

Sept. 4, 1928.

1,682,971

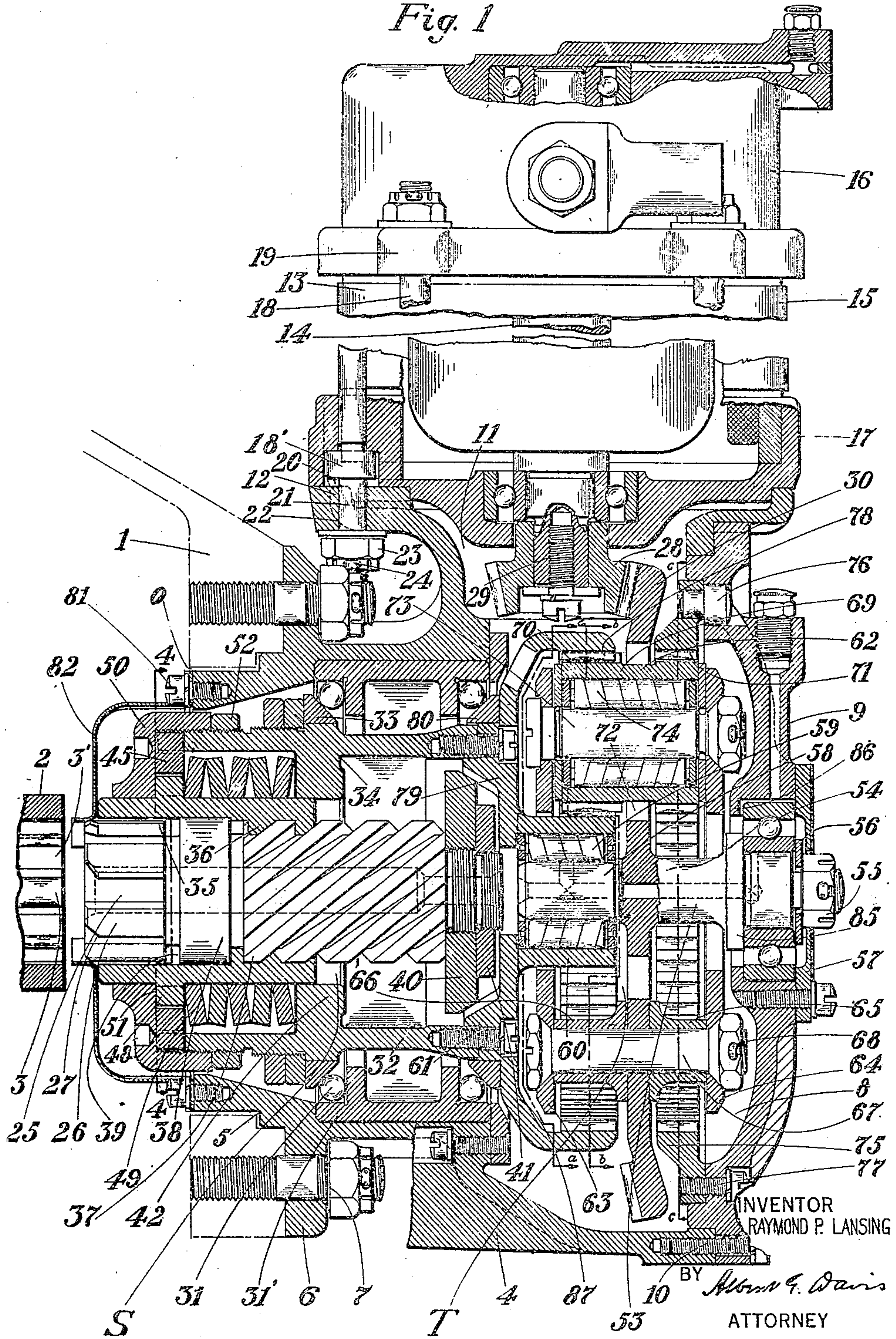
R. P. LANSING

ENGINE STARTING APPARATUS

Filed June 30, 1919

2 Sheets-Sheet 1

Fig. 1



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2 Sheets-Sheet 2

Fig. 2

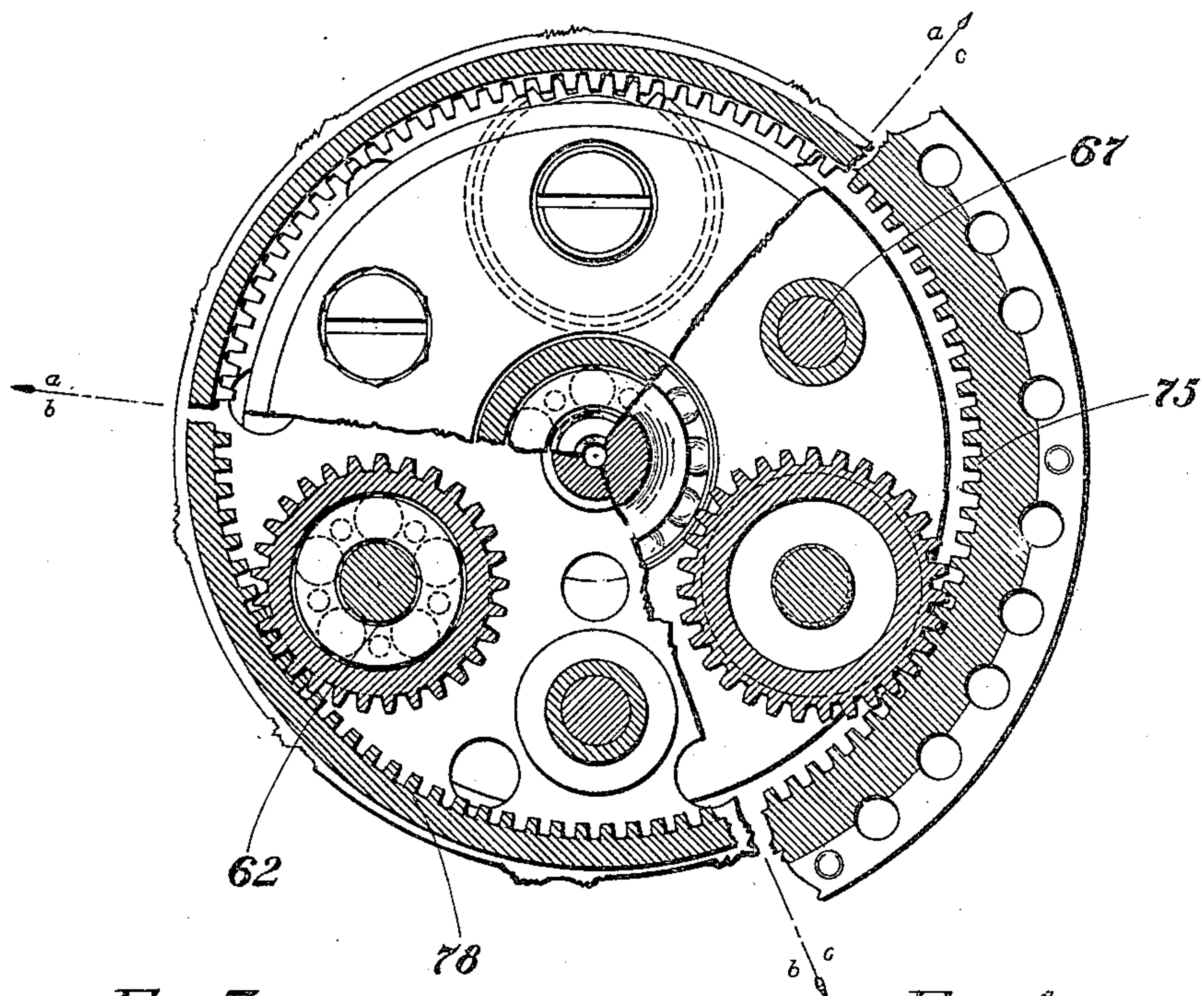


Fig. 3

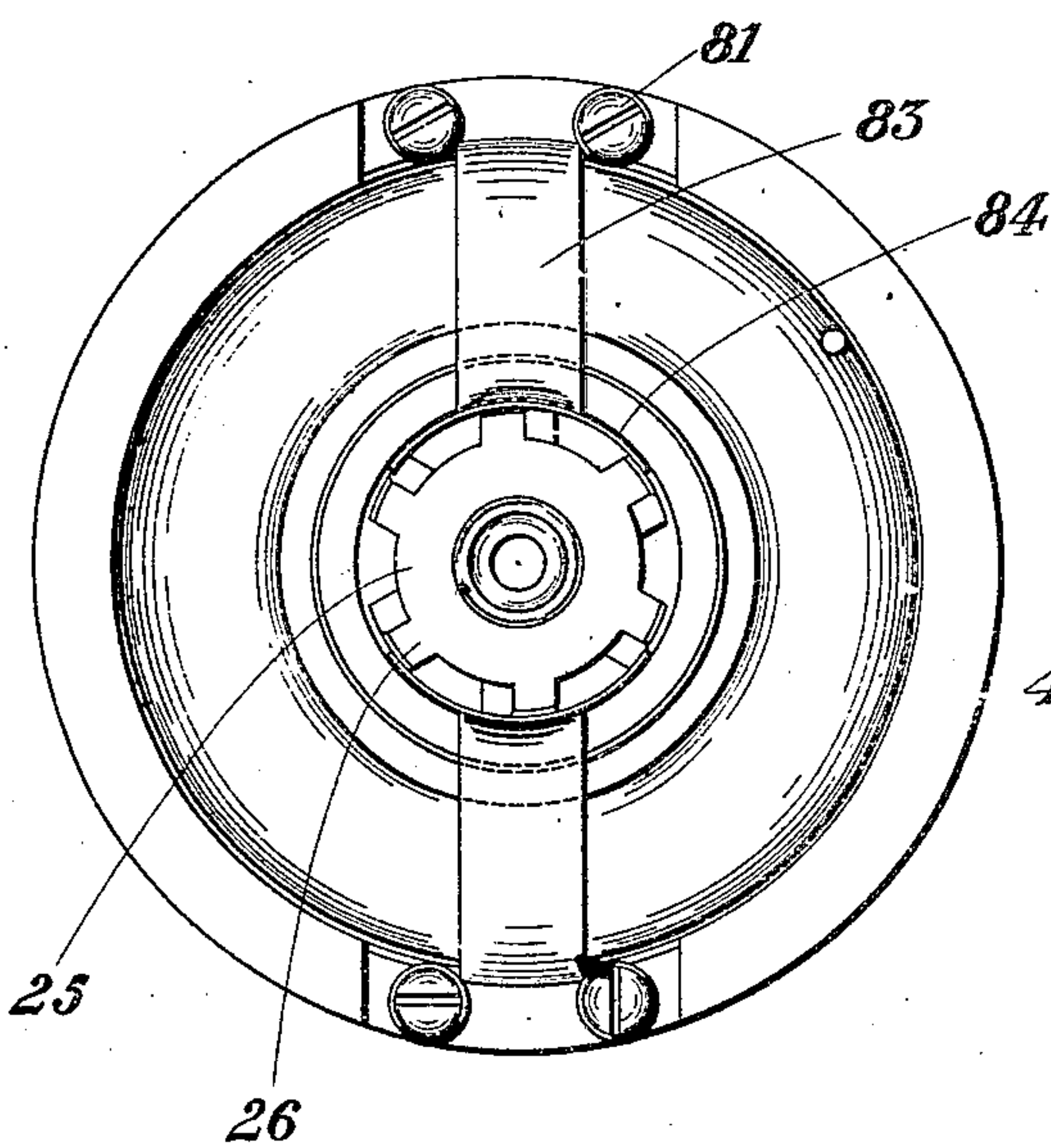
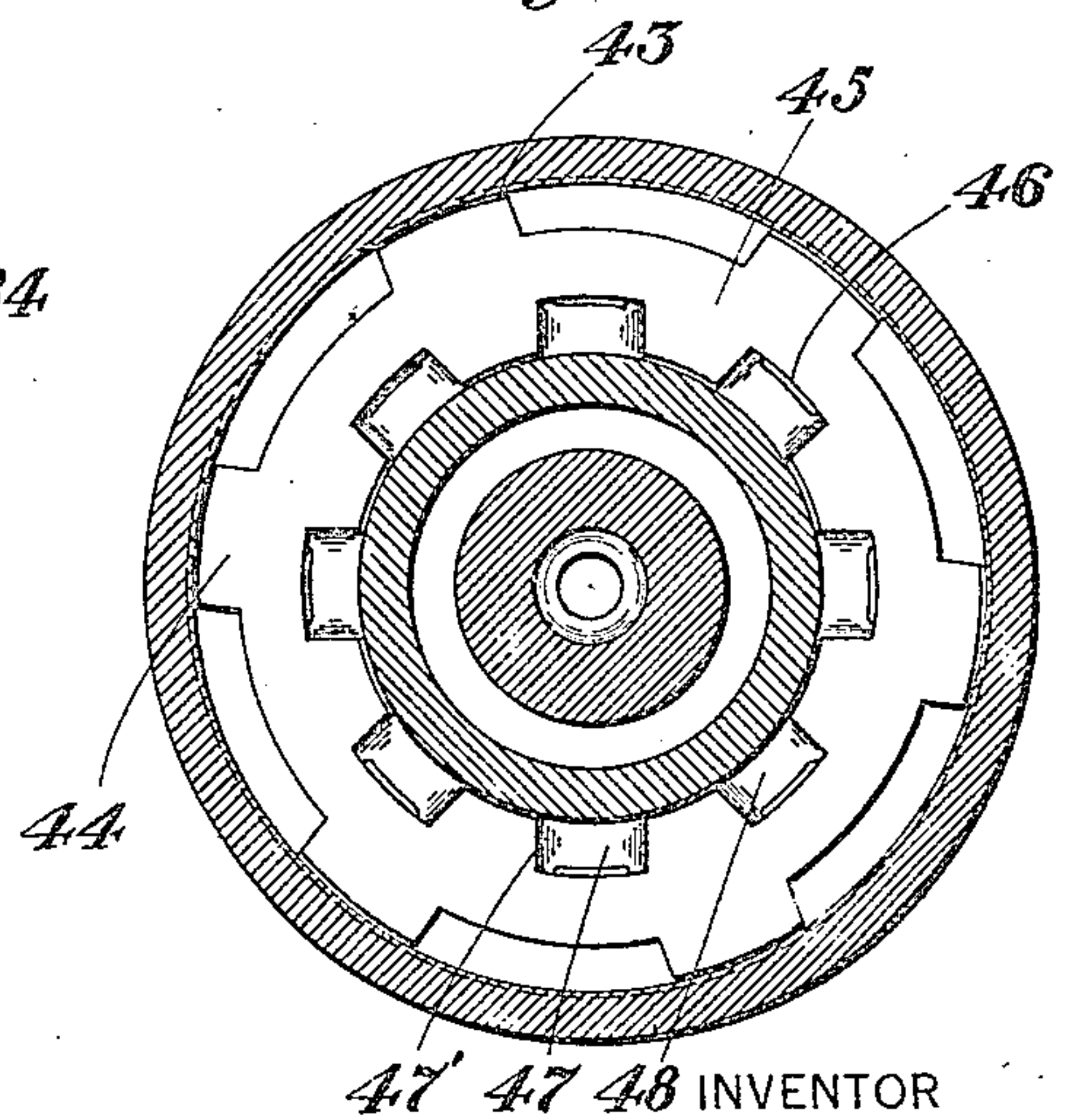


Fig. 4



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ENGINE-STARTING APPARATUS.

Application filed June 30, 1919. Serial No. 307,713.

This invention relates to starting apparatus and with regard to the more specific features thereof, to means for starting internal combustion engines.

One of the objects is to provide practical, reliable, and compact means for starting a source of power.

Another object is to provide apparatus of the above type of simple, durable and light construction which shall, without damage to the parts, withstand even unusually adverse cranking conditions of the engine.

Another object is to provide apparatus of the above type which shall be convenient in control and whose action is automatic.

Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings wherein is shown one of the various possible embodiments of the several features of this invention, Fig. 1 is a fragmentary view of an engine with my starter applied thereto shown in longitudinal section with parts in elevation. Fig. 2 shows a sectional view of my reduction gearing taken along the lines *a-a*, *b-b* and *c-c*, of Fig. 1 with parts broken away for each section to show corresponding sector views of the gearing. Fig. 3 is an end view of the transmission of my starter viewed from the engine end, and Fig. 4 is a sectional view taken along the line 4-4 of Fig. 1.

Similar reference characters refer to similar parts throughout the different views of the drawings.

This invention is an improvement upon that of the copending application of Roland Chilton, Serial No. 274,938, filed February 4th, 1919. The invention, in common with that of the said application is particularly applicable to engines having hollow crankshaft members and has its especial use in connection with airplane engines. The invention, however, is also applicable to advantage to other types of engines incapable of starting under their own power whether station-

ary or for propelling vehicles and without regard to the crankshaft construction.

Referring now to the drawings I have shown a portion 1 of the crankcase of an engine having therein a crankshaft at the extreme rear end of which I provide a splined socket portion 2, comprising a number of equidistant internal splines 3 separated by grooves 3¹ therebetween rectangular, in cross-section. The specific manner of applying the splined socket to the engine taken by itself is no part of this invention and is, therefore, neither shown nor described. The arrangement disclosed in the copending application above referred to may be employed to advantage in this case.

The crankcase is preferably provided with a faced end having a circular opening O therein, with its center on the prolonged axis of the socket portion 2. The starter unit comprises a casting 4 having a pilot 5 extending into and substantially lining the opening O in the crankcase and having a flange 6 fitting against the faced end of the crankcase and bolted thereto as at 7. The opposite end of the casting 4 is open as at 8 and a separable head 9 bolted to the casting as at 10 closes said open end. The upper end of the casting 4 has an opening 11 bounded by a circular flange 12 adapted to support the starting motor 13 with the shaft 14 of the latter in vertical position.

The motor is preferably an electric one of the series wound type, the detailed construction of which is no part of this invention. This motor preferably includes a yoke 15, an upper end head 16, and a lower end head 17, the two end heads being secured together by bolts 18 passing through integral lugs 19 in said heads. The lower end of each bolt 18 has a flange 18¹ countersunk within an opening 20 in end head 17 and each bolt has an extension 21 projecting beyond said head. The assembled motor with projecting bolts 21 is secured to casting 4 by passing the bolt extensions 21 into corresponding openings 22 in the flange 12, and bolting the motor in place by threading nuts 23 upon the free ends of the bolt extensions and locking them in place by cotter pins or the like 24.

Aligned with splined socket portion 2 I provide a toothed driving member 25 having

splines 26 adapted to enter into the grooves 3¹ between the splines 3 for clutching engagement with the socket member 2 but normally out of engagement therewith. Each of the splines is preferably beveled as at 27 in the manner and for the purpose of the co-

As my starter is shown mounted on the rear end of the engine, I will in the description of its details designate the portion of any element nearer the engine, as the forward and that remote therefrom as the rear end or portion thereof.

Between the motor 13 and the driving member 25 I interpose a transmission preferably comprising torque multiplying mechanism driven by the motor and designated in its entirety by letter T, and mechanism responsive to the starting of the motor, for shifting driving member 25 into mesh with socket member 2, and then transmitting torque, said latter mechanism being designated in its entirety by letter S. Mechanism S will now be described.

Within a cylindrical wall in the casting 4 and coaxial with the driving member 25 I provide the outer race 31¹ of a ball bearing 31 within which is journaled a barrel member 32. The inner race 33 of bearing 31 may be maintained in place by lock nuts 34 on the barrel at one side of the bearing. Within the barrel and concentric therewith I preferably provide a cylindrical hub nut or internally screw threaded sleeve 35 extending beyond the inner end of the barrel having its nut or threaded portion at the rear end as shown at 36 and having a smooth bore 39 at its forward portion. Threaded into the nut is a screw shaft 37, having the driving member 25 at its forward end as an integral part thereof. An integral guide pilot 38 for the screw shaft is interposed between the threaded part and the driving member and fits within the smooth bore 39 of the hub. The threads 37 are preferably sufficiently steep to render the driving member incapable of arresting axial pressure. At the rear end of screw shaft 37 there is preferably threaded a stop plate 40 locked in place by a lock nut 41. This stop plate is adapted to contact when the driving member is in mesh, with an inwardly extending ledge or flange 42 integral with the barrel.

The barrel is connected to transmit driving torque to the hub nut 35 through a special form of dog clutch which will now be described. This clutch includes a splined plate 45 having splines 44 fitting into corresponding recesses 43 in the forward end of the barrel, the said spline plate having rectangular recesses 46 in its inner periphery for lodging splines 47 formed on a flange 48 integral with the hub nut 35. Splines 47 are preferably, laterally rounded on both edges as at 47¹ at their forward end. Encircling the hub

nut 35 and interposed between flange 48 on the hub nut and flange 42 within the barrel I provide a plurality of annular dished washers 49 preferably of a tough alloy spring steel. A cap 50 is threaded over the free end of the barrel, and locked thereto by a lock nut as at 52, and has a rim encircling the hub nut as at 51 thus keeping the clutch and associated parts in assembled relation.

Referring now to the torque multiplying mechanism T, there is preferably provided a bevel pinion 28 secured to the lower end of motor shaft 14 by any desired means as at 29 and meshing with a bevel gear 30 at right angles to the pinion. Gear 30 has a central integral axle in line with screw shaft 37 the rearwardly extending portion 53 of which axle is journaled within a ball bearing 54 limited against displacement in one direction by a flange 85 in the axle, and by a shoulder 86 in the cover 9. A washer 56 is interposed between the bearing and the nut 55 which latter is threaded onto the free end of the axle and locked in place by any appropriate means. A cover plate 57 serves to prevent access to the ball bearing.

The forwardly extending axle portion 58 of gear 30 is journaled within a roller bearing 59 lodged within a journal box 60 forming an integral part of a plate 87, said plate being rigidly attached by means of screws 61 or the like to the barrel 32, of the mechanism S.

The gear 30 forms a spider for carrying a set of preferably three planetary gear units 62 in a manner now to be described. A pair of spider plates 63 and 64 are secured to the spider 30 in spaced relation therefrom one on each side thereof. For this purpose I provide at each of preferably three equidistant points, a bolt 67 extending transversely through spider plate 63, spider 30 and spider plate 64. A pair of spacer collars 65 and 66 are provided about each bolt, one on each side of the spider, thus spacing the spider plates from said spider. Any appropriate means such as shown at 68 is provided for locking bolts 67 in position.

Each planetary gear unit 62 preferably comprises a hub 69 having a gear 70 cut integrally thereon at one end and a gear 71 at the other, the number of teeth of gear 70 being less than that of gear 71. Three equidistant openings 72 are preferably provided in the spider 30, through each of which extends one of the planetary units 62, each being mounted in place by means of a bolt pin 73 passing transversely through the spider plates and secured thereto, and having mounted thereon a roller bearing 74 about which the gear hub 69 may rotate.

Cooperating with the set of gears 71 I provide a stationary internal gear 75 preferably secured to the cover 9 by dowels 76 and bolts 77. A rotatable internal gear 78 preferably of a somewhat lesser number of

teeth than gear 75 meshes with the set of gears 70 and forms an integral part of plate 87, which plate, as heretofore noted is secured to the barrel at 61. A portion of the inner race of ball bearing 31 is mounted upon plate 87 as at 80.

Upon the forward end of casting 4 I preferably secure by means of screws 81, a pair of spring steel brake members 82 each having a radial portion 83 extending to the driving member 25 and a peripheral portion 84, extending circumferentially about a portion of the driving member 25 and in contact with the tops of its splines for a purpose appearing more fully in the description of the operation below.

I prefer to assemble my starting unit as follows: The hub nut 35 is threaded upon the screw shaft 37, the dished washers 49 are slipped over the rear end of the hub nut, and then spline plate 45 is passed over the forward end thereof and brought into cooperation with the splined flange 48. The barrel 32 is now slipped over the screw shaft until the recesses 43 are brought into proper coaction with spline plate 45 whereupon the stop plate 40 may be threaded onto the end of the shaft and locked in position by lock nut 41. The ball bearing 31 may now be slipped over the barrel whereupon the plate 87 carrying both the internal gear 78 and the journal box 60 is secured to the said barrel by means of screws 61. The transmission thus far described is then passed into the casting 4 through the open rear end 8. The motor is applied to the casting at its upper end and secured thereto by the bolts in the manner obvious from the drawings and the description above. Thereupon the spider 30 carrying the set of planetary units 62 is inserted into the head 9 to which the internal gear 75 has been previously secured by means of the dowels 76 and bolts 77. The next step is to mount the head 9 upon the casting, meshing planetary gears 70 with internal gear 78, and inserting axle portion 58 into journal box 60. Nut 55 and cover member 57 may then be applied to complete the assembly.

The entire starter unit is applied to the engine by simply inserting its forward end into the opening O in the crankcase of the engine until the flange 6 on the unit comes into contact with the faced end of the crankcase when it may be securely fastened in place by means of bolts 7.

It is noted that a substantial portion of the transmission mechanism of my unit fits in the interior of the crankcase of the engine and that the electric motor 13 by reason of its vertical position does not extend beyond the extreme rear end of the transmission mechanism. It is thus seen that my unit extends only a relatively small distance back of the engine and can be applied with ease between the engine and the usual fire bulkhead separ-

rating the latter from the gasoline tank, in commercial forms of aeronautic vehicles.

In operation, assuming preliminary adjustments such as ignition to have been made a starting switch preferably of the ordinary single bridging contact type (not shown) is closed, connecting the motor with a source of electrical power preferably a storage battery (not shown). The motor is thus set into rapid rotation and through bevel pinion 28 causes a rotation of the gear or spider member 30 with its axle portions 53 and 58 rotating in ball bearing 54 and roller bearing 59 respectively. The spider plates 63 and 64 being rigid with the spider, rotate with it thus causing a revolution of the planetary units 62 about the axle. By reason of the cooperation of gears 71 on the planetary units with internal gear 75, each hub 62 is caused to rotate about its pin 73 and to impart rotation to its integral gear 71. By a well understood differential action which need not be set forth at length, the internal gear 78 is thus rotated at a reduced speed bearing a definite low ratio, with respect to the speed of spider 30.

The internal gear being rigid with the barrel 32 the said barrel is caused to rotate and to transmit its rotation through the clutch 45—48 to the hub nut 35. By reason of the braking members 82, the driving member 25 and its integral screw shaft 37 are impeded in their tendency to rotate with nut 35, and accordingly the rotation of the hub nut will compel the screw shaft 37 steadied by guide pilot 38, to thread its way through the nut portion 36 until the driving member 25 is automatically brought into mesh with the internally splined socket portion 2. When this occurs the stop plate 40 abuts the flange 42, and further longitudinal movement of the screw shaft with its integral driving member is thus prevented. The subsequent rotation of the barrel is transmitted through clutch 45—48 to the hub nut and then to the screw shaft and driving member normally establishing a positive driving connection between the motor 13 and the driven member 2 to crank the engine.

After the engine has started and rotates under its own power it causes the driving member to rotate at a higher speed than that imparted to the hub nut 35 by the electric motor. The screw shaft 37 therefore by a well known action draws the driving member out of engagement with the engine and the braking members 82 thereupon function to prevent undesired reentry of the driving member while the engine or vehicle is in motion, and this regardless of the roughness or grade of the course.

If the electric motor is still running after the engine has started and the driving member has been demeshed the screw shaft may again feed forwardly toward the end of the crankshaft. As soon as the driving member

contacts the end of the rapidly rotating crankshaft, there will be imparted to the screw shaft a rate of rotation sufficiently high to cause the driving member again to recede.

5 If, as encountered in practice at times the initial explosion within the engine should occur prematurely that is on the upward or compression stroke instead of substantially at the extreme upper position of the piston, 10 then the premature explosion tends to rotate the engine in the wrong direction thus in effect producing a sudden material increase in the resistance of the engine to cranking. This phenomenon is usually designated as 15 "back-fire", a term which I employ with this meaning in certain of the claims.

Upon back-fire the resistance offered by the engine is ordinarily greater than can be overcome by my starter unit which is preferably 20 designed for lightness and compactness to produce a torque not greatly in excess of that required for cranking under normal conditions. The sudden growth of resistance of the engine to cranking therefore suddenly 25 arrests the screw shaft against turning and in the absence of special construction would also arrest the remainder of the transmission and the electric motor with danger of injury due to the inertia of the parts and the consequent likelihood of destruction of the mechanism. By my construction the motor 30 through the reduction gearing and the barrel 32 continues to rotate the hub nut 35 through the clutch 45—48. Since the driving member 25 with its integral screw shaft 37 is arrested by the engine during back-fire so that it can not be rotated it follows that the rotation of the hub nut 35 will cause this member to thread its way backwardly along the 40 screw shaft 37 thus drawing its integral splined flange 48 backwardly against the resistance of dished washers 49 out of cooperation with spline plate 45 thereby disconnecting the clutch 45—48 to break the mechanical circuit between the motor and the 45 engine. The continued rotation of the motor is transmitted to the spline plate 45 which rotates without load until its inner recesses are in alignment with the splines on flange 48, when the compressed dished washers 49 are 50 free to expand to urge the splined flange 48 and with it the integral hub nut 35 into cooperation with the splined plate 45, thus reconnecting the clutch. If the condition of 55 back-fire persists the clutch will again disconnect as set forth and this alternate automatic disconnection and reconnection of the clutch may continue for the duration of the back-fire. My starter is thus substantially 60 proof against injury under even severe conditions of back-fire. When normal cranking again takes place the operation proceeds in the normal manner above described.

In normal cranking when no back-fire occurs, the dished washers 49 may come into

play to ease the shock of starting. The initial resistance offered by the engine to turning of the driving member and its integral screw shaft may result in the hub nut 35 moving backwardly slightly against the resistance of spring washers 49, until the resistance 70 of the washers to further compression exceeds that of the engine to cranking. The amount of compression of the dished washers will increase with the stiffness of the engine, thus 75 causing a yielding application of torque to the engine. The dished washers are however preferably made of such strength as to permit entire disconnection of clutch 45—48 only under conditions approximating the severity of a back-fire. 80

Upon starting of the motor if the ends of splines 26 should abut the ends of splines 3 jamming will not occur since as above noted 85 threads 37 are made sufficiently steep to render the driving member incapable of arresting axial pressure. The driving member will accordingly rotate and after a slight turning movement, the splines on the driving member will be in proper alignment with the 90 grooves 31 between the splines on the crankshaft, whereupon meshing and the subsequent action proceed in the normal manner described above.

Although I have shown a preferred arrangement with my motor extending upwardly from the base of the unit, it is to be understood that I may apply my unit with good results with the motor extending either 95 vertically downwardly or laterally. 100

Many of the features of my invention are applicable to the type of starter in which some or all of the torque multiplying mechanism is interposed between the ultimate driving member of the starter and the engine to 105 be cranked, as for instance, in the copending application of Joseph Bijur Serial No. 224,494 filed March 25th, 1918. It is also to be noted that certain of the features of this invention may be applied to the front instead 110 of the rear end of the engine as in the said copending Bijur application, or in other manners. It is to be understood, however, that as to all these features, I prefer to employ the specific construction shown and described. 115

As to the planetary gear reduction it is to be understood that I may if desired apply the torque to the spider member centrally instead of peripherally and that I may employ a starting motor parallel instead of perpendicular to the crankshaft, and connected to the spider by spur instead of bevel gearing. 120 As to these features also it is to be understood that the specific construction shown and described constitutes my preferred form. 125

It will thus be seen that there is herein described apparatus in which the several features of this invention are embodied, and which apparatus in its action attains the various objects of the invention and is well 130

suited to meet the requirements of practical use.

As many changes could be made in the above construction and many apparently
5 widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be
10 interpreted as illustrative and not in a limiting sense.

Having thus described my invention what I claim as new and desire to secure by Letters-Patent is:

15 1. The combination in an engine starter, of a starting means, a transmission connecting said means to an engine, said transmission including a splined hub, an annular plate embracing said hub, and splined at its inner periphery to cooperate with the splines on said
20 hub, and means responsive to a back-fire of said engine to move said hub out of engagement with said plate for interrupting said transmission.

25 2. The combination in an engine starter, of a starting means, a transmission for connecting said means to an engine, a clutch in said transmission comprising a hub having a plurality of splines, and an annular plate embracing said hub and having splines on its
30 inner periphery interfitting those of said hub; a toothed driving member coaxial with said hub and adapted to mesh with an engine member, means responsive to a back-fire of
35 said engine, to move said hub out of engagement with said plate, and means to restore said clutch to operative condition after said back-fire has terminated.

3. In an engine starter, in combination, a
40 starting means, a transmission for connecting said means to an engine, a clutch in said transmission comprising a hub member having a splined flange, an annular plate encircling said flange, and having splines on its
45 inner periphery cooperating with the splines on said flange, a plurality of annular dished washers encircling said hub on one side of said flange, and means responsive to a back-fire, to disconnect the elements of said clutch
50 against the compression of said washers.

4. In combination, an engine, a starting means, a transmission for connecting said means to said engine, said transmission including a clutch having two normally cooperating elements and a threaded connection
55 between said engine, and one of said clutch elements, to cause disconnection of said clutch responsive to a back-fire.

5. In an engine starter, in combination, a
60 starting means having a driving member adapted to coact with an engine for cranking, a clutch interposed between said means and said driving member, one of the elements of said clutch being connected to said means,
65 and the other having a threaded connection

relative to said driving member, whereby upon a sudden increase of resistance to cranking resulting from a back-fire or the like, said clutch elements will automatically disconnect.

6. In an engine starter, in combination, a starting means having a toothed driving member adapted to be connected to an engine, a transmission between said means and said driving member, including a screw shaft
75 coaxial with said driving member, a nut on said shaft, a dog clutch element rigid with said nut, and a cooperating dog clutch element connected to said motor.

7. In an engine starter, in combination, a starting means having a transmission adapted to connect it to an engine, said transmission including an annular clutch plate connected to said means and splined at its inner periphery, a hub having an external splined
85 portion coacting with said plate, said hub having a coaxial nut portion, a shaft threaded through said nut portion, and a toothed driving member connected to said shaft.

8. In an engine starter, in combination, a starting means having a transmission adapted to connect it to an engine, said transmission including an annular clutch plate connected to said means and splined at its inner periphery, a hub having an external splined
95 flange coacting with said plate, a dished washer back of said flange, said hub having a coaxial nut portion, a shaft threaded through said nut portion for longitudinal movement thereof, and rotation therewith, and a
100 toothed driving member rigid with the forward end of said shaft.

9. In apparatus of the character described, in combination, an engine having a toothed driven member, a starting means having a
105 toothed driving member normally displaced from said driven member, means responsive to starting of the starting means for bringing said driving member into mesh with said driven member and normally establishing a
110 positive driving connection between said starting means and said driven member for cranking the engine, a clutch interposed between said starting means and said driving member, and means responsive to a back-
115 fire of the engine for disconnecting the elements of said clutch.

10. In an engine starter, in combination, an engine, a driven member connected thereto, a starting means having a driving member adapted to cooperate with said driven member for cranking said engine, but normally out of engagement therewith, a clutch between said means and said engine, and means involving a screw shaft for causing
125 automatic engagement of said driving and said driven members upon starting of the motor, automatic disengagement upon starting of said engine, and for causing disengagement of the elements of said clutch upon a
130

sudden increase in resistance of the engine to cranking resulting from a back-fire or the like.

11. In apparatus of the character described, in combination, an engine, a starting means, a positive transmission between said means and said engine, means responsive to the starting of said starting means for establishing said transmission between said starting means and said engine to normally positively drive the latter, means responsive to starting of said engine, to disconnect said transmission at one part, and means responsive to a back-fire of said engine to disconnect the transmission at another part.

12. In apparatus of the character described, in combination, an engine, a toothed driven member connected thereto, a starting means, a toothed driving member connected thereto and adapted to move automatically into mesh with said driven member to establish a normal positive driving connection between said starting means and said driven member, means responsive to starting of said engine to disconnect said driving from said driven member, and means responsive to a back-fire of said engine, to interrupt the mechanical connection between said starting means and said driving member.

13. In apparatus of the character described, in combination, a toothed driven member connected to an engine, a starting means having a toothed driving member normally displaced from said driven member, screw shaft means responsive to starting of the said starting means for bringing said driving member into mesh with said driven member for cranking the engine, and a clutch interposed between said starting means and said driving member adapted to be disengaged by the action of said screw shaft means upon backfire of the engine.

14. In an engine starter, in combination, a starting means, a barrel driven therefrom, a sleeve within the barrel, a driving member driven from said sleeve and adapted to be moved into engagement with an engine, and a clutch which directly and positively connects the barrel and sleeve for the transmission of all normal torques and positively disconnects them in event of an abnormal torque.

15. In an engine starter, in combination, a starting means, a barrel driven therefrom, a plate splined thereto to be driven thereby, said plate having a splined opening, a screw shaft, and a cooperating nut, one of said latter elements having splines cooperating with said splined opening, and a toothed driving member controlled by said screw shaft.

16. In an engine starter, in combination, a starting means, a barrel driven therefrom, a hub concentrically mounted within said barrel, said hub having a flange, an annular plate splined to said flange at its inner and

to said barrel at its outer periphery, dished annular washers encircling said hub and within said barrel, a toothed driving member adapted to engage with an engine, and means for transmitting thrust and torque from said hub to said driving member.

17. In an engine starter, in combination, a starting means, a barrel rotated thereby, a hub nut concentrically mounted within said barrel, said hub nut having a flange, an annular plate splined to said flange at its inner and to said barrel at its outer periphery, yielding means within said barrel resisting longitudinal displacement of said hub nut, a screw shaft threaded into said nut, and a toothed driving member on said shaft.

18. In an engine starter, in combination, a starting means, a barrel rotated thereby, a hub nut concentrically mounted within said barrel, said hub nut having a flange, an annular plate having its inner periphery splined to the edge of said flange, said plate being connected for rotation with said barrel, yielding means within said barrel resisting longitudinal displacement of said hub nut, a screw shaft threaded into said nut, and a toothed driving member rigid with said screw shaft.

19. In apparatus of the character described, in combination, an engine, a starting means, cooperating clutching elements one on said engine, and one under control of said starting means, means responsive to starting of said starting means to cause said clutching elements to engage each other, said means including a hub nut and a screw shaft supported by the latter in threaded relation, said motor controlled clutching element being on said screw shaft.

20. In apparatus of the character described, in combination, a starting means, a transmission for said means, said transmission including a hub, a shaft supported in said hub, an engine driving member on said shaft, means for causing rotation of said hub to move said shaft longitudinally, a stop, and a flange on said shaft adapted to abut said stop, when said engine driving member reaches torque transmitting relation.

21. In apparatus of the character described, in combination, a starting means, a transmission for said means, said transmission including a barrel, a concentric hub adapted to rotate therewith, a screw shaft threaded into said hub, and having a toothed engine driving member near its outer end, an internal flange on said barrel, and a plate on said screw shaft adapted to abut said flange when said driving member reaches meshing position.

22. In apparatus of the character described, in combination, a starting means, a transmission for said means, said transmission including a barrel, a hub concentric therewith, a clutch connecting said barrel to said hub, a screw shaft threaded into said hub, and hav-

ing a toothed engine driving member near its outer end, an internal flange on said barrel, means on said shaft adapted to abut said barrel when said driving member reaches cranking position, and a plurality of dished annular washers embracing said hub within said barrel, and between said clutch and said flange.

23. In apparatus of the character described, in combination, a barrel, having an internal flange, an annular plate splined to said barrel near its open end, a hub nut within said barrel, having a flange splined to said plate, a plurality of annular dished washers encircling said hub nut and disposed between said barrel flange and said hub flange, a screw shaft threaded into said hub nut, and a cap secured to said barrel and overlapping said hub flange to maintain the parts in assembled relation.

24. In engine starting apparatus, in combination, a starting means having a shaft, a pinion thereon, planetary reduction gearing driven thereby, a barrel driven by said reduction gearing, a sleeve operatively connected to the barrel, an engine driving member, and means associated with said sleeve and said engine driving member for causing automatic movement of said driving member from inoperative to operative position.

25. In engine starting apparatus, in combination, a starting means having a shaft, a pinion thereon, planetary reduction gearing driven thereby, a barrel driven by said reduction gearing, an internally screw threaded sleeve operatively connected to said barrel, and a screw threaded shaft cooperating with the threads on said sleeve and having an engine driving member at one end thereof arranged for automatic movement from inoperative to operative position upon relative rotation of said sleeve and shaft.

26. In engine starting apparatus, in combination, a starting means having a shaft, a barrel, means for driving said barrel from said shaft, a sleeve operatively connected to the barrel, an engine driving member, said barrel surrounding said sleeve and driving member, and means associated with said sleeve and said engine driving member for causing automatic movement of said driving member from inoperative to operative position.

27. In engine starting apparatus, in combination, a starting means having a shaft, a barrel, means for driving said barrel from said shaft, an internally screw threaded sleeve operatively connected to said barrel, and a screw threaded shaft cooperating with the threads on said sleeve and having an engine driving member at one end thereof arranged for automatic movement from inoperative to operative position upon relative rotation of said sleeve and shaft.

28. In engine starting apparatus, in combination, a starting means having a shaft, a

barrel, means for driving said barrel from said shaft, a sleeve within said barrel and operatively connected thereto, an engine driving member, and means associated with said sleeve and said engine driving member for causing automatic movement of said driving member from inoperative to operative position.

29. In engine starting apparatus, in combination, a starting means having a shaft, a barrel, means for driving said barrel from said shaft, an internally screw threaded sleeve within said barrel and operatively connected thereto, and a screw threaded shaft cooperating with the threads on said sleeve and having an engine driving member at one end thereof arranged for automatic movement from inoperative to operative position upon relative rotation of said sleeve and shaft.

30. In apparatus of the character described, in combination, an engine, a starting means, a barrel, reduction gearing connecting said means to drive said barrel, a toothed engine driving member driven from said barrel, a clutch interposed between said barrel and said driving member, and means responsive to a back-fire of said engine to cause said clutch to disengage.

31. In apparatus of the character described, in combination, an engine, a starting means, a bevel pinion turning therewith, reduction gearing including a bevel gear meshing with said pinion and at right angles thereto, a barrel driven from said reduction gearing, a toothed engine driving member driven from said barrel, a clutch interposed between said barrel and said driving member, means responsive to a back-fire of said engine to cause said clutch to disengage, and means for causing automatic reengagement of said clutch upon termination of said back-fire.

32. In engine starting apparatus, in combination, a housing, a motor supported in vertical position thereon and having a portion extending through an opening in said housing, a transmission in said housing including planetary gearing, bevel gearing connecting the motor to the planetary gearing, a barrel driven by said planetary gearing, and an engine driving member driven by said barrel; said transmission having two bearings in said housing, and said planetary gearing having one bearing in said barrel.

33. In apparatus of the character described, in combination, an engine having a crankshaft, with internal teeth at its end, a starting means, a nut member driven thereby, a screw shaft threaded into said nut, and having a toothed driving member near its end, aligned with the end of said crankshaft for meshing therewith, and means for exerting a braking action on said screw shaft, to compel movement thereof toward mesh.

34. An engine starter drive including a ro-

tatable barrel, a nut arranged within the barrel and operatively connected to be driven thereby in the forward direction of rotation for the cranking of the engine, a screw shaft threaded in the nut and having its sole bearing therein, said shaft being arranged to float in the nut and carrying a driving member adapted to be moved longitudinally into engagement with a member of the engine to be started.

35. An engine starter drive including a rotatable barrel, a nut arranged within the barrel and operatively connected therewith to be driven thereby in the forward direction of rotation for the cranking of the engine, a screw shaft threaded in the nut and having its sole bearing therein, said shaft being arranged to float in the nut and carrying a driving member adapted to be moved longitudinally into engagement with a member of the engine to be started and having means for limiting its longitudinal movements in opposite directions.

36. An engine starter drive including a rotatable driving barrel, a nut arranged within the barrel and operatively connected therewith, a screw shaft threaded in the nut, said shaft carrying a driving member adapted to be moved longitudinally into engagement with a member of the engine to be started and having means for limiting its longitudinal movements in opposite directions consisting of a projection on one end of the shaft and a shoulder on the interior of the barrel.

37. An engine starter drive including a rotatable driving barrel, a nut arranged within the barrel and operatively connected therewith and having an axial movement relative to the barrel, a screw shaft threaded in the nut and supported wholly thereby, said shaft being adapted to move longitudinally into engagement with a member of the engine to be started to rotate the latter.

38. An engine starter drive including a rotatable driving barrel, a nut arranged within the barrel and operatively connected therewith, means responsive to back-fire conditions for disabling such connection, a screw shaft threaded in the nut and adapted to engage a member of the engine to be started.

39. An engine starter drive including a rotatable driving barrel, a nut arranged within the barrel concentric of the central axis thereof, a driving connection between the barrel and nut, said nut being normally stationary as to longitudinal movement but capable of a limited longitudinal movement to disable such driving connection in case of back-fire, and a screw shaft threaded in the nut and adapted to engage a member of the engine to be started.

40. An engine starter drive including a rotatable driving barrel, a nut arranged within the barrel concentric of the central axis thereof, a driving connection between the barrel

and nut, said nut being normally stationary as to longitudinal movement but capable of a limited longitudinal movement to disable such driving connection in case of back-fire, yielding means acting on the nut to normally maintain such driving connection, and a screw shaft threaded in the nut and adapted to engage a member of the engine to be started.

41. An engine starter drive including a rotatable driving barrel, a nut arranged within the barrel concentric of the central axis thereof, a driving connection between the barrel and nut, said nut being normally stationary as to longitudinal movement but capable of a limited longitudinal movement to disable such driving connection in case of back-fire, said barrel and nut having parallel flanges spaced apart, spring means interposed between such flanges to normally maintain such driving connection, and a screw shaft threaded in the nut and adapted to engage a member of the engine to be started.

42. An engine starter drive including a rotatable driving barrel, a nut arranged within the barrel concentric of the central axis thereof, a driving connection between the barrel and nut, said nut being normally stationary as to longitudinal movement but capable of a limited longitudinal movement to disable such driving connection in case of back-fire, said barrel and nut having parallel flanges spaced apart, a series of dished washers arranged in the space between such flanges and forming spring means to normally maintain such driving connection, and a screw shaft threaded in the nut and adapted to engage a member of the engine to be started.

43. An engine starter drive including a rotatable driving barrel, a control member mounted concentrically therein and rotatable therewith and having an axial movement relative to the barrel, and an engine driving member mounted within the control member and centrally of the barrel, said control and driving members having cooperating means whereby the rotation of the control member advances the driving member longitudinally into engagement with a member of the engine to be started and then rotates such driving member.

44. An engine starter drive including a rotatable driving barrel, a control member mounted concentrically therein and rotatable therewith, said barrel and control member having a disconnectable driving connection, and said control member being normally stationary longitudinally but capable of a limited longitudinal movement in case of excessive resistance to the rotation of the control member, and an engine driving member mounted within the control member and centrally of the barrel, said control and driving members having cooperating means whereby the rotation of the control member advances

the driving member longitudinally into engagement with a member of the engine to be started and then rotates such driving member.

5 45. An engine starter drive including a rotatable driving barrel, a control member mounted concentrically therein and rotatable therewith, and an engine driving member mounted within the control member and centrally of the barrel, and supported wholly by the control member, said control and driving members having cooperating means whereby the rotation of the control member advances the driving member longitudinally into engagement with a member of the engine to be started and then rotates such driving member, in combination with rotatable driving mechanism operatively connected with said barrel, the axis of rotation of which mechanism is coincident with the axis of rotation of said barrel and said engine driving member.

46. An engine starter drive including a rotatable driving barrel, a control member mounted concentrically therein and rotatable therewith, and an engine driving member mounted within the control member and centrally of the barrel, and supported wholly by the control member, said control and driving members having cooperating means whereby the rotation of the control member advances the driving member longitudinally into engagement with a member of the engine to be started and then rotates such driving member in combination with rotatable driving mechanism operatively connected with said barrel, and including a gear wheel secured to one end of the barrel, and planetary gearing cooperating with said gear wheel and having an axis of rotation coincident with the axis of rotation of said barrel and said engine driving member.

47. An engine starter drive including a rotatable driving barrel, a nut arranged within the barrel and operatively connected therewith, means responsive to back-fire conditions for disabling such connection, and a shaft mounted in the nut and adapted to be advanced by relative movement between the nut and itself into engagement with a member of the engine to be started.

48. An engine starter drive including a rotatable barrel which is interiorly screw threaded, and a driving member normally contained within the barrel and threaded to the threads of the latter whereby when the barrel is rotated the driving member is automatically caused to move longitudinally and project outside the barrel and to engage a member of the engine to be started.

49. An engine starter drive including a rotatable barrel which is interiorly screw threaded, and a driving member normally contained within the barrel and having at one end means for engaging a member of the en-

gine to be started and having at its other end screw threads engaging the threads of the barrel, whereby when the barrel is rotated the driving member is automatically caused to move longitudinally and project outside the barrel and to engage said engine member.

50. An engine starter drive including a rotatable barrel which is internally screw threaded, a driving member normally contained within the barrel and threaded to the threads of the latter whereby when the barrel is rotated the driving member is automatically caused to move longitudinally and project outside the barrel and to engage a member of the engine to be started, and means for causing a yielding application of the torque from the driving member to the engine member.

51. An engine starter drive including a rotatable hollow screw member, means for rotating such member, and a screw shaft threaded in such member and floating in that member by having its sole bearing therein, said shaft carrying a driving member adapted to be moved longitudinally by virtue of the rotation of such screw member into engagement with a member of the engine to be started.

52. An engine starter drive including a rotatable hollow member provided at one end of its bore with screw threads and with a plain portion for the remainder of such bore, means for rotating such member, and a shaft having screw threads cooperating with the threads of such hollow member of the same diameter as such plain portion and cooperating therewith and also having a driving member adapted to be moved longitudinally into engagement with a member of the engine to be started.

53. An engine starter drive including a rotatable hollow member provided at one end of its bore with screw threads and with a plain portion for the remainder of such bore, means for rotating such member, and a shaft having at one end screw threads cooperating with the threads of such hollow member and at the other end a driving member adapted to be moved longitudinally into engagement with a member of the engine to be started, and also having intermediate its length an enlargement acting as a pilot in the plain portion of the bore of the hollow member and as a stop by contact against one end of said threads.

54. An engine starter drive including a rotatable hollow member provided at one end of its bore with screw threads and with a plain portion for the remainder of such bore, means for rotating such member, a shaft having screw threads cooperating with the threads of such hollow member and also having a driving member adapted to be moved longitudinally into engagement with a member of the engine to be started, and a stop de-

vice carried by the shaft at its screw threaded end.

55. In an engine starter, in combination, a rotatable driving barrel, a sleeve arranged
5 within and concentric with the barrel, a clutch connected directly with the barrel and sleeve respectively for the transmission of torque and adapted to disconnect the barrel
10 and sleeve when the torque exceeds a predetermined amount, and a driving member mounted within the sleeve for longitudinal movement thereof and rotary movement
therewith.

56. In an engine starter, in combination, a
15 rotatable driving barrel, a sleeve arranged

within and concentric with the barrel, a clutch connected directly with the barrel and sleeve respectively for the transmission of torque, and a driving member mounted within the sleeve for longitudinal movement
20 thereof and rotary movement therewith, said driving member comprising a shaft portion adapted to engage the bore of the sleeve and an engine engaging portion at one end which is normally retracted within the confines of
25 such sleeve.

In testimony whereof, I have signed my name to this specification this 24th day of June, 1919.

RAYMOND P. LANSING.