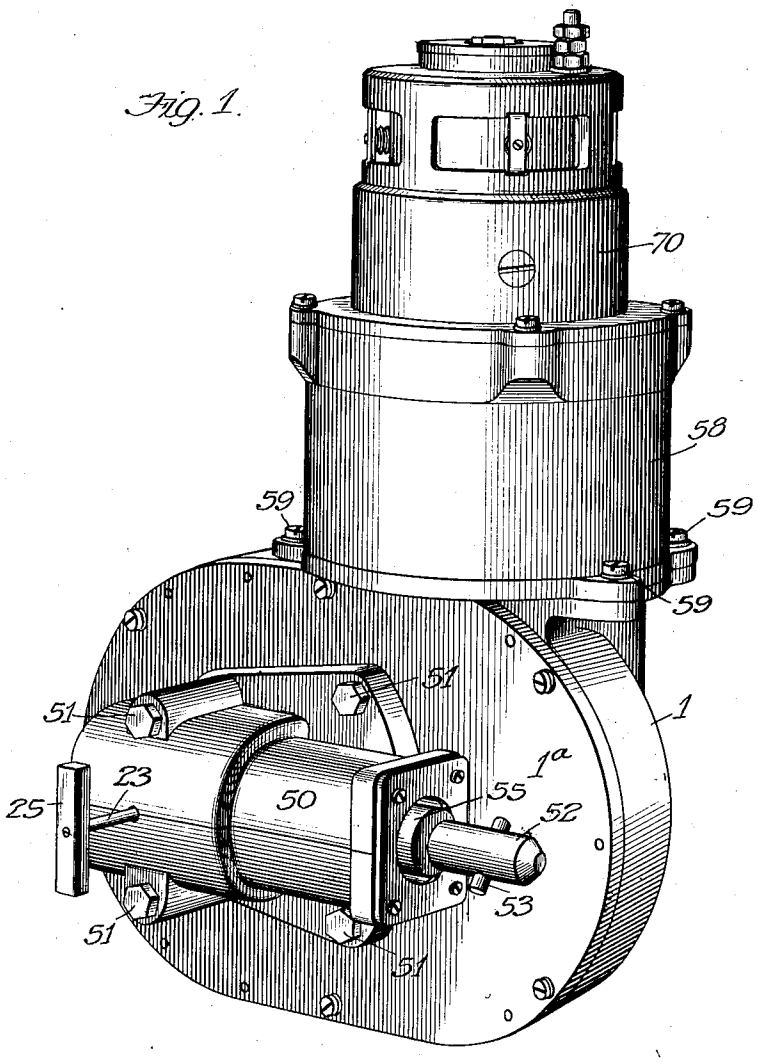
Dec. 10, 1929. R. P. LANSING 1,739,469

ENGINE STARTER

Filed Sept. 28, 1925 4 Sheets-Sheet 1

Fig. 1.



Witness
Martin H. Olsen.

Inventor
Raymond P. Lansing
By Rector, Hibben, Davis & Macauley
His Attys

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ENGINE STARTER

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Fig. 2.

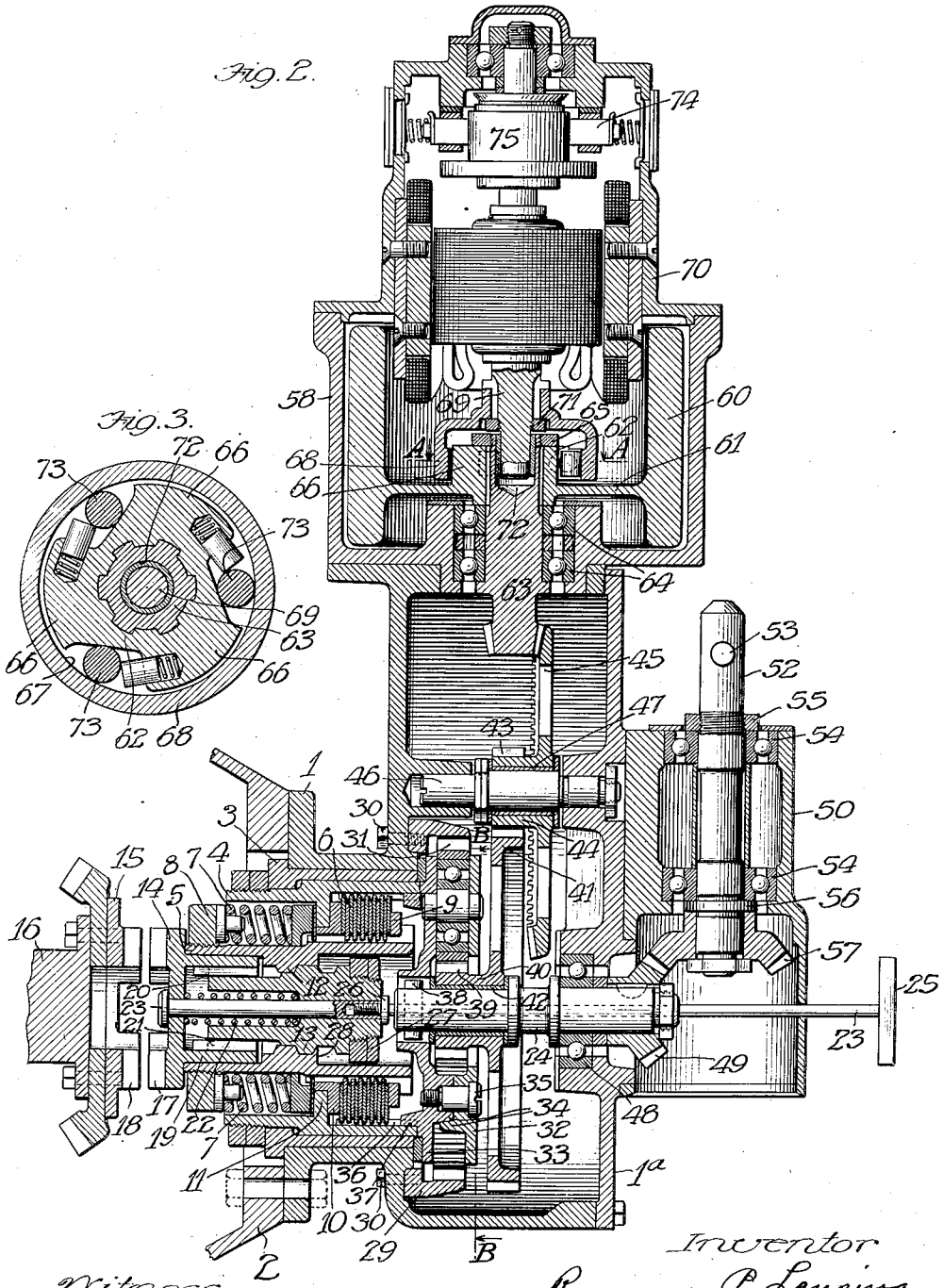

Fig. 3.

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Martin H. Olsen.

Inventor
Raymond P. Lansing
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ENGINE STARTER

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Fig. 4

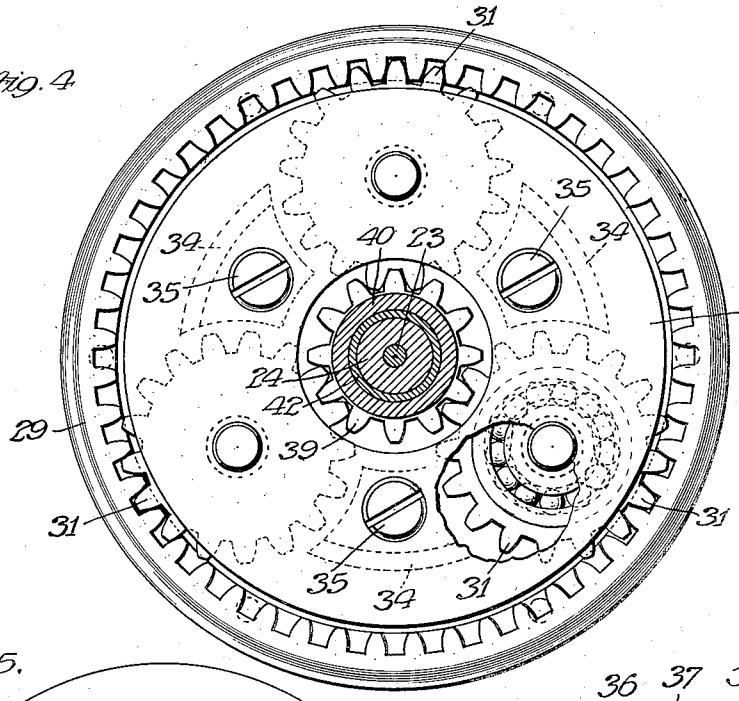

Fig. 5.

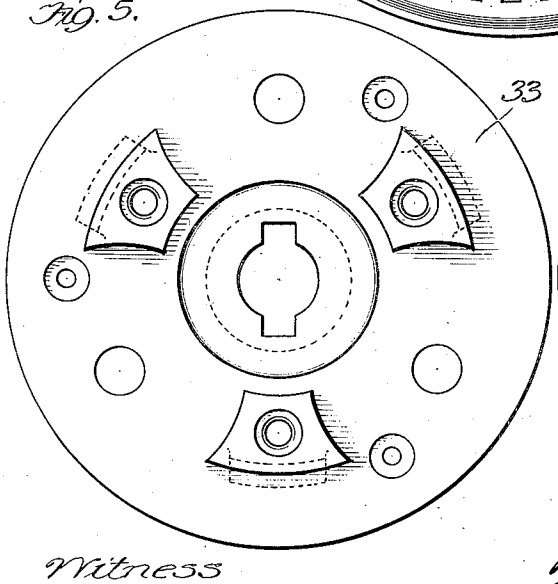

Fig. 6.

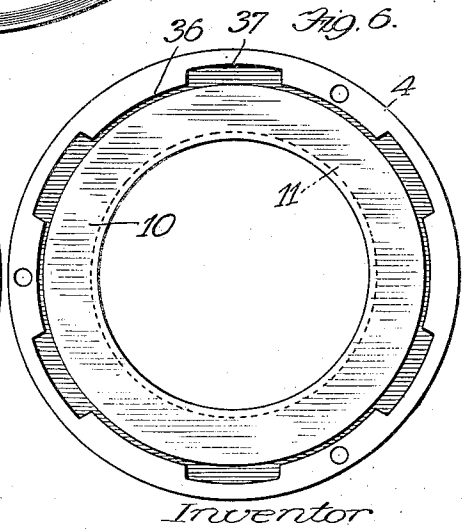

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Fig. 7.

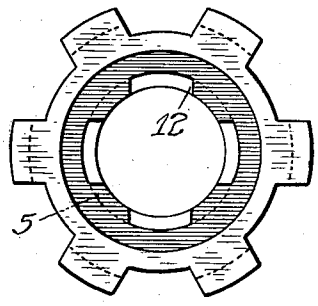


Fig. 8.

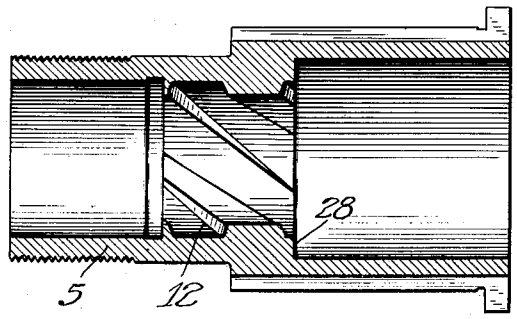


Fig. 9.

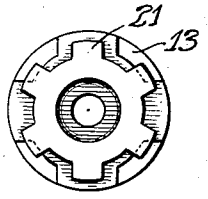


Fig. 10.

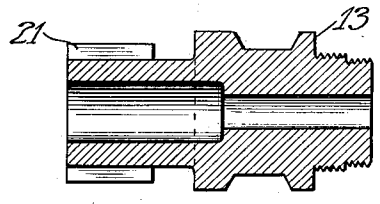


Fig. 11.

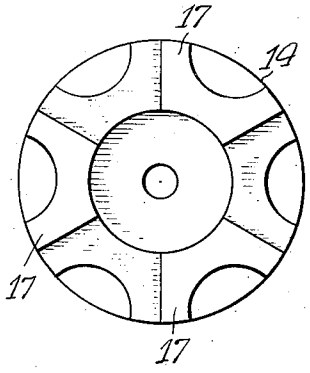


Fig. 12.

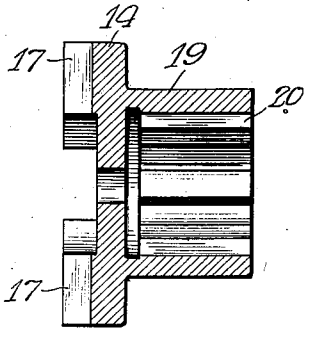


Fig. 13.

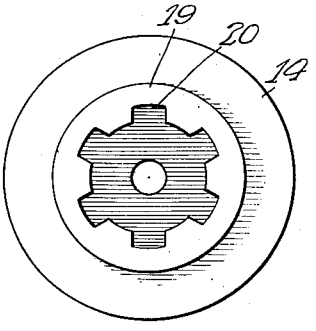
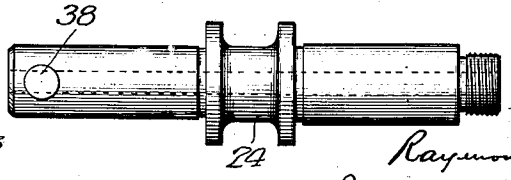


Fig. 14.



Witness

Martin H. Olsen.

Inventor

Raymond P. Lansing

By Rector, Hibben Davis & Macauley

His Attys

Patented Dec. 10, 1929 1,739,469

UNITED STATES PATENT OFFICE

RAYMOND P. LANSING, OF MONTCLAIR, NEW JERSEY, ASSIGNOR TO ECLIPSE MACHINE COMPANY, OF ELMIRA, NEW YORK, A CORPORATION OF NEW YORK

ENGINE STARTER

Application filed September 28, 1925. Serial No. 59,113.

My invention relates to engine starting apparatus for the starting of engines such as internal combustion engines and more particularly, but not necessarily, airplane engines, and the object thereof is to provide a simple, efficient and reliable apparatus for either manual or power operation or both and characterized by the provision of inertia means which are actuated by such power means or manual means for the accumulation and storing of energy which is thereupon utilized by the application thereof to the engine for cranking the same, and further characterized by the provision of means for disconnecting the power means such as an electric motor when the manual means are operated and still further characterized in the construction hereinafter described by the provision of novel and efficient clutch mechanism, whereby the inertia means is operatively connected at the will of the operator with a member of the engine to be started and the energy of such inertia means is transmitted to such engine member and the engine is thereby cranked.

In the drawings Fig. 1 is a perspective of my apparatus; Fig. 2 a vertical section thereof but taken on an irregular line in order to show the manual means in horizontal section; Fig. 3 a section on the line A—A of Fig. 2; Fig. 4 a section on line B—B of Fig. 2; Fig. 5 an elevation of one of the plates of the reduction gearing; Fig. 6 an elevation of the rotatable driving barrel with the friction disks removed; Figs. 7 and 8 detailed views of the screw sleeve or shell; Figs. 9 and 10 detailed views of the driving member within the screw sleeve but with its clutch member removed; Figs. 11, 12 and 13 detailed views of such clutch member and Fig. 14 a detailed view of the main shaft of the reduction gearing.

My apparatus comprises a transmission or drive having an element adapted to engage a member of the engine to be started and power means or a prime mover such as an electric motor and manually operated means. The power means and the manual means may be combined in the same apparatus and may be used separately or conjointly if desired and moreover either one or the other of these two power means may be dispensed with in respect to a complete apparatus, whereupon such apparatus would be operated either wholly by power means, or wholly by manual means.

The drive or transmission includes the drive proper and reduction gearing. First describing the drive proper the same is located within the main casing 1 which is suitably supported as by being detachably connected with the crank case 2 of the engine, a small portion of which is illustrated. Within a bushing 3 in the casing there rotates a driving barrel 4 and a shell 5 concentrically arranged therewithin and providing a considerable annular space between them to receive a yieldable driving connection which is here in the form of a friction clutch 6. This clutch is composed of two sets of clutch plates or disks which are splined respectively to the interior of the barrel and the exterior of the shell. The proper pressure for the disks is provided by a series of springs 7 located in such annular space and such pressure is regulated by the adjustable nut 8 screwing onto the outer end of the shell. The thrust of these springs tends to force the shell outwardly whereby the ring 9 clamps the disks together by forcing them against the ring 10 which bears against the annular internal flange 11 within the shell.

The shell 5 is provided with internal long lead threads 12 (Figs. 2 and 7) on which is threaded a screw shaft 13 which constitutes the main or body portion of the driving member whose other principal portion is a clutch member 14 which is adapted to engage a member of the engine to be started such as the corresponding clutch element 15 forming a part of or secured to a rotatable part of the engine such as the crank shaft 16 thereof. The clutch element 14 is in the form of a disk having clutch jaws 17 adapted to engage the complementary clutch jaws 18 on the engine member and provided with a hub or sleeve portion 19 which has a bearing fit within the shell 5 and which has internal longitudinal splines and grooves 20 cooperating with corresponding splines and grooves 21 on the outer end portion of the exterior of the screw shaft 13,

whereby the clutch element 14 and the screw shaft 13 have a relative longitudinal movement of limited degree independent of each other. The clutch element 14 is held in its outward position with a yielding pressure in suitable manner as by means of a coiled spring 22 which bears at its outer end against the bottom of the sleeve 19 and at its inner end against the bottom of a socket formed in the outer end of the screw shaft. The outward movement of the clutch element 14 is limited by the head of a rod 23 which passes centrally through the driving member parts and centrally through the main supporting shaft 24 of the reduction gearing, such rod being a manually operated rod terminating in a handle 25 at a point exterior of the apparatus and in the present instance being located adjacent the exterior of the casing of the manually operated means. In the present instance, for assembly purposes, this rod is made in two sections screwing together intermediate the length of the rod and provided at the point of juncture with a flange 26 bearing against the inner end of the screw shaft in order to limit the movement of the rod to the left with respect to the screw shaft, Fig. 2. The inner end of the screw shaft is provided with two nuts 27 the one nearest the end of the screw shaft being a lock nut and the other providing an abutment for the outward movement of the screw shaft against the internal shoulder 28 within the shell 5.

Next referring to the reduction gearing the same is contained within the main casing 1 and the cover plate 1^a by which such gearing is supported and in which it has its bearings. A main stationary internal gear 29 is secured by screws 30 to the casing 1 and with the same meshes a series of three planetary gears 31 which are journaled between two parallel plates 32 and 33. These plates are spaced apart by suitable lugs 34 on adjacent faces of these two plates and the same are held together by screws 35. The inner plate 33 is connected with the driving barrel 4 in suitable manner and in the present instance the same is splined to the inner end thereof through the splines 36 and grooves 37 cooperating with corresponding splines and grooves on the outer face of the plate 33. This plate 33 has a hub provided with longitudinal grooves adapted to receive the oppositely extending projections or pins 38 at the left hand end of the shaft 24 (Fig. 2) whereby such shaft and plate are detachably connected and the shaft is adapted to drive the plate and its attached gearing.

The pinions 31 mesh with a central pinion 39 which as shown and by preference is formed as a part of the hub 40 of a gear 41 mounted to rotate freely upon the shaft 24 through the bushing 42. This gear 41 meshes with a pinion 43 which as shown and by preference is formed upon the hub 44 of a beveled gear 45 which is mounted to rotate freely upon the shaft 46 through the medium of a bushing 47.

The right hand end of the shaft 24 (Fig. 2) is journaled in bearings 48 in the casing plate 1^a and extends therethrough and to such projecting end a beveled pinion 49 is secured. This pinion forms a part of the manual means and the same extends into a small casing 50 secured by screws 51 to the casing plate 1^a. In addition to this pinion 49 the manual means consists of a cranking shaft 52 extending extraneous of the casing 50 and thereat provided with suitable means as the pins 53 for engagement with an ordinary hand crank. This cranking shaft 52 is journaled in ball bearings 54 within the casing 50 and the same is held in proper position longitudinally by the nut 55 and collar 56. The shaft 52 is provided at its inner end with a beveled pinion 57 meshing with the corresponding pinion 49.

Describing the inertia means the same comprises a fly wheel and operating connections with the beveled gear 45 and with the prime mover which is here an electric motor, such inertia means being contained within and supported by a casing 58 which is secured to the main casing 1 in suitable manner as by the screws 59. The fly wheel comprises a rim 60 having the predetermined or desired mass or weight, a web 61 and a hub 62. This hub is drivingly secured as by splining to a vertical shaft 63 which is journaled in the bearings 64 in the casing 58 and has a bevel pinion meshing with gear 45. The fly wheel is held in proper position on the shaft 63 and with respect to its bearings by the nut 65. The outer surface of the hub is formed as one of the members 66 of a one-way or over-running clutch, the other rotatable member of which 67 is formed on the inner circumference of a shell 68 secured in suitable manner as by splining to the extended armature shaft 69 of an electric motor 70 and held in place thereon by the nut 71. The outer end of the armature shaft extends downwardly into the sleeve and is received by the socket 72 in the upper end of the shaft 63 acting as a bearing for such lower end of the armature shaft. The clutch may be of any desired type but in the present instance it is of the friction ball or roller type in which spring pressed balls or rollers 73 located in recesses in the clutch element 66 are employed to frictionally engage and grip the inner circumference of the other clutch element 67.

Describing a cycle of operation of the apparatus and starting first with the utilization of the power means or electric motor as the source of energy and with the parts in their normal position shown in Fig. 2 in which the clutch elements 14 and 15 are disengaged, when the motor is energized the shaft 63 will be rapidly rotated through the over-run-

ning clutch which is adapted to transmit torque in one direction only, and in the present instance from the electric motor to the shaft 63 and to the succeeding elements in the train of the transmission. The fly wheel is consequently rapidly rotated and when its R. P. M. reaches a predetermined figure such as in practice from fifteen thousand to twenty thousand the current may if desired be switched off from the electric motor and thereupon the rod 23 is manually moved inwardly, that is to the left in Fig. 2, and the screw shaft and its clutch element 14 are moved longitudinally and such clutch element is thereby advanced and brought into engagement with the other clutch element 15—and the engine is thereby cranked in view of the fact that the clutch element 14 is being rotated through the drive or transmission by means of the flywheel, and such rotation will continue so long as there is sufficient energy left in the fly wheel for that purpose. Describing transmission of torque from the shaft 63 through the reduction gearing and the drive proper, the rotation of the shaft 63 will rotate the gears 45 and 41 whereupon the central pinion 39 will be rotated and consequently the planetary pinions 31. As a result these latter pinions by reason of their meshing with the internal stationary gear 29 will cause the entire frame or cage by which they are supported consisting of the plates 32 and 33 to be rotated. Inasmuch as the plate 33 is drivingly connected to the driving barrel 4 the latter will be rotated and consequently the shell or nut 5 will be rotated through the medium of the friction clutch 6. Although the screw shaft 13 is screw threaded to the now revolving shell or nut 5 it will not advance longitudinally but will rotate with such shell and consequently the clutch element 14 will likewise be rotated. However, at this time such clutch element is in normal position that is out of engagement with the engine clutch element 15, but when the rod 23 is moved to the left (Fig. 2) as hereinbefore explained the screw shaft will be moved longitudinally whereupon said clutch elements will be brought into engagement and the torque or accumulated energy of the inertia means or fly wheel will be transmitted to the engine to crank the same.

When the engine starts on its own power the excess speed of rotation of the engine and its clutch element 15 will cause the screw shaft and its clutch element 14 to be retracted by the screw action between the screw shaft and its sleeve or nut 5 and thereby to become disengaged from the engine in automatic manner.

Next describing the manual means as the source of energy a hand crank is applied to the cranking shaft 52 and rotated by the operator first slowly until the fly-wheel gathers speed and thereupon more rapidly until the desired or predetermined R. P. M. of the fly wheel is reached. In this operation the torque is transmitted from the cranking shaft 52 through the pinions 57 and 49 to the shaft 24 and thence through the cage or frame of the planetary pinions 31 to the pinions 31 and 39 and gear 45 and thence to the shaft 63 and finally to the fly-wheel 60. In this operation owing to the presence of the one-way clutch the torque is not transmitted to the electric motor but such motor is disconnected from the shaft 63 and it will thereupon remain idle. This is of advantage inasmuch as the considerable load occasioned by the pressure of the brushes 74 upon the commutator 75 is removed from the cranking operation. This load is considerable owing to the fact that it is multiplied many times through the gearing described. The fly-wheel having now been rotated to the proper speed the rod 23 is operated and the engine cranked in the same manner as above explained.

The engagement between the clutch elements 14 and 15 is a yielding one owing to the provision of relative longitudinal movement between the clutch element 14 and the screw shaft. In case the clutch jaws do not register at the time of such advanced movement of the jaws 17 the clutch element 14 will be momentarily stopped but the screw shaft will continue its longitudinal movement and owing to such stoppage the screw shaft will rotate slightly and thereupon bring the clutch jaws 17 and 18 into register whereupon the spring 22 will snap the jaws 17 into engagement with the jaws 18.

The construction is such that the rotation of the clutch element 14 is in a direction the reverse of that of the cranking rotation, that is the direction of rotation of the nut 5, and consequently the actual engaging speed of the clutch element 14 is a resultant speed which is the difference between the forward speed and this backward speed of the clutch element 14, therefore, the engagement between the clutch jaws is at a low speed which is of considerable advantage.

In case of back fire of the engine or of any undue resistance of the engine during cranking operation the friction clutch 6 will slip and the parts of the apparatus will thereby be protected.

In the event that after the engine has once started but the explosions should then cease after the clutch jaws have become automatically disengaged, the rod 23 may be again operated to engage the clutch jaws for a second cranking operation, there being sufficient energy still available in the fly-wheel for another cranking operation, inasmuch as in practice a number of successive starts or crankings of large airplane engines may be obtained from one single accumulation of energy in the flywheel.

If, upon cranking, the engine should fail to start because of no explosions and the engine should come to rest with the clutch jaws in engagement, the construction is such that these jaws may be readily disengaged manually. Under said conditions, the operator draws the rod 23 to the right (Fig. 2) thereby first withdrawing the jaws 17 from mesh with jaws 18, because of relative movement of the clutch element 14 with respect to the screw shaft 13 against the tension of spring 22, and then when the body of such clutch element abuts the left hand end of the screw shaft, the entire screw shaft and clutch element are withdrawn to full extent to the right, that is to normal position.

I claim:

1. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device operatively connected with the driving member, power means and manual means operatively connected with the inertia device for actuating the same by either of such two means or by both combined, and means for automatically disconnecting the power means when the manual means alone is operated.

2. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device operatively connected with the driving member, power means and manual means operatively connected with the inertia device for actuating the same by either of such two means or by both combined, and a one way clutch for automatically disconnecting the power means when the manual means alone is operated.

3. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device operatively connected with the driving member, power means and manual means operatively connected with the inertia device for actuating the same by either of such two means or by both combined, said inertia device comprising a flywheel, and driving connections between the power means and the flywheel including a one-way clutch for driving only in the direction from the power means to the flywheel.

4. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device operatively connected with the driving member, power means and manual means operatively connected with the inertia device for actuating the same by either of such two means or by both combined, said inertia device comprising a flywheel and the power means comprising an electric motor, and driving connections between the motor and the flywheel including a one-way clutch for driving only in the direction from the motor to the flywheel.

5. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device operatively connected with the driving member, power means and manual means operatively connected with the inertia device for actuating the same by either of such two means or by both combined, said power means comprising an electric motor having an extended armature shaft, and said inertia device comprising a flywheel mounted to rotate concentric of such extended portion of the armature shaft and operatively connected therewith.

6. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device operatively connected with the driving member, power means and manual means operatively connected with the inertia device for actuating the same by either of such two means or by both combined, said power means comprising an electric motor having an extended armature shaft, and said inertia device comprising a flywheel, and driving connections between the flywheel and such armature shaft including means for driving only in a direction from the motor to the flywheel.

7. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device operatively connected with the driving member, power means and manual means operatively connected with the inertia device for actuating the same by either of such two means or by both combined, said power means comprising an electric motor having an extended armature shaft, and said inertia device comprising a flywheel, and driving connections between the flywheel and such armature shaft including means for driving only in a direction from the motor to the flywheel, said last named means consisting of a one-way clutch, one member of which is connected with the armature shaft and the other member of which is connected with the flywheel.

8. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device operatively connected with the driving member, power means and manual means operatively connected with the inertia device for actuating the same by either of such two means or by both combined, said power means comprising an electric motor having an extended armature shaft and said inertia device comprising a flywheel composed of a rim, a web and a central hub concentric of such shaft, and driving connections between the shaft and hub including an automatic disconnect means for disconnecting

the motor when the manual means alone is operated.

9. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device operatively connected with the driving member, power means and manual means operatively connected with the inertia device for actuating the same by either of such two means or by both combined, said power means comprising an electric motor having an extended armature shaft and said inertia device comprising a flywheel composed of a rim, a web and a central hub concentric of such shaft, and driving connections between the shaft and hub including a one-way clutch, one member of which is connected with the shaft and the other of which is connected with the hub of the flywheel.

10. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device operatively connected with the driving member, power means and manual means operatively connected with the inertia device for actuating the same by either of such two means or by both combined, said power means comprising an electric motor having an extended armature shaft and said inertia device comprising a flywheel composed of a rim, a web and a central hub concentric of such shaft, and driving connections between the shaft and hub including a friction ball clutch, one member of which is connected with the shaft and the other of which is connected with the hub of the flywheel.

11. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, reduction gearing which is operatively connected with the driving member and which includes a shaft, power means and manual means operatively connected with said gearing, said power means comprising an electric motor having an extended armature shaft, an inertia device connected with said gearing shaft and arranged concentric of the armature shaft, and driving connections between the armature shaft and the inertia device.

12. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, reduction gearing which is operatively connected with the driving member and which includes a shaft, power means and manual means operatively connected with said gearing, said power means comprising an electric motor having an extended armature shaft, an inertia device connected with said gearing shaft and arranged concentric of the armature shaft, and driving connections between the armature shaft and the inertia device, including means for disconnecting the armature shaft when the manual means alone is operated.

13. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, reduction gearing which is operatively connected with the driving member and which includes a shaft, power means and manual means operatively connected with said gearing, said power means comprising an electric motor having an extended armature shaft, an inertia device connected with said gearing shaft and arranged concentric of the armature shaft, said gearing shaft having an end socket into which the outer end of the armature shaft extends, and a one-way driving connection between the armature shaft and the inertia device.

14. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, reduction gearing which is operatively connected with the driving member and which includes a shaft, power means and manual means operatively connected with said gearing, said power means comprising an electric motor having an extended armature shaft, an inertia device connected with said gearing shaft and arranged concentric of the armature shaft, said gearing shaft having an end socket into which the outer end of the armature shaft extends, and said inertia device comprising a flywheel having a hub connected with the gearing shaft, and a one-way clutch, one member of which is connected with the said hub and the other of which is connected with the armature shaft.

15. In an engine starter, a drive including a rotatable inertia device, means for rotating said device, a driving member adapted to engage and crank a member of the engine to be started and operatively connected with the inertia device, said driving member including a relatively movable clutch element adapted to engage such engine member but normally out of engagement therewith, and means for moving the clutch element into such engagement at the will of the operator and means responsive to starting torque to maintain such clutch-engagement.

16. In an engine starter, a drive including a rotatable inertia device, means for rotating said device, a driving member adapted to engage and crank a member of the engine to be started and operatively connected with the inertia device, said driving member including a relatively movable clutch element adapted to engage such engine member, and means for moving the clutch element into such engagement at the will of the operator and automatic means between such clutch-element and the inertia device for disengaging such driving member when the engine operates under its own power.

17. In an engine starter, a drive including

a rotatable inertia device, means for rotating said device, a driving member adapted to engage and crank a member of the engine to be started and operatively connected with the inertia device, said driving member including a relatively movable clutch element adapted to engage such engine member, means included in the operative connections between said clutch-element and said inertia device for retracting the clutch-element when the engine operates under its own power, and means for moving the clutch element into such engagement at the will of the operator, such last named means comprising a manually operated rod connected with said driving member.

18. In an engine starter, a drive including a rotatable inertia device, means for rotating said device, a driving member adapted to be moved to engage and crank a member of the engine to be started and operatively connected with the inertia device, said driving member including a body portion and a clutch element connected therewith for movement laterally and adapted to engage such engine member, and means for moving the clutch element into such engagement at the will of the operator.

19. In an engine starter, a drive including a rotatable inertia device, means for rotating said device, a driving member adapted to be moved to engage and crank a member of the engine to be started and operatively connected with the inertia device, said driving member including two parts, to-wit, a body portion and a clutch element splined to each other for relative movement, one with respect to the other, and means for moving the clutch element into engagement with the engine member at the will of the operator.

20. In an engine starter, a drive including a rotatable inertia device, means for rotating said device, a driving member adapted to engage and crank a member of the engine to be started and operatively connected with the inertia device, said driving member including two parts, to-wit, a body portion and a clutch element splined to each other for relative movement, one with respect to the other, and means for moving the clutch element into engagement with the engine member at the will of the operator, and yielding means for normally holding said two parts extended.

21. In an engine starter, a drive including a rotatable inertia device, means for rotating said device, a driving member adapted to engage and crank a member of the engine to be started and operatively connected with the inertia device, said driving member including two parts, to-wit a body portion and a clutch element splined to each other for relative movement, one with respect to the other, and a manually operated rod passing through said body portion and clutch element and adapted to advance the driving member into engagement with the engine member.

22. In an engine starter, a drive including a rotatable inertia device, means for rotating said device, a driving member adapted to engage and crank a member of the engine to be started and operatively connected with the inertia device, said driving member including two parts, to-wit a body portion and a clutch element splined to each other for relative movement, one with respect to the other, and a manually operated rod passing through said body portion and clutch element and adapted to advance the driving member into engagement with the engine member, said rod having means to limit the relative movement of the two parts of the driving member.

23. In an engine starter, a drive including a rotatable inertia device, means for rotating said device, a driving member adapted to engage and crank a member of the engine to be started and operatively connected with the inertia device, said driving member including two parts to-wit a body portion and a clutch element splined to each other for relative movement, one with respect to the other, and a manually operated rod passing through said body portion and clutch element and adapted to advance the driving member into engagement with the engine member said rod having means for engagement with the body portion to thereby advance the clutch element into engagement.

24. In an engine starter, a drive including a rotatable inertia device, means for rotating said device, a driving member adapted to engage and crank a member of the engine to be started and operatively connected with the inertia device, transmission mechanism between said inertia device and the driving member including a rotatable shell, screw action means between the shell and driving member, said driving member including a relatively movable clutch element adapted to engage such engine member, and means for moving the clutch element into such engagement at the will of the operator.

25. In an engine starter, a drive including a rotatable inertia device, means for rotating said device, a driving member adapted to engage and crank a member of the engine to be started and operatively connected with the inertia device, transmission mechanism between said inertia device and the driving member including a rotatable shell having internal screw threads, said driving member being contained within the shell and comprising a body portion having corresponding screw threads and also comprising a clutch member movable relatively to the body portion, and means for moving the clutch element into engagement with the engine member at the will of the operator.

26. In an engine starter, a drive including a rotatable inertia device, means for rotating said device, a driving member adapted to engage and crank a member of the engine to be started and operatively connected with the inertia device, transmission mechanism between said inertia device, and the driving member including a rotatable shell having internal screw threads, said driving member being contained within the shell and comprising a body portion having splines at one end and screw threads intermediate its length engaging the other screw threads and also comprising a clutch element splined to said body portion by said splines, and means for moving the driving member into engagement with the engine member at the will of the operator.

27. In an engine starter, a drive including a rotatable inertia device, means for rotating said device, a driving member adapted to engage and crank a member of the engine to be started and operatively connected with the inertia device, transmission mechanism between said inertia device and the driving member including a rotatable shell having internal screw threads, said driving member being contained within the shell and comprising a body portion having splines at one end and screw intermediate its length engaging the other screw threads and also comprising a clutch element having clutch means to engage the engine member and a sleeve portion splined to said body portion by said splines and bearing within the shell, and means for moving the driving member into engagement with the engine member at the will of the operator.

28. In an engine starter, a drive including a rotatable inertia device, means for rotating said device, a driving member adapted to engage and crank a member of the engine to be started and operatively connected with the inertia device, transmission mechanism between said inertia device and the driving member including a rotatable shell having internal screw threads, said driving member being contained within the shell and comprising a body portion having splines at one end and screw intermediate its length engaging the other screw threads and also comprising a clutch element having clutch means to engage the engine member and a sleeve portion splined to said body portion by said splines and bearing within the shell, and a rod passing through said body portion and the clutch element for moving them into engagement with the engine member at the will of the operator.

29. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, a fly wheel, means for rotating the fly wheel to store energy therein, and reduction gearing between such fly wheel and the driving member comprising a stationary internal gear, a central pinion driven by the fly wheel, a series of planetary pinions meshing with said central pinion, a rotatable frame in which the planetary pinions are mounted, said frame being operatively connected with the driving member.

30. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device, means for operating such device, and reduction gearing between such inertia device and the driving member comprising a stationary internal gear, a central pinion driven by the inertia device, a series of planetary pinions meshing with said central pinion, a rotatable frame in which the planetary pinions are mounted, a rotatable barrel to which such frame is drivingly connected a rotatable shell which is operatively connected with and driven by the barrel, and which is also operatively connected with the driving member, and manual means drivably connected to said barrel for actuating the inertia device to store energy therein.

31. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device, power means for operating such device, and reduction gearing between such inertia device and the driving member comprising a stationary internal gear, a central pinion driven by the inertia device, a series of planetary pinions meshing with said central pinion, a rotatable frame in which the planetary pinions are mounted, a rotatable barrel to which such frame is drivingly connected, a rotatable shell which is operatively connected with and driven by the barrel, said shell having screw threads on its interior and said driving member having external screw threads cooperating with the other screw threads, and manual means for rotating the inertia device to store energy therein.

32. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device, means for operating such device, and reduction gearing between such inertia device and the driving member comprising a stationary internal gear, a central pinion driven by the inertia device, a series of planetary pinions meshing with said central pinion, a rotatable frame in which the planetary pinions are mounted, a shaft on which the central pinion is mounted, and a manually operated rod extending through such shaft and engaging the driving member for operating the latter.

33. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device, power means for operating such device, and reduction gearing between such inertia device and the driving member com-

prising a stationary internal gear, a central pinion driven by the inertia device, a series of planetary pinions meshing with said central pinion, a rotatable frame in which the planetary pinions are mounted, a shaft on which the central pinion is mounted and which is operatively connected with said frame, and manually operated means for rotating the shaft.

34. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device, means for operating such device, and reduction gearing between such inertia device and the driving member comprising a stationary internal gear, a central pinion driven by the inertia device, a series of planetary pinions meshing with said central pinion, a rotatable frame in which the planetary pinions are mounted, a shaft on which the central pinion is mounted and which is operatively connected with said frame, a manually operated rod extending through such shaft and engaging the driving member for operating the latter, and manually operated means for rotating the shaft.

35. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device, means for operating such device, and reduction gearing between such inertia device and the driving member comprising a stationary internal gear, a central pinion driven by the inertia device, a series of planetary pinions meshing with said central pinion, a rotatable frame in which the planetary pinions are mounted, a shaft on which the central pinion is mounted and which is operatively connected with said frame, manually operated means for rotating the shaft, and power means for rotating the inertia device.

36. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device, means for operating such device, and reduction gearing between such inertia device and the driving member comprising a stationary internal gear, a central pinion driven by the inertia device, a series of planetary pinions meshing with said central pinion, a rotatable frame in which the planetary pinions are mounted, a shaft on which the central pinion is mounted and which is operatively connected with said frame, manually operated means for rotating the shaft, and an electric motor for directly rotating the inertia device.

37. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, an inertia device, means for operating such device, and reduction gearing between such inertia device and the driving member comprising a stationary internal gear, a central pinion driven by the inertia device, a series of planetary pinions meshing with said central pinion, a rotatable frame in which the planetary pinions are mounted, a shaft on which the central pinion is mounted and which is operatively connected with said frame, manually operated means for rotating the shaft and thereby rotating the inertia device through the reduction gearing, an electric motor for directly rotating the inertia device, and an over-running clutch between the motor and the inertia device.

38. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, reduction gearing operatively connected with the driving member, an inertia device in the form of a fly-wheel operatively connected with the reduction gearing, an electric motor directly connected to the flywheel, and manual means connected to the flywheel indirectly through the reduction gearing.

39. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, means for actuating the driving member, manually operated means for moving such driving member into engagement with the engine member and for disengaging the same therefrom in the event that the engine does not start after cranking but comes to rest with said parts in engagement, and automatic means between said driving member and said actuating means for disengaging the driving member from the engine member when the engine operates under its own power.

40. In an engine starter, a drive including a two-part longitudinally movable driving member having a clutch element movable longitudinally relatively of its other part and adapted to engage and crank a member of the engine to be started, means for actuating the driving means, and manually operated means for moving the entire driving member longitudinally in one direction to bring its clutch element into engagement with the engine member and for moving the clutch element independently in the opposite direction for disengagement purposes.

41. In an engine starter, a drive including a longitudinally movable driving member having at one end a clutch element movable longitudinally thereof and adapted to engage and crank a member of the engine to be started, means for actuating the driving means, yieldable means for holding such clutch element and driving member extended, and manually operated means for moving the entire driving member longitudinally in one direction to bring its clutch element into engagement with the engine member and for moving the clutch element independently in the opposite direction against such yieldable means for disengagement purposes.

42. In an engine starter, a drive including a longitudinally movable driving member having a clutch element movable longitudinally thereof and adapted to engage and crank a member of the engine to be started, means for actuating the driving member, and a manually operated rod extending through the driving member and its clutch element and having means for moving them longitudinally in one direction to bring the clutch element into engagement with the engine member and for moving such clutch element in the opposite direction to disengage it from the engine member.

43. In an engine starter, a drive including a longitudinally movable driving member having a clutch element movable longitudinally thereof and adapted to engage and crank a member of the engine to be started, means for actuating the driving member, and a manually operated rod extending through the driving member and its clutch element said rod having intermediate its length a projection for moving said driving member and its clutch element longitudinally in one direction to bring the clutch element into engagement with the engine member and having at one end a projection for moving said clutch element longitudinally to disengage it from the engine member.

44. In an engine starter, a drive including a longitudinally movable driving member having a clutch element movable longitudinally thereof and adapted to engage and crank a member of the engine to be started, means for actuating the driving member, and a manually operated rod extending through the driving member and its clutch element and having means for moving them longitudinally in one direction to bring the clutch element into engagement with the engine member and for moving such clutch element in the opposite direction to disengage it from the engine member said clutch element having a longitudinal movement relative to the driving member.

45. In an engine starter, a drive including a longitudinally movable driving member having a clutch element movable longitudinally relatively thereof and adapted to engage and crank a member of the engine to be started, means for actuating the driving means, and manually operated means for moving the entire driving member longitudinally in one direction to bring its clutch element into engagement with the engine member and for moving the clutch element independently in the opposite direction for disengagement purposes said clutch element being splined to the driving member for independent longitudinal movement with respect thereto.

46. In an engine starter, a drive including a longitudinally movable driving member having a clutch element movable longitudinally relatively thereof and adapted to engage and crank a member of the engine to be started, means for actuating the driving means, and manually operated means for moving the entire driving member longitudinally in one direction to bring its clutch element into engagement with the engine member and for moving the clutch element independently in the opposite direction for disengagement purposes and a spring interposed between the driving member and clutch element for holding them extended.

47. In an engine starter, a drive including a longitudinally movable driving member having a clutch element movable longitudinally thereof and adapted to engage and crank a member of the engine to be started, means for actuating the driving member, and a manually operated rod extending through the driving member and its clutch element and having means for moving them longitudinally in one direction to bring the clutch element into engagement with the engine member and for moving such clutch element in the opposite direction to disengage it from the engine member and yieldable means for holding the driving member and clutch element extended, said end projection of the rod limiting such extension.

48. In an engine starter, a drive including a rotatable inertia device, means for rotating such device, a driving member adapted to engage and crank a member of the engine to be started, manually operated means concentric of the driving member for moving such driving member into engagement with the engine member after the inertia device has been brought up to speed and for disengaging the same therefrom in the event that the engine does not start after cranking but comes to rest with said parts in engagement, and means between said driving member and inertia device for automatically disengaging said driving member from said engine when the engine operates under its own power.

49. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, means for actuating the driving member, manually operated means concentric of the driving member for disengaging the driving member from the engine member in the event that the engine does not start after cranking but comes to rest with said parts in engagement, and means between said driving member and said actuating means for automatically disengaging said driving member from said engine member when said engine operates under its own power.

50. In an engine starter, in combination with an engine having a clutch element, a driving member having a complementary clutch element adapted to engage the other clutch element and to thereby crank the engine, means for actuating the driving mem-

ber including means for disengaging said clutch-elements when said engine operates under its own power and manually operated means concentric of the driving member for disengaging the clutch elements in the event that the engine does not start after cranking but comes to rest with the clutch elements in engagement.

51. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, a rotatable inertia device operatively connected with the driving member, means for rotating the inertia device, and transmission mechanism between such device and said means including structure for transmitting torque in a direction only from said means to said device.

52. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, a rotatable inertia device operatively connected with the driving member, an electric motor for rotating the inertia device, and transmission mechanism between the motor and inertia device and adapted to transmit torque in a direction only from the motor to said device.

53. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, a rotatable inertia device operatively connected with the driving member, an electric motor for rotating the inertia device, and transmission mechanism between the motor and inertia device including means for disconnecting the motor from said device when the latter is otherwise driven.

54. In an engine starter a drive including a driving member adapted to engage and crank a member of the engine to be started, a rotatable inertia device operatively connected with the driving member, power means and manual means for rotating the inertia device, transmission mechanism between the manual means and the inertia device, and transmission mechanism between the power means and the inertia device including means for operatively disconnecting the power means from said device when the manual means only is operated.

55. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, a rotatable inertia device operatively connected with the driving member, power means and manual means for rotating the inertia device, and transmission mechanism between the power means and said device for automatically establishing driving relation therewith when such power means is operated and for automatically disestablishing such driving relation when the manual means alone is the one operated.

56. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, a rotatable inertia device operatively connected with the driving member, power means and manual means for rotating the inertia device, and transmission mechanism between the power means and said device including a one way clutch for transmitting torque in a direction only from the power means to said device and for disestablishing driving relation between them when the manual means only is the one operated.

57. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, mechanism for actuating the driving member such mechanism including, means for yieldingly holding such driving member into engagement with the engine member, and manually operated means for disengaging said members at the will of the operator.

58. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, mechanism for actuating the driving member, means combined with said actuating mechanism to receive power therefrom for automatically establishing the final stage of the driving relation of the driving member with the engine member and for yieldingly holding said members into engagement, and manually operated means for disengaging said members at the will of the operator.

59. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, mechanism for actuating the driving member, screw action means between said mechanism and said driving member for holding such driving member into engagement with the engine member, and manually operated means for disengaging said members at the will of the operator.

60. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, mechanism for actuating the driving member, screw action means between said mechanism and said driving member for automatically establishing the final stage of the driving relation of the driving member with the engine member and for holding said members into engagement, and manually operated means for disengaging said members at the will of the operator.

61. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, mechanism for actuating the driving member, manually operated means for moving the driving member to a position of engagement with the engine member and for thereby establishing the first stage of the driving relation of said members and for disengaging said members at the will of the operator,

and means for automatically establishing the final stage of the driving relation between said members.

62. In an engine starter, a drive including a driving member adapted to engage and crank a member of the engine to be started, mechanism for actuating the driving member, screw action means between said mechanism and said driving member for automatically establishing the final stage of the driving relation of said members and for holding said members into engagement, and manually operated means for establishing the first stage of such driving relation and for disengaging said members at the will of the operator.

63. In an engine starter, a drive including a two part driving member, one part being an engagement member adapted to engage a member of the engine to be started and the other part being a control member which is mounted for longitudinal and rotary movement and which is connected to rotate with the engagement member, means for actuating the control member, and means for withdrawing the engagement member from its engagement with the engine member without movement of the control member.

64. In an engine starter, a drive including a two part driving member, one part being an engagement member adapted to engage a member of the engine to be started and the other part being a control member which is mounted for longitudinal and rotary movement and which is connected to rotate with the engagement member, screw action means for assuring full longitudinal travel of the control member for engagement purposes and for rotating such control member and engagement member, and means for withdrawing the engagement member from its engagement with the engine member without movement of the control member.

65. In an engine starter, a drive including a two part driving member, one part being an engagement member adapted to engage a member of the engine to be started and the other part being a control member which is mounted for longitudinal and rotary movement and which is connected to rotate with the engagement member, means for actuating the control member, and means for shifting the engagement member longitudinally and relatively to the control member for withdrawing such engagement member from its engagement with the engine member.

RAYMOND P. LANSING.