Nov. 20, 1934. L. GÉRARD 1,981,789

STARTING DEVICE FOR INTERNAL COMBUSTION ENGINES

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Fig. 1

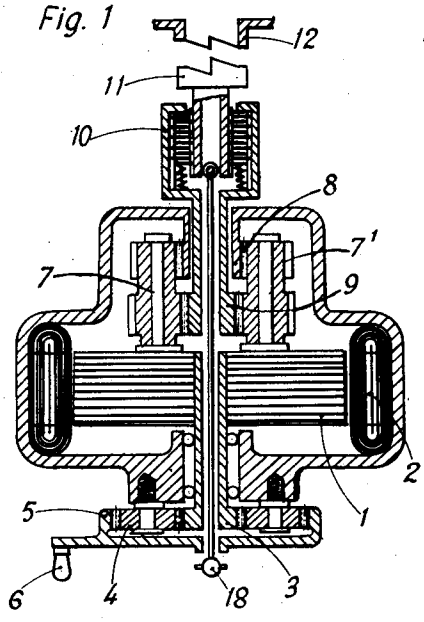



Fig. 2

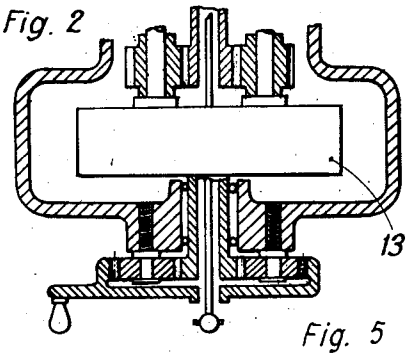



Fig. 5

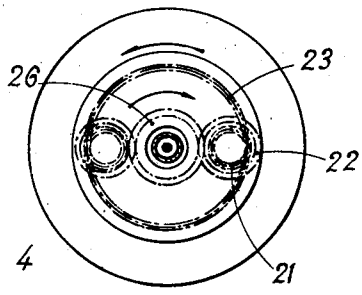
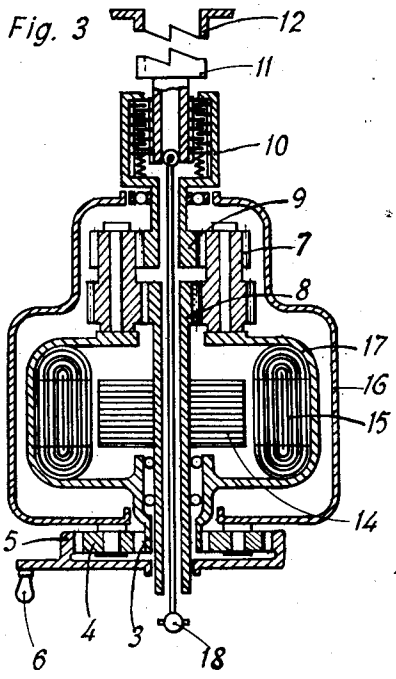
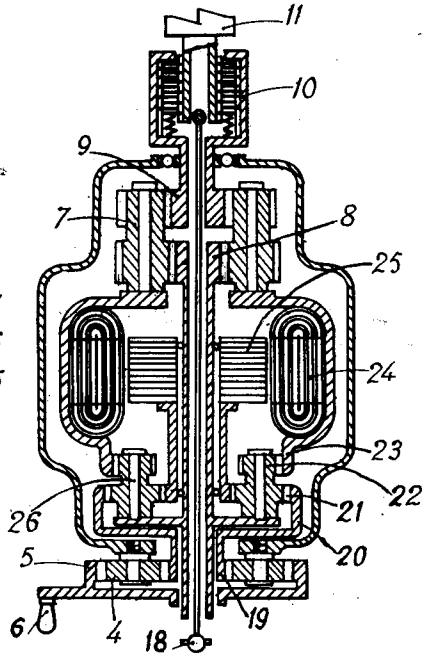



Fig. 4

Fig. 3




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Fig. 7

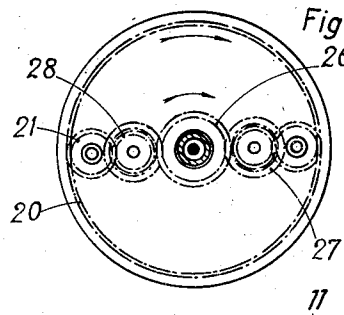



Fig. 8

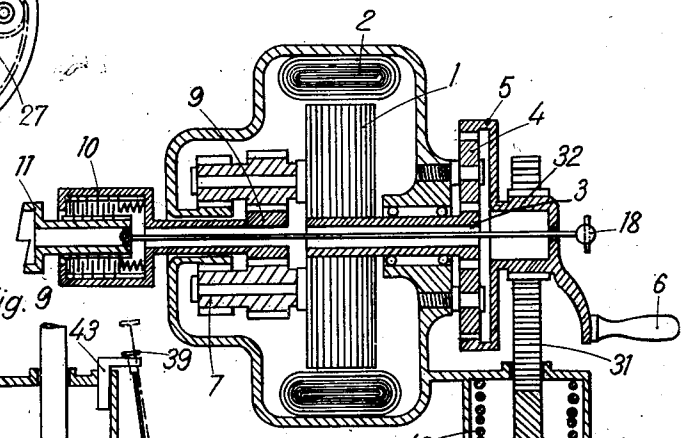



Fig. 9

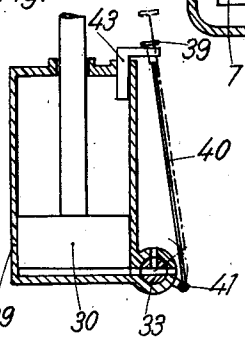
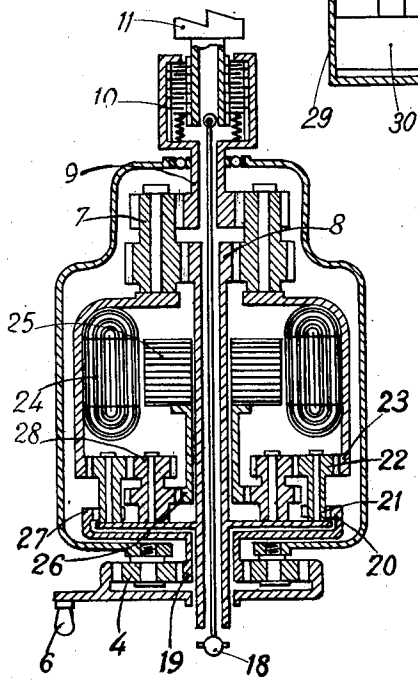
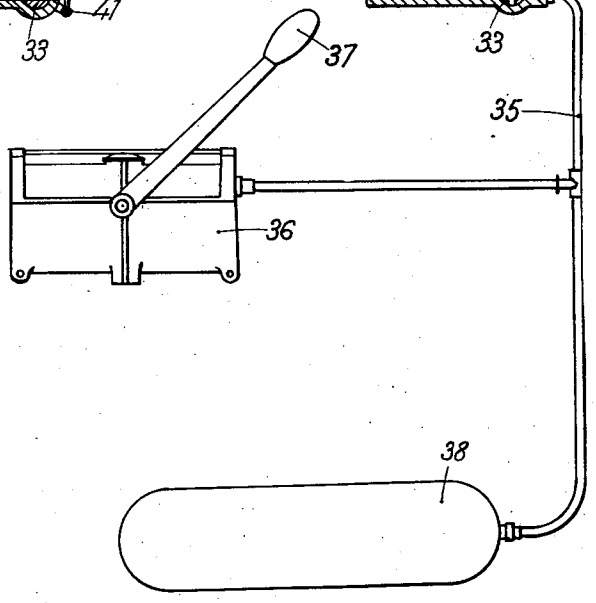



Fig. 6




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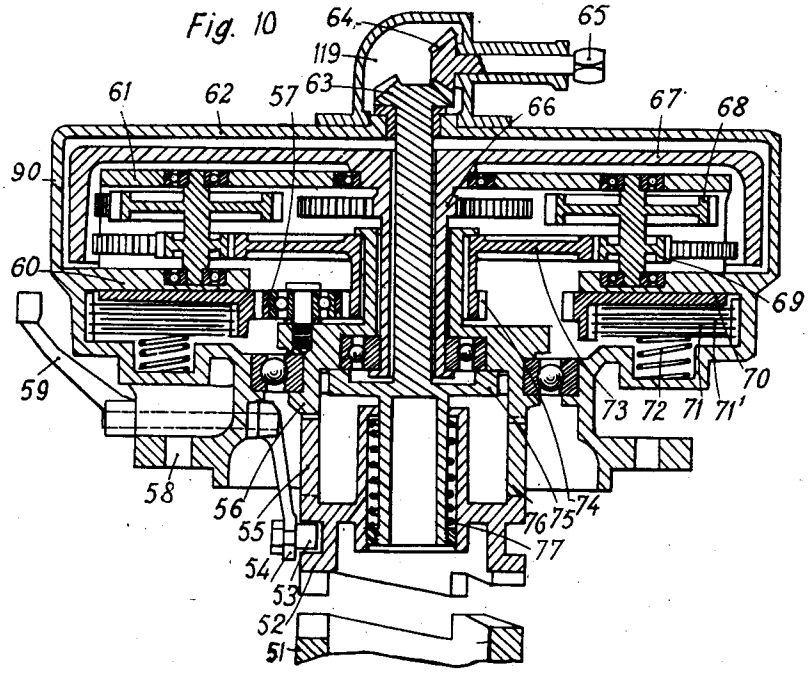
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Fig. 10




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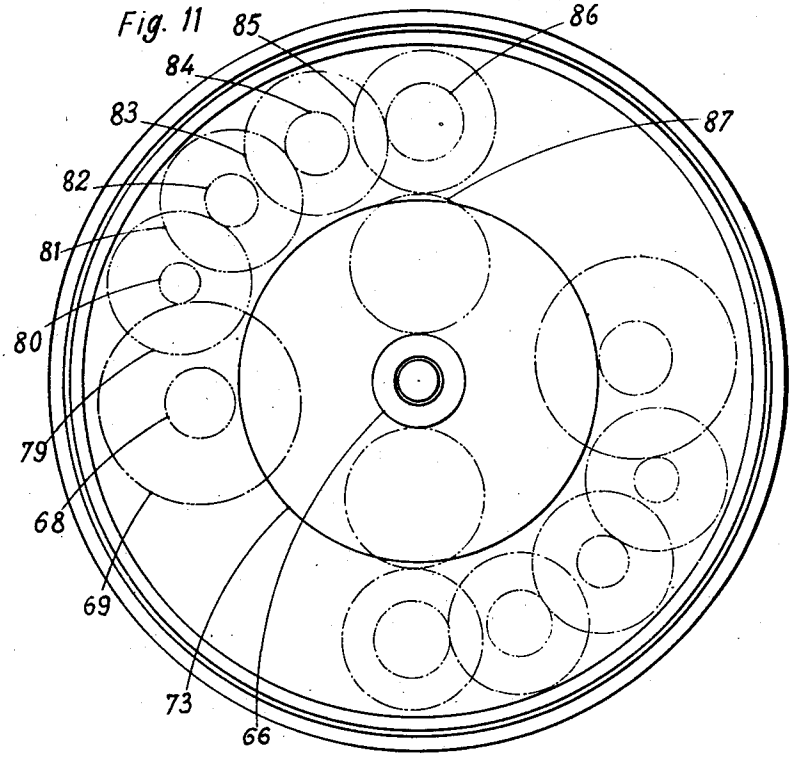
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Fig. 11




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Fig. 12

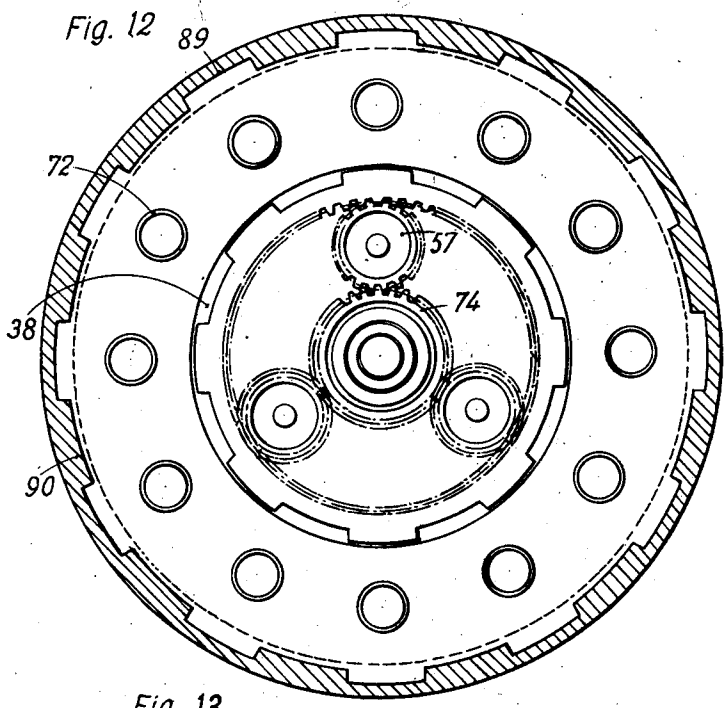



Fig. 13

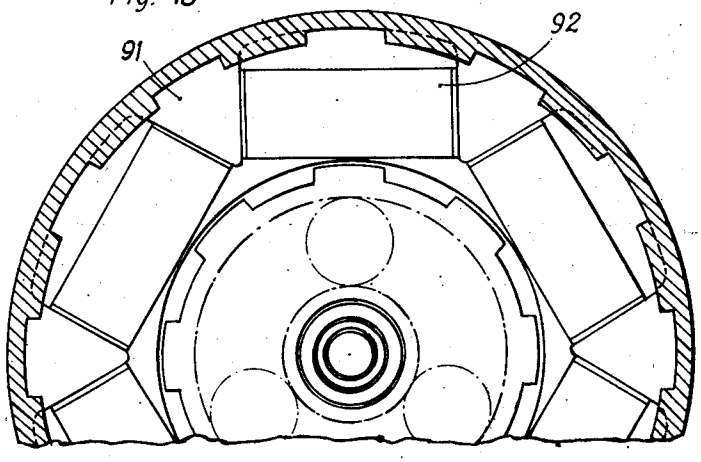
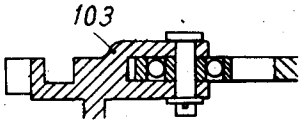



Fig. 23



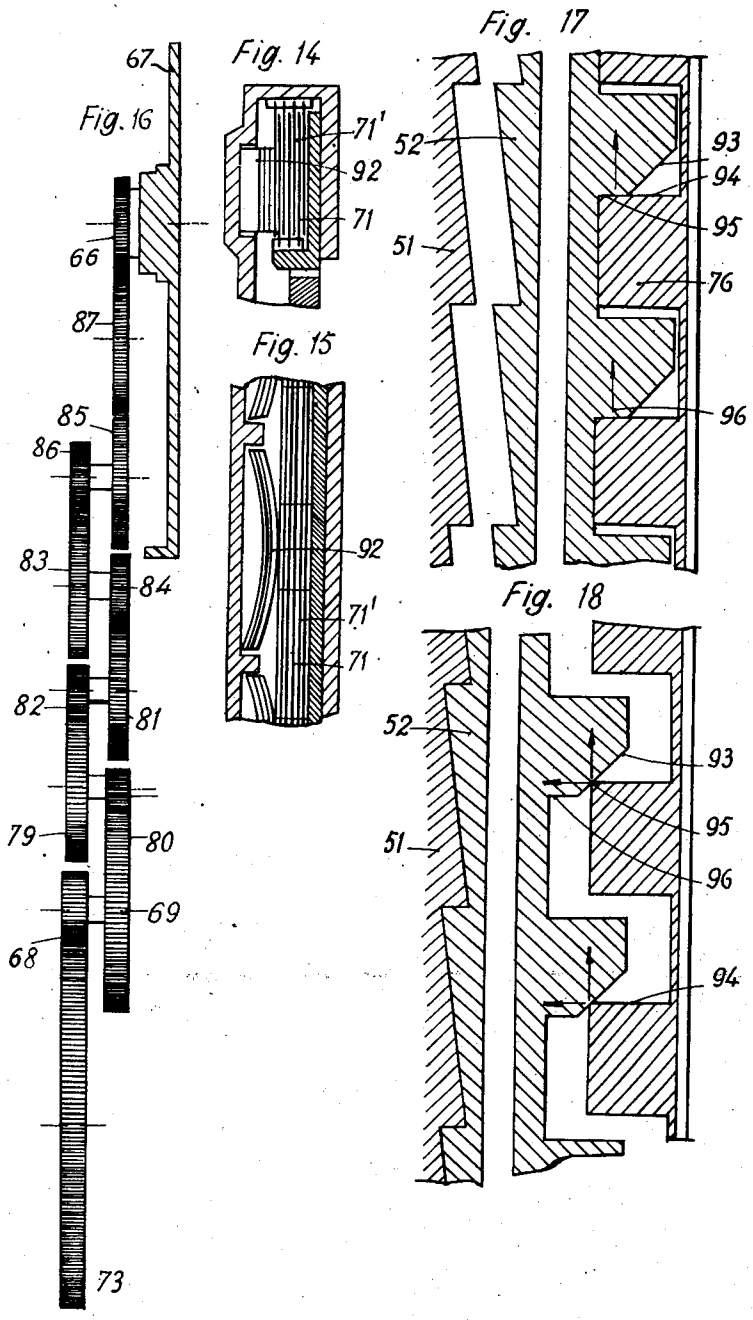

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Fig. 24

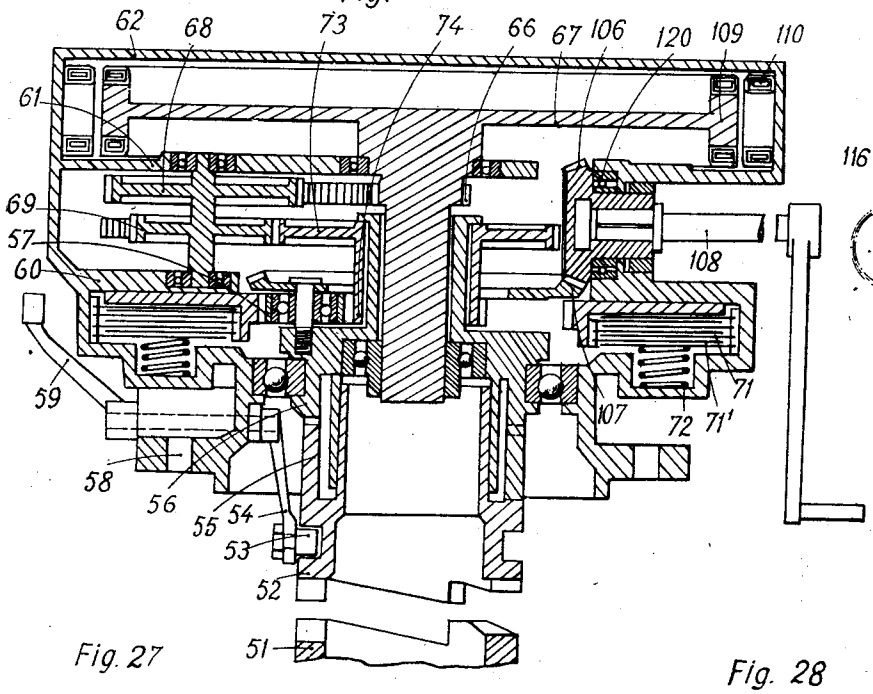



Fig. 26

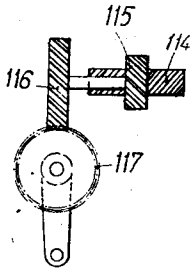



Fig. 27

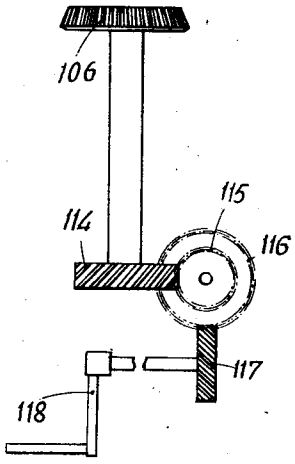



Fig. 19

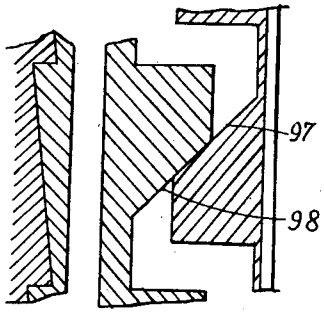
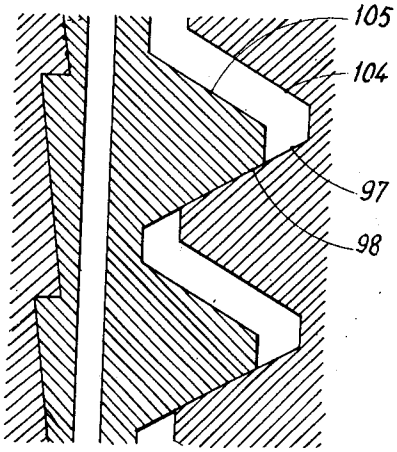



Fig. 28




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Fig. 21

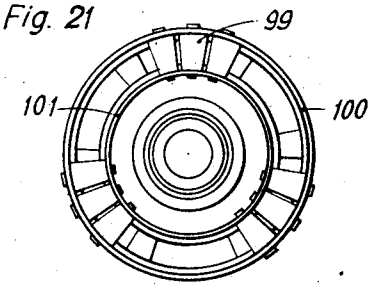



Fig. 20

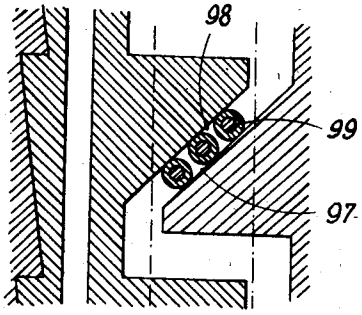



Fig. 22

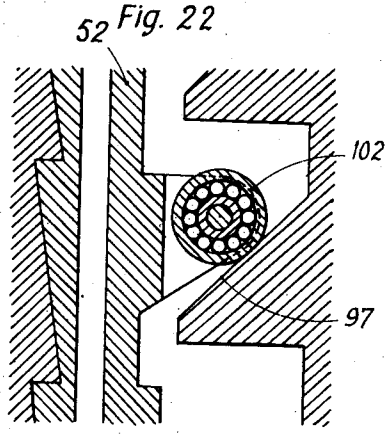
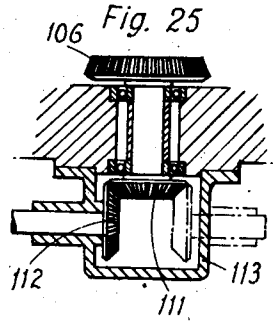



Fig. 25




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# UNITED STATES PATENT OFFICE

1,981,789

## STARTING DEVICE FOR INTERNAL COMBUSTION ENGINES

Léon Gérard, Sevres, France, assignor to Paul Viet, Billancourt, France

Application October 4, 1929, Serial No. 397,435
In France November 22, 1928

2 Claims. (Cl. 123—179)

The present invention has for its object to combine in a common apparatus utilizing the kinetic energy of a mass in movement, adapted for instance for the starting of internal combustion engines, various methods of starting in which muscular force and electric, pneumatic or other power are employed, which combination affords a simple apparatus and enables the use of the inertia of the whole operative mass of the apparatus to the maximum degree, while eliminating the dead centers and the flywheels or additional masses.

The invention further relates to forms of construction adapted to facilitate the engagement of the starter with the motor to be started, by the use of jaw clutch members having inversely disposed teeth, whereby all adjustment when the starter is installed upon the said motor will be eliminated. A friction brake cooperating with a stationary disk allows a certain slip in the case of an abrupt starting or an excessive resistance.

The following description, with reference to the accompanying diagrammatic drawings which are given by way of example, shows various embodiments of the invention.

Fig. 1 represents a motor starter apparatus, actuated by muscular force or by electric current, in which the armature alone, which is movable and is of large diameter, serves as the flywheel.

Fig. 2 is a modification of the apparatus shown in Figure 1, in which the apparatus is driven solely by muscular force and hence does not comprise a field, the armature being replaced by a steel mass.

Fig. 3 is an apparatus analogous to Figure 1, in which the field alone is movable and the armature is fixed, in order to facilitate the arrangement of the electrical parts.

Fig. 4 is a longitudinal section of a combination apparatus in which the field and armature rotate in opposite directions, so that their masses are added together for the obtainment of the maximum kinetic energy of a greater number of rotating parts, their speed of rotation being such that the speed V of the armature+the speed $v$ of the field will give the speed W at which the armature would rotate if the field were fixed, and inversely.

Fig. 5 is a cross section showing the pinions controlling the cooperating rotation of the armature and the field, which rotate in contrary directions.

Fig. 6 is an apparatus analogous to Figure 4, but provided with an interposed reversing pinion by which the field and armature are rotated in the same direction and at different speeds.

Fig. 7 is a cross section showing a set of gearing for the control of the cooperating rotation of the field and armature, both rotating in the same direction.

Figs. 8 and 9 show apparatus in which the energy required to rotate the starter is furnished by muscular force, electric power, or compressed air; the apparatus may be constructed for the possible use of one or two of these sources of power.

Figure 8 shows an apparatus in which the admission and the discharge of compressed air is controlled by a hand controlled two-way cock.

Fig. 9 shows an apparatus in which the compressed air is admitted by hand control and it is automatically discharged at the end of the stroke by means of a movable tappet adapted to close the air admission cock or valve while opening the discharge cock or valve.

Fig. 10 is a lengthwise section of a starter of the inertia type employing muscular force.

Fig. 11 is a front view showing the position of the sets of speed-increasing pinions used as planetary pinions.

Fig. 12 is a cross section showing the disposition of the friction brake disks and the planetary pinions which bear upon the stationary braked disk.

Fig. 13 is a view analogous to Figure 12, in which the cylindrical coiled springs of the friction brake are replaced by single or multiple strips.

Figs. 14 and 15 are front and side views of the strips shown in Figure 13.

Fig. 16 is a developed view showing the engagement of all the speed-increasing planetary pinions, allowing a comparison of the minimum space actually occupied in the starter, with the space covered by the developed view.

Figs. 17, 18, 19, 20, 21, 22 and 23 are diagrammatic views showing different arrangements of clutch teeth.

Fig. 24 shows a starter provided with an electric motor of large diameter whose armature forms a flywheel and which can be set in motion by hand, if required, by means of starting pinions disposed at the middle part of the starter instead of at its end as shown in Figure 10.

Fig. 25 shows a like device, with an additional bevel pinion by which the position of the starting handle can be changed.

Figs. 26 and 27 are modifications in which the controlling element may assume any position

with reference to the coupling of the worm gearing.

Fig. 28 shows an arrangement of clutch teeth.

Referring to the apparatus shown in Figure 1, this comprises a stationary field 2 secured to the casing, and a movable armature 1 keyed to a shaft and provided with a pinion 3 engaging an internal tooth disk 5, through the medium of pinions 4—4'. The gearing 3—4—5 forms a speed-increasing device which may be differently constructed, by the use of worm gearing, bevel gearing, sets of epicycloidal gearing, or the like, in such manner that a handle 6 may be used to rotate the pinion 3 at a greatly increased speed in order to rotate the said armature 1 in the most rapid manner.

In the case of an exclusively electric control, the said apparatus may comprise a clutch device. Upon the rotor or armature 1 is mounted a speed-reducing device, given by way of example, which comprises the planetary pinions 7—7' engaging a stationary gear wheel 8 secured to the casing, and also engaging a pinion 9 in such manner as to rotate the latter at a very slow speed.

At the end of the casing is disposed the clutch 10, which herein comprises multiple disks, and in which is movable the hub or core of a jaw clutch member 11 cooperating with a like member 12 mounted on the motor starter. The clutch member 11 may be engaged or removed by a controlling device 18.

The armature is given a very large diameter in order to form a flywheel whose inertia, when set in rotation by hand or by an electric current, will afford a considerable kinetic energy adapted to start the motor.

In the apparatus shown in Figure 2, muscular force is alone employed. The field 2 is eliminated, and the armature 1 is replaced by a steel flywheel 13 of like dimensions.

In Figure 3, the armature 14 is stationary, and the field 15 having a heavy weight is provided with a speed-increasing device 5—4—3 adapted for hand control, and with a speed-reducing device 7—8—9, also with the clutch 10—11. The principle is the same as in Figure 1, except that the armature is stationary and the field is movable.

In the arrangement shown in Figures 4 and 5, the armature 25 turns to the right, for instance, and the field 24 turns to the left. The weights of the field and armature act to increase the kinetic energy of the apparatus. Herein the number of stationary parts is reduced to the minimum, that is, the outer casing and the stationary supports for the reaction of the speed increasing and reducing device. In this apparatus, the speed-increasing device 6—5—4 engages the ring or disk 19—20 having a double set of internal teeth, thus rotating the pinions 21—22 which drive the armature 25 and its pinion 26 in one direction, while the field 24 and its internal tooth disk 23 rotate in the other direction. The speed-reduction device 7—8—9 may be secured to the field or to the armature (herein it is mounted on the armature) and it transmits the power to the disk clutch 10 and to the jaw clutch member 11, as above specified.

In the apparatus shown in Figures 6 and 7, the armature 23 and the field 24 rotate in the same direction, due to the supplementary reversing pinions 27—28. Otherwise the construction is the same as in Figures 4 and 5.

An electric motor may also be employed which comprises a stationary field and armature cooperating with a rotating flywheel, or a movable field and armature rotating about a stationary flywheel.

In the apparatus shown in Figure 8, the air compressed in a recipient 38 by a pump 36 controlled by a lever 37 may be admitted when desired into the cylinder 29 by opening the cock 33. The compressed air thus supplied will raise the piston 30 whose rod comprises a rack 31 cooperating with the pinion 32, secured to an internal tooth disk 5 forming part of the speed-increasing device 3, and thus the motion is transmitted in the same manner as in Figure 1.

At the end of the stroke, that is, when the apparatus has reached the speed necessary to start the engine, the cock 33 can be so turned that the compressed air in the cylinder 29 can be evacuated into the atmosphere. A spring 42 serves to return the piston 30 and the rack 31 to the starting point, for the next use of the compressed air.

The air employed in the cylinder 29 can be evacuated as shown by way of example in Figure 9. A movable tappet 43 entering the cylinder 29 is impelled by piston 30, and said tappet acts upon a knob 39 secured to a rod 40 which is connected to a lever 41 controlling the cock 33 adapted to open or close the compressed air conduit leading from the said recipient 38. As before, the energy of the compressed air can be used in sole combination with the muscular power exercised by means of the handle 6, and herein the field 2 and armature 1 are eliminated, substituting a heavy mass as shown in Figure 2 at 13.

In the apparatus shown in Figures 10 and 11, the motor to be started comprises a jaw clutch member 51 engaging the like member 52 of the starter, when the motor is being started. When the said starter has been set in motion by the crank-operated device 65 acting upon the bevel gearing 63—64, the clutch member 52 is engaged with its cooperating member 51 by means of the levers 59—54 and the stud 53, thus compressing the reaction spring 77. At this time, the power stored up in the flywheel 67 is imparted through the pinion 66 to two, three or more sets of speed-reducing pinions 87, 85, 86, 83, 84, 81, 82, 79, 80, 69, 68, 73, 74 and thence to the planetary pinions 57 which bear upon the stationary toothed disk 70. The said planetary pinions 57 (of which two, three or more can be used) drive by their axles the casing 56 which is provided with clutch teeth by which all adjustment when mounting the motor to be started is dispensed with. When a great force is exercised at starting, the abrupt action of the teeth 52 of the apparatus engaging the teeth 51 of the motor will be attenuated by the friction brake bearing upon the stationary disk 70 through the medium of the disks 71—71' which are mounted alternately on the said disk 70 and the stationary casing of the apparatus and are compressed by springs 72.

Under the action of an excessive force, the disk 70 will no longer remain stationary but will slip, thus slowing or even stopping the motion of the member 36 carrying the teeth 52; the disk 70 will absorb the dynamic energy of the flywheel 67 either wholly or partially.

In Figures 13, 14 and 15, the springs 72 of the friction brake are replaced by the spring strips 92 which bear upon the stationary casing 90 in order to act upon the disks 71—71', and the device is actuated by the stops 91 disposed upon the casing 90.

As above stated, the starting apparatus is operated by the handle which carries the entrain-

ing device 65 and which acts through the medium of the pinions 63—64 to rotate the casing 56 by means of the entraining device 76 which is keyed to the latter and which serves as a guide for the clutch member 52.

The starting gear wheels being disposed at the end of the starting apparatus, Figure 10, their position is adjustable by means of a small bearing cap which may be turned about in its position on the starter casing. In a modification shown in Figure 24, this orientation is effected in the middle part by the handle 108 adapted to drive the pinion 106 which is maintained by a ball bearing of large diameter 120. The pinion 106 engages a bevel gear wheel or disk 107 mounted on the casing 56 and rotatable with the same and with the planetary pinions 57.

In Fig. 24, it is observed that the flywheel 67 may be replaced by an armature 109 of large diameter serving the same purpose; the field 110 is secured in the interior of the casing 62 of the starter. The armature 109 or the field 110, or both, may be movable.

The orientation of the starting apparatus is effected upon the face opposite the motor to be started, and for this purpose, numerous securing holes 58 in the casing correspond to a suitable number of holes in the motor to be started. This adjustment of the position of the starter with reference to the motor is completed by an orientation of the handle 108 in a plane perpendicular to the axis of the starter, by the addition of a rotatable casing 113 containing two bevel gear wheels 111—112 which control the starting pinion 106 (Figure 25).

This general control may also be effected by the apparatus shown in Figures 26 and 27, which comprises worm gearing adapted to turn the handle into all desired positions. Said handle actuates a pinion 117 cooperating with a pinion 116 secured to a pinion 114 which is keyed to the shaft of the bevel wheel 106. This construction might operate a similar set of bevel gearing.

When the starting apparatus is rotated, a self-regulating arrangement is employed in which the clutch member 52 is engaged with the clutch member 51 by means of the levers 59 and 54. The device is shown in Figures 17–18, and it comprises the projections on the casing 56 and on the member 55. In the starting position (Fig. 17), and in the clutched position as shown in Fig. 18, the projection 76 of the actuating casing 56 will slide upon the rectilinear part 96 of the projections of the member 55. When the projections 51—52 are at the beginning of their engagement, the rounded edge 95 of the projections 76 will act upon the inclined plane 83 of the projections of the member 55 carrying the claw 52, and this produces a resultant which then serves for the circumferential motion, and for the end-to-end reaction, which tends to further engage the claw 52 with the projections 51 of the motor to be actuated.

Figure 19 shows a modification in which the rectilinear part of the ramp is eliminated when a small stroke will suffice for the engagement of the clutch member 52; the projection of the casing 56 and the projection of the member 59 each comprise a ramp 97—98.

The sides of the ramps of the entraining casing 56 and of the member 55 carrying the claw 52 may be cut so as to form gear teeth or rack teeth, as shown at 97, 98, 104, 105 in Figure 28.

To avoid all excessive friction and to facilitate the engagement of the jaws 61—52, there may be interposed between the ramps 77 and 98, one of the modifications shown in Figures 19 and 22, friction rollers 99, Figures 20 and 21 which are held in place by rollers 100—101 or by small rollers provided with ball bearings 102 secured to the member 55 carrying the jaw 52 by means of forked brackets 103 and adapted to roll upon the ramp 97 of the casing 56. An inverse arrangement may be employed in which the ball bearing 102 is mounted on the actuating casing 56 and rests upon the ramp 98 of the member 55 carrying the claw 52.

The said apparatus is susceptible of various modifications in detail without change in the principle of the invention, which consists essentially in the use of the kinetic energy of a heavy mass rotated by suitable means, which energy is imparted to the starting device by the multiple sets of gearing having the circumferential position, whereby the general size of the apparatus is reduced.

I claim:

1. A starter for internal combustion engines comprising a member adapted to have clutching engagement with the shaft of the engine, means for driving said member including concentrically disposed field and armature elements, a system of gearing between said elements including an internally toothed gear on the one and an externally toothed gear on the other of said elements a larger and a smaller externally toothed gear meshing respectively with the said externally and internally toothed gears for increasing the speed of one element relatively to the speed of the other element and means for rotating the elements in reverse directions about the axis of the member under their own power to rotate the member.

2. A starter for internal combustion engines comprising a member for clutching engagement with the crank shaft of the engine, a concentrically disposed armature and field magnet rotatable under their own power about the axis of the member, a speed increasing gear, a gear train between the speed increasing gear and field magnet operable by the speed increasing gear for rotating the armature and field magnet in reverse direction, and a speed reducing gear, between the field magnet and said member.

LÉON GÉRARD.