 17 for engagement with a hand crank (not shown), whereby said shaft 14 may be manually rotated. Fixedly secured in any suitable manner to the inner end of shaft 14 is a bevel gear 18 which meshes with a bevel gear 19 secured to and rotatable with the outer end of a sleeve 20. The inner end of sleeve 20 is provided with one or more flat surfaces by which it is drivably secured to the closed end of a cup-shaped member or barrel 21 which is provided centrally with a correspondingly broached opening with which the end of the sleeve 20 registers, the barrel 21 being rotatably mounted, as by means of ball bearings 22, in the housing section 4.

Immediately to the right (as viewed in Fig. 2) of the closed end of barrel 21, there is provided a set of planetary gears 25, preferably three in number and spaced at intervals of 120 degrees, one of said planetary gears 25 being shown in section above the center line and the other in elevation below the center line. Each of the gears 25 is mounted in the manner indicated for one of said gears—the one shown in section—such mounting consisting of the provision of ball bearings 24 surrounding a sleeve 23 formed integrally with a ring 26 which constitutes a retainer for the ball bearings 24, said ring and sleeve being attached to the barrel by means of a screw 27 which extends through said sleeve and is threaded into the closed end of said barrel. Planetary gears 25 mesh with an internal gear 28 that is fixedly secured to the housing section 4, as by means of studs 29. The planetary gears also mesh with a sun gear 30 which is rotatably mounted on sleeve 20 and which is preferably formed integrally with a spur gear 31 that is likewise rotatably mounted on said sleeve 20, a suitable bushing 31a being interposed between the sleeve and the integrally formed members, if desired.

In mesh with the spur gear 31 is a pinion 32 which may be formed integrally with a shaft 33 that is rotatably mounted, as by means of ball bearings 34, in a hub 35. In the form shown this hub constitutes an integral part of a diaphragm or

spider 36 which is clamped between the flanged portions of the housing sections 4 and 6 by the bolts 7. Rigidly secured to shaft 33 closely adjacent the pinion 32 is a spur gear 37 which meshes with a pinion 38 drivably attached to a sleeve 39 which is keyed to the hub 40 of flywheel 11 for rotation therewith. In the illustrated embodiment, flywheel 11 is rotatably mounted, as by means of ball bearings 41 that engage the flywheel hub and are supported by diaphragm 36. Preferably the outer end of sleeve 20 is rotatably supported by a ball bearing 43 positioned in a hub 42 formed in housing portion 6. Bearing 43 is retained in a recess in said hub by a suitable retaining ring 44.

When the shaft 14 is manually rotated by means of the hand crank (not shown), this motion is transmitted through bevel gears 18, 19, sleeve 20, barrel 21, planetary gears 25, sun gear 30, spur gear 31, pinion 32, spur gear 37 and pinion 38 to the flywheel 11, whereby the latter is rotated. Due to the train of gearing employed, one rotation of shaft 14 results in a large number of rotations of the flywheel, whereby the latter may be rotated at high speed.

After the flywheel has been brought to the desired speed of rotation, the operator may discontinue the actuation of the hand crank. Barrel 21 is now driven by the flywheel through the gearing described above, which gearing at this time operates as motion reduction means and drives said barrel at a much lower speed than that at which the flywheel is rotating.

Means are interposed between barrel 21 and the engine engaging member 12 whereby the energy stored in the rotating flywheel 11 is effective to drive said member, and preferably said means include a yielding driving connection in order that no damage may result to the gearing described above in the event that an unusual load is placed on the driven member or starter jaw 12. In the form shown said means include a multiple disk clutch 45, a portion of the disks thereof being splined to the inner surface of barrel 21 and the remaining portion of said disks being splined to the outer surface of a nut 46 provided with a flanged portion. The disks of the clutch are held between the closed end of barrel 21 and the flanged nut 46, and the pressure with which said disks are held in frictional engagement may be varied by means of suitable coil springs 47 and a nut 48 threaded into the outer end of barrel 21. By adjusting the nut 48 relative to barrel 21 the amount of spring pressure on the clutch disks is varied to secure the desired torque value for the clutch.

The inner bore of nut 46 is threaded to engage a threaded shaft 49 which is adapted for rotary and longitudinal movement relative to said nut. Secured to the outer end of shaft 49 is a nut 50 which constitutes a stop member for limiting the outward movement of said shaft relative to the nut 46. The opposite end of shaft 49 is splined to receive a laterally projecting splined portion 12a of starter jaw 12, whereby said jaw is longitudinally movable relative to said shaft but is adapted for rotation therewith. A coil spring 51 is interposed between the hub portion of jaw 12 and the adjacent end of shaft 49 to yieldingly resist movement of the jaw toward the shaft.

Means are provided for moving starter jaw 12 into engagement with the jaw member 13 provided on the engine crank shaft whereby the energy of flywheel 11 is effective to rotate said crank shaft. For this purpose a rod 52 slidably

extends through sleeve 20, threaded shaft 49 and the hub of starter jaw 12. The inner end of rod 52 is threaded to receive a nut 53 which engages the hub portion of jaw 12 and maintains said jaw in operative engagement with shaft 49. The outer end of rod 52 terminates closely adjacent the longitudinal axis of shaft 14 and intermediate its ends said rod is provided with a shoulder 52a having abutting engagement with the outer end of threaded shaft 49 for a purpose to be described hereinafter. The outer end of rod 52 is provided with a pin 54 which slidably extends through a slot 55 formed in one end of a link 56, the outer end of the link being pivotally connected at 67 to a rod 68 which extends substantially parallel to shaft 14 and is slidably mounted in a cover plate 69 that is secured to the outer face of shaft housing 9 as by means of screws 70. Surrounding rod 68 within the cover plate 69 is a coil spring 71 which abuts at one end against said cover plate and at its opposite end against a shoulder or collar 72 secured to the rod, the spring being thus mounted in such a manner as to force rod 68 downwardly as viewed in Fig. 2, whereby link 56 is normally maintained at an angle to rod 52 with the pin 54 in the inner end of slot 55. Attached to pin 54 is one end of a spring 73 that has its opposite end secured to rod 68 adjacent the pivotal connection for link 56.

Means are provided for driving the booster magneto 10 from the flywheel 11 after said flywheel has been brought to the proper speed of rotation, and said means are so constructed that the driving engagement for the booster magneto is made with a member which rotates at relatively low speed, whereby said driving connection may be readily effected. For this purpose there is rotatably mounted in the cranking shaft housing 69, diametrically opposite shaft 14, a stub shaft 74 which carries on its inner end a bevel gear 75 the downwardly extending hub of which has a splined or equivalent connection with the shaft 74 for longitudinal movement relative to the stub shaft and for rotary movement therewith. The outer end of shaft 74 extends into a gear housing 76 that is preferably formed in two parts, the inner part being rigidly attached to the cranking shaft housing 9 by means of a plurality of screws 77 (Fig. 3), and the outer half 78 being secured to the inner half as by means of bolts 79. Keyed to the end of shaft 74 which projects into the lower portion of housing 76 is a spur gear 80 which meshes with a pinion 81 that is rotatably mounted on a stub shaft 82 carried by said housing (Fig. 3). Secured in any suitable manner to pinion 81 for rotation therewith is a spur gear 83 which meshes with a pinion 84 carried on a shaft 85 that is rotatably mounted in housing 76 and extends outwardly from the housing towards the armature shaft 86 of the booster magneto. Preferably shafts 85 and 86 are detachably connected by means of interlocking teeth of any suitable type.

Means are provided for moving the bevel gear 75 along shaft 74 into meshing engagement with bevel gear 19, after flywheel 11 has been brought to the desired speed of rotation, and in the form shown said means are so constructed as to include rod 68, whereby bevel gears 19 and 75 may be meshed at the same time that members 12 and 13 are engaged. For this purpose a shifter fork 87 is attached to a reduced portion 68a of the shaft 68 and the arms of said fork extend

into an annular groove 88 formed in the hub portion of bevel gear 75.

The operation of the device is as follows: shaft 14 is manually rotated by means of the hand crank (not shown). This movement is transmitted to the flywheel in a manner described above, whereby the flywheel is rotated at high speed and energy is stored therein. Since no load is placed on starter jaw 12 during the time that energy is being stored in the flywheel, said jaw and the remaining elements within barrel 21 rotate as a unit; and since bevel gear 75 is not in engagement with bevel gear 19 no extra effort is required on the part of the operator to actuate shaft 14, as the armature shaft of the magneto is not rotated at this time.

When the flywheel has been brought to the proper speed of rotation the operator exerts a force on rod 68, either directly or through suitable means, to move said rod upwardly as viewed in Fig. 2. This movement is transmitted through link 56 and pin 54 to rod 52, whereby the latter is moved to the left. The engagement of the shoulder on rod 52 with the threaded shaft 49 serves to move said shaft to the left, whereupon jaw 12 is yieldingly forced to the left by spring 51. Due to the use of the slot in the end of link 56 the entire movement of rod 52 is not a positive one. Rod 68 and link 56 initiate the movement of rod 52 and the inertia of shaft 49 and nut 46 coacts with the action of the threads between said shaft and nut to complete the meshing action. The energy of the flywheel 11 is now effective to rotate the crank shaft and start the engine.

Simultaneously with the movement of starter jaw 12 into driving engagement with jaw 13, the shifter fork 87, due to its engagement with the enlarged end of rod 68 and its engagement with the hub of gear 75, slides said gear along shaft 74 into mesh with the bevel gear 19, whereupon motion is transmitted through the gearing, shown in Fig. 3, to the magneto armature shaft and the latter is rotated at a speed sufficiently high to supply the necessary ignition current for starting. Due to the relatively low speed of rotation of the bevel gear 19 no difficulty is encountered in meshing gear 75 therewith. The sliding bevel gear 75 need not be a theoretical gear and it may be found desirable to use teeth of a very short face rather than the form of bevel gear illustrated.

No extra operation is required on the part of the operator to establish the driving connection between the magneto armature shaft and the flywheel since said connection is made by actuation of the means employed for moving starter jaw 12 into meshing engagement with jaw 13 on the engine crank shaft.

When the engine starts under its own power and the speed of rotation of the crank shaft is greater than the speed of rotation of the starter jaw, the inclined surfaces of the teeth of the jaws act to force jaw 12 to the right out of driving engagement and against the tension of spring 51, in the event that rod 52 is being held in meshing position. If rod 68 has been released, however, driving engagement will be maintained between jaws 12 and 13 until the speed of jaw 13, due to the operation of the engine, becomes greater than the speed of jaw 12, whereupon the over-running action of the screw threads of shaft 49 and nut 46 results in the disengagement of jaw 12, the shaft, the nut, the jaw and spring 51 moving to the right, as viewed in Fig. 2, as a unit.

The movable parts within barrel 21 are so constructed as to permit jaw 12 to be manually pulled out of engagement with jaw 13 in the event that the energy in flywheel 11 has been completely expended without the engine firing, in which case the starter elements are likely to come to rest with jaws 12 and 13 in engagement. If a downwardly directed force is now exerted on rod 68 this force will be transmitted through link 56, rod 52 and nut 53 to jaw 12 and the latter will be moved to the right compressing spring 51. Threaded shaft 49 will not move until the jaws are completely disengaged, at which time said shaft will be moved quite rapidly to the right as spring 51 expands to its normal length.

There is thus provided means whereby a booster magneto is adapted to be driven by the flywheel of an inertia starter, said means being so constituted that no extra effort is required on the part of the operator, for storing energy in the flywheel, since during this latter operation the magneto is not in driving relation with the flywheel. No additional operation is required to establish the driving connection between the magneto and flywheel since this connection is effected by the operation which results in engagement of the starter jaw with the engine crank shaft, common means being employed for performing these two operations. The driving connection between the flywheel and magneto is made by an element which rotates at low speed, and accordingly little difficulty is involved in making the connection and any likelihood of damage to the parts is avoided. The flywheel and magneto may be connected in such a manner that the armature shaft of the latter is rotated at very high speed and this permits the use of a light, small magneto for supplying the necessary ignition current but it will be understood that the elements of the apparatus may be varied to obtain any desired speed for the armature shaft.

Various changes may be made in the details of construction of the apparatus. For example, other power means may be employed for rotating the flywheel in lieu of, or as a supplement to, the hand power means shown at 14. It will be apparent that changes may be made in the arrangement and form of the motion transmitting means employed between the flywheel and the booster magneto and of the means directly employed for forming the driving connection to the magneto. Reference will therefore be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. In combination with a starter embodying a high speed flywheel, a magneto adapted to be driven by said starter, gearing connected to said flywheel, a relatively low speed element rotatable with the low speed end of said gearing, and step-up gearing connected to the armature shaft of said magneto, a member of said step-up gearing being movable into engagement with said low speed element whereby the magneto is driven by the flywheel.

2. In combination with an inertia starter embodying a high speed flywheel, manually operable means for storing energy in said flywheel, a member extending through said flywheel adapted to be engaged by said manually operable means, means drivably connecting said member to said flywheel, an electric machine adapted to be driven by said flywheel, gearing operatively connected to said electric machine, and a member drivably connected with said gearing and adapt-

ed to be moved into engagement with said first named member.

3. In combination with an inertia starter, a magneto adapted to be driven by said starter, manually operable means for storing energy in the inertia element of said starter, and members adapted to be engaged for establishing a driving connection between said inertia element and the magneto, one of said members being rotatable at a speed substantially equal to that of the said cranking shaft.

4. In combination with an inertia starter provided with a housing, a cranking shaft housing secured thereto, a cranking shaft in said housing, a relatively low speed gear adapted to be rotated by said shaft, means for connecting said gear to the inertia element of said starter, a booster magneto, driving means for said magneto including a slidably mounted member, and means for moving said slidably mounted member into driving engagement with said relatively low speed gear adapted to be rotated by said shaft.

5. In engine starting apparatus of the class described, a driven member movable to engine engaging position, a flywheel for driving said member, an auxiliary engine unit, gearing interposed between said flywheel and driven member, step-up gearing operatively connected to said auxiliary engine unit, manually operable means for actuating said first named gearing to rotate the flywheel, and means for drivably connecting said step-up gearing with an element of said gearing means rotatable at the same speed as said manually operable means.

6. In combination with an engine starter including a flywheel and a driven member adapted to be moved into engine engaging position, an auxiliary engine unit, gearing means associated with said auxiliary engine unit and common means for drivably connecting said gearing means with said flywheel and for moving said driven member into engine engaging position, said common means including a rod slidably extending through said driven member, and a second rod connected to said first named rod, said second rod being slidably disposed at substantially right angles to said first named rod.

7. In combination with an engine inertia starter including a flywheel and a driven member movable into engine engaging position, an auxiliary engine unit, means for drivably connecting said flywheel and auxiliary engine unit, and an operating rod shiftable crosswise with respect to the axis of the driven member to effect movement of said driven member into engine engaging position and to actuate said connecting means.

8. In engine starting apparatus of the type embodying an engine engaging member, a flywheel for driving said member, means including a barrel for transmitting the motion of the flywheel to said engine engaging member, an element rotatable with and at the speed of said barrel, an auxiliary engine unit adapted to be driven by said flywheel, and a member drivably connected to said auxiliary engine unit and movable into driving engagement with said element.

9. In engine starting apparatus of the type embodying a high speed flywheel, an auxiliary engine unit adapted to be driven by said flywheel, means intermediate said flywheel and auxiliary engine unit for transmitting the rotation of the flywheel to the rotor of the auxiliary engine unit, said means including a train of motion reduction gearing and a train of step-up gearing, and manually operable means for drivably connect-

ing the low speed end of one of said gear trains to the low speed end of the other.

10. In engine starting apparatus of the type embodying a high speed flywheel, an electrical machine adapted to be driven by said flywheel, means intermediate said flywheel and electrical machine for transmitting the rotation of the flywheel to the rotor of the electrical machine, said means including a train of motion reduction gearing and a train of step-up gearing, and manually operable means for connecting the low speed end of one of said gear trains to the low speed end of the other, said last named means including a member controlling the engine engaging action of said starter, and a gear shifting member movable with said first named member.

11. In engine starting apparatus of the type embodying a high speed flywheel, an electrical machine adapted to be driven by said flywheel, means intermediate said flywheel and electrical machine for transmitting the rotation of the flywheel to the rotor of the electric machine, said means including a train of motion reduction gearing and a train of step-up gearing, gear shifting means for drivably connecting the low speed end of one of said gear trains to the low speed end of the other, meshing means for controlling the engine engaging action of the starter, and common control means for said gear shifting and meshing means.

12. In engine starting apparatus of the type embodying a high speed flywheel, an auxiliary engine unit adapted to be driven by said flywheel, means intermediate said flywheel and auxiliary unit for transmitting the rotation of the flywheel to the rotor of the unit, said means including a pair of gear trains, and manually operable means for connecting one end of one of said gears with one end of the other, said last named means controlling the engine engaging action of the starter, and a gear shifting member movable with said first named member.

13. In engine starting apparatus of the type embodying a high speed flywheel and an engine engaging member rotatable therewith, an auxiliary engine unit adapted to be driven by said flywheel, means intermediate with said flywheel and auxiliary unit for transmitting the rotation of the flywheel to the rotor of said unit, said means including a pair of gear trains and gear shifting means for drivably connecting one of said gear trains with the other, means for controlling the meshing movement of said engine engaging member, and common controlling means for said engine engaging and gear shifting means.

14. In engine starting apparatus of the type

embodying a driving member, an auxiliary engine unit adapted to be driven by said driving member, means intermediate said driving member and auxiliary unit for transmitting the rotation of the driving member to the rotor of the unit, said means including a pair of gear trains, and manually operable means for connecting one end of one of said gears with one end of the other, said last named means controlling the engine engaging action of the starter, and a gear shifting member movable with said first named member.

15. In engine starting apparatus of the type embodying a driving member and an engine engaging member rotatable therewith, an auxiliary engine unit adapted to be driven by said driving member, means intermediate with said driving member and auxiliary unit for transmitting the rotation of the driving member to the rotor of said unit, said means including a pair of gear trains and gear shifting means for drivably connecting one of said gear trains with the other, means for controlling the meshing movement of said engine engaging member, and common controlling means for said engine engaging and gear shifting means.

16. In combination, with an inertia starter including a flywheel and a driven member adapted to be moved into engine engaging position, an auxiliary unit, normally disengaged means for drivably connecting said auxiliary unit and flywheel, means concentric with the driven member for causing endwise actuation thereof, and common means for actuating said concentric means and said normally disengaged means.

17. In engine starting apparatus of the type embodying a high speed flywheel, an electric machine adapted to be driven by said flywheel, and means intermediate said flywheel and electric machine for transmitting the rotation of the flywheel to the armature shaft of the electric machine, said means including a train of motion reduction gearing and a train of step-up gearing connected by a member extending through the flywheel.

18. In combination with a starter including a flywheel, means including a cranking shaft for accelerating said flywheel, a magneto mounted adjacent said starter, an actuating shaft for said magneto, said actuating shaft being axially aligned with said cranking shaft, and manually operable means disposed adjacent and parallel to both said shafts for establishing a driving connection between said magneto and said flywheel.

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