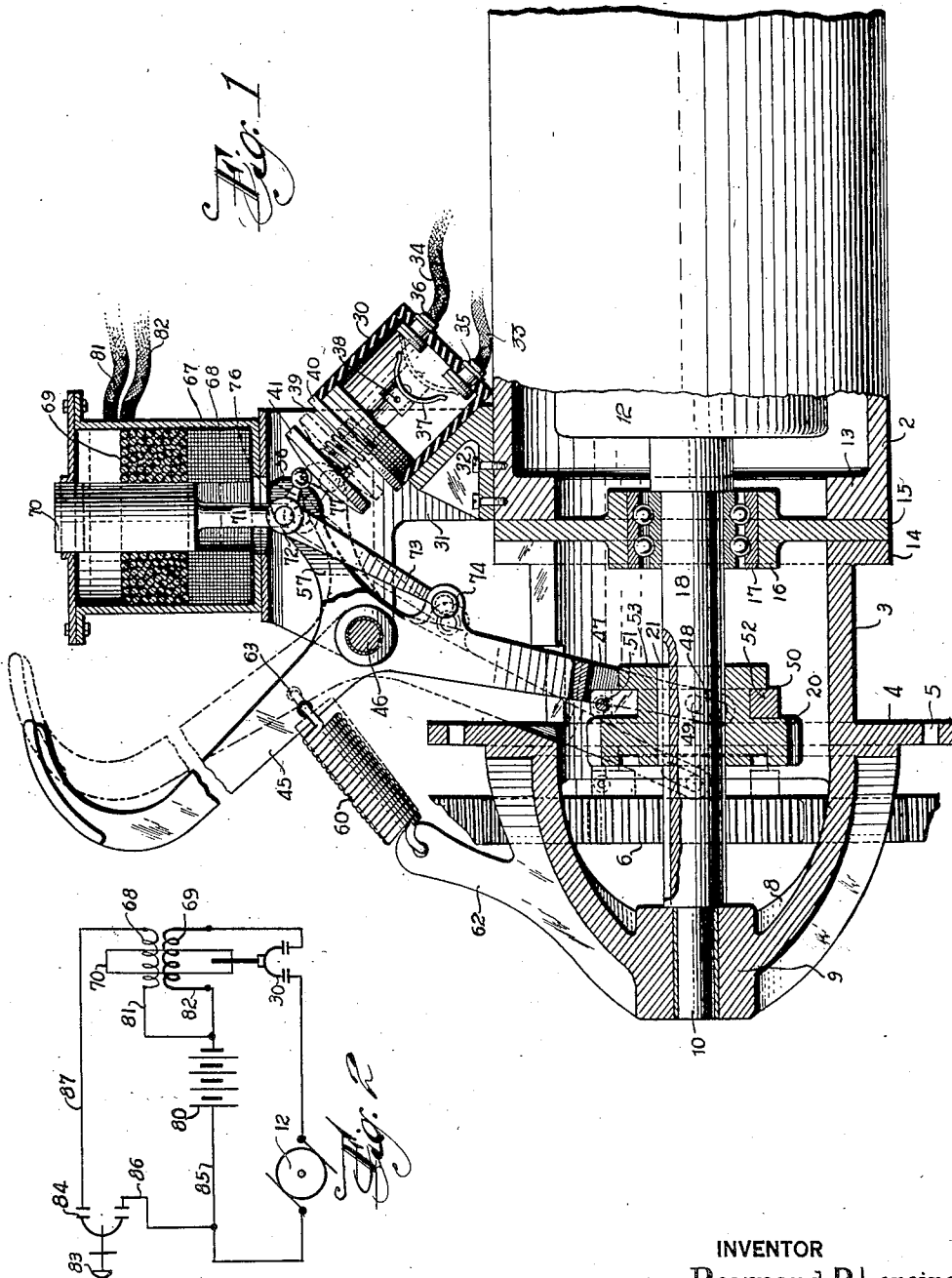


Sept. 25, 1934.

R. P. LANSING
STARTING MECHANISM

1,974,870

Filed May 8, 1931



INVENTOR
Raymond P. Lansing
BY
F. B. Smith
ATTORNEY

UNITED STATES PATENT OFFICE

1,974,870

STARTING MECHANISM

Raymond P. Lansing, Montclair, N. J., assignor
to Eclipse Aviation Corporation, East Orange,
N. J., a corporation of New Jersey

Application May 8, 1931, Serial No. 536,036

8 Claims. (Cl. 290—38)

This invention relates to starting mechanisms, and more particularly to starters for engines of the internal combustion type.

One of the objects of the invention is to provide, in an engine starter, novel means for producing engagement between the cranking member and a member of the engine to be started.

Another object of the invention is to provide in an engine starter of the motor-driven type, novel means for controlling the energization of the driving motor.

Another object of the invention is to provide, in an engine starter of the motor-driven type, novel means for controlling the energization of the driving motor by combined manual and electro-magnetic action, or, in the alternative, by purely manual action.

A further object of the invention is to provide, in a device of the foregoing character, novel means for automatically energizing the motor driving means in response to a predetermined movement of the engagement producing means above referred to.

Another object of the invention is to provide means serving to establish a definite relationship in the operation of the motor energizing, engagement producing, disengaging and motor de-energizing means.

Another object of the invention is to provide combined manually and automatically operable means for achieving the objects above set forth.

A further object of the invention is to provide in an engine starter, novel means for producing engagement between the cranking member and the engine member by combined manual and electro-magnetic action, or, in the alternative, by purely manual action.

A further object of the invention is to provide in a motor-driven starter of the type above described, novel means for energizing the motor, said means being operable automatically prior to the establishment of driving relation between the starter and the engaged member of the engine.

A further object of the invention is to provide novel electro-magnetically controlled means for operating the engine-engaging means.

A further object of the invention is to provide in an engine starter, novel electro-magnetic means for maintaining engagement between the engaged members of the starter and the engine during the period of cranking, in combination with means opposing such electro-magnetic means, but ineffective to disengage said elements until starting of the engine under its own power.

Another object is to provide apparatus of the foregoing character which is of relatively simple construction, readily accessible, and positive in its operation.

Other objects and advantages to be derived

from the use of the invention disclosed herein will become evident on a consideration of the following description when read with reference to the accompanying drawing illustrating one embodiment of the invention. It is to be expressly understood, however, that said drawing is for the purpose of illustration only, and is not to be construed as a definition of the limits of the invention, reference being had for this purpose to the appended claims:

In the drawing,

Fig. 1 is a transverse sectional view of a device embodying the invention; and

Fig. 2 is a schematic illustration of the electrical parts and circuits.

Referring more particularly to Fig. 1, the invention is therein shown embodied in a casing having two sections, 2 and 3, joined by suitable means to be described, the section 3 having a flange 4 provided with suitable apertures 5 through which may be inserted bolts or other means for fastening the flange 4 to the crankcase (not shown) of an engine to be started, a rotatable member of which is indicated at 6. The member 6 is preferably provided with gear teeth, as shown, for a purpose which will appear hereinafter, and may be considered as the fly-wheel of the engine to be started, or other rotatable member drivably connected to the engine crankshaft.

The section 3 of the casing is further provided with an inwardly extending portion 8 terminating in a cylindrical boss 9 having a suitable central aperture for the reception of the end portion 10 of the drive shaft of the motor, whose casing 2 encloses an armature 12. The casing 2 also has a flange 13 adapted to be secured to the flange 14 of casing 3, between which flanges is interposed a transversely disposed wall 15 having a cylindrical hub 16 serving for the reception of a suitable bearing member 17 on which the armature shaft 18 is rotatably supported.

The means preferably employed for drivably connecting the shaft 18 of the starter with the engine member 6 comprises a pinion 20 surrounding the shaft 18, and splined or otherwise suitably secured thereto, as indicated at 21, so as to be rotatable therewith, but movable longitudinally thereof from the position shown in full lines in Fig. 1, to the position indicated in dash lines, in which position the pinion meshes with the teeth of the member 6.

In the form shown, the novel means for producing such engagement between the pinion 20 and the engine member 6 comprises combined manual and electro-magnetic means, or in the alternative, remotely controlled electro-magnetic means; the operation in either case involving the provision of a motor energizing circuit including

a switch operable in one case by electro-magnetic action, and in the other, by manual action.

A switch for this purpose, as shown in Fig. 1, may include a casing member 30, supported on a suitable bracket 31 attached to the motor housing 2 by suitable means 32, the casing 30 having openings at its lower end for the insertion of suitable current conducting leads 33 and 34 terminating in contact posts 35 and 36, the said contact posts being insulated in any suitable manner for the remaining elements, and being adapted to be bridged by a contact plate 37 provided at the lower end of the switch operating stem 38, the latter being operatively engaged by a suitable spring 39 adapted to engage a cover plate 40 of the housing 30, and to normally hold the switch operating button 41 and contacts 35, 36 and 37 in the position indicated in full lines.

Novel combined manual and electro-magnetic means for operating switch button 41 to close the motor circuit, and for meshing pinion 20 with the member 6 are illustrated in Fig. 1 as taking the form of a lever 45 pivoted intermediate its ends on a suitable pivot 46, which may be mounted in bracket 31. Lever 45 is provided at its lower end with a bifurcated portion or yoke 47 provided with slotted portions 48 adapted to engage pins 49 of a band 50, the ends of which are suitably joined as by means of a pin 51. The hub portion 53 of pinion 20 is provided with an annular groove 52 to receive the loosely fitted band 50.

Extending laterally from the lever 45, at a point adjacent the pivot 46, is a third arm 57 having a rounded end portion or finger 56 adapted to engage the switch button 41 upon movement of the lever 45 from the position indicated in full lines to that shown in dash lines. A suitable spring 60, having one end secured to a finger 62 on boss 9 and its other end secured to lever 45, is provided to normally maintain the lever in the position shown in full lines, that is, with the pinion 20 in non-meshing position, and contacts 35, 36 and 37 open.

The combined manual and electro-magnetic means is preferably constituted by a solenoid having a conducting casing 67 supported on the bracket 31 and enclosing a pair of coils 68 and 69 of the same or different electrical resistance values and wound in any suitable way about a movable core or plunger 70. As shown, the coils are laterally spaced and coaxially arranged, but it is within the scope of the invention to use any other commonly employed method of winding, as, for example, superimposing (either in whole or in part) one winding on the other. The core or plunger 70 preferably terminates in a portion 71 of reduced diameter having a pivotal connection 72 with a link 73, the lower end of which is pivotally secured to an ear or lug 74 on the lever 45. Link 73 is preferably provided with a laterally projecting arm 76 terminating in a knob 77 adapted for operative engagement with switch button 41, as shown.

In Fig. 2 there is schematically illustrated a suitable method of controlling the electrical energization of the solenoid 67 and the motor 12. Referring to this figure, a suitable source of current is indicated at 80, while reference characters 81 and 82 designate the leads for the windings of coils 68 and 69 respectively. Other electrical parts are indicated in the diagram by the same characters employed to indicate the corresponding parts in Fig. 1. Reference character 83 is used in Fig. 1 to indicate a suitable switch,

having contacts 84 accessible for manual operation.

Assuming it is desired to operate the starting mechanism by the remote control means (switch 83) indicated in Fig. 2, closure of the contacts 84 of the switch will cause current to flow from the source 80 through the conductors 85 and 86, contacts 84, conductor 87, the winding of coil 68, and thence back to the source by way of conductor 81. The energization of the coil 68 results in a downward movement of core 70, whereby link 73 is effective to swing lever 45 in a clockwise direction, to move pinion 20 toward meshing position; while knob 77 acts on the switch 30 to close contacts 35, 36 and 37, thereby energizing the coil 69 in series with the switch and motor and creating a sufficiently strong magnetic pull on the core 70 to draw the latter downwardly a further distance, this further movement being sufficient for link 73 to shift lever 45 to a position such that pinion 20 is fully meshed with the engine member 6. It is only after completion of this final stage of the meshing movement of the pinion 20 that the armature shaft 18 begins to rotate at any appreciable speed, the full energization of the motor being delayed primarily by the inductive or "inductance" effect of the circuit, due to the self-induction characteristic of the coil 69, which characteristic impedes the passage of current of maximum value until after the lapse of a predetermined time interval, (represented by the equation

$$T = 2\pi\sqrt{LC}$$

or

$$T = L/R$$

L being measured in henries, C in farads, and R in ohms), during which the magneto-motive force exerted upon the core 70 increases. This self-induction or "electric inertia", coupled with the physical inertia due to the friction in the mechanical parts and brushes of the motor itself, delays the acceleration of the armature shaft 18 for an interval which, although brief, is greater than that required for the solenoid to complete the meshing movement of the pinion 20.

In the event that the teeth of pinion 20 strike those of the engine member 6 during the meshing movement the obstruction will be only temporary, as the first rotative impulse of the motor will turn pinion 20 sufficiently to avoid the obstruction, where upon the continued pressure exerted by the plunger 70, in response to the electro-magnetic influence to which it is subjected, will insure movement of the pinion into full meshing engagement, whereby the engine is cranked and started. During this cranking operation, the magnetic force in coil 69 is sufficient to hold the pinion firmly in engagement against the tendency of spring 50 to retract it.

When the engine starts under its own power, the resultant greater speed which is now imparted to the motor develops therein an electro-motive force opposing that of the source 80, whereby the field of coil 69 is weakened and spring 60 is accordingly effective to withdraw the pinion 20 from engagement with engine member 6. It will be noted, moreover that this result will occur on starting of the engine under its own power, whether or not the operator has in the meantime allowed the switch 83 to return to the open position, although it will be understood that there is no purpose in maintaining the latter closed beyond the time of

starting of the engine under its own power. In fact it may be released sooner, since coil 69 is sufficient in itself to hold the plunger in motor energizing position, and thereby hold its own circuit closed.

In the event of failure of switch 84, or when its use is not desired, the engine may be started by foot or other manual pressure exerted on the end of lever 45; in which event the operation will be as above described, except that finger 56, under those conditions, will be the means for closing the motor switch rather than knob 77.

There is thus disclosed a novel engine starter of the electrically driven type wherein engagement of the engine starter with the engine may be produced either by remotely controlled electro-magnetic means or by direct action of the manually operated means; and wherein the interrelation of the parts with the electrical driving means is such that both the meshing and driving action are produced in response to a single act on the part of the operator, such act being in one case the closure of a preliminary electric circuit, and in the other case, the manual operation of a mechanical meshing and motor energizing device.

While the particular embodiment of the invention which is here illustrated is considered to possess a high degree of merit in the form illustrated, those skilled in the art may modify the structure and arrangement of the component parts, and therefore, the claims are not to be narrowed in construction by reference to the accompanying drawing. For example, any suitable driving mechanism employing gears or other equivalent driving connections may be substituted for the direct driving means herein shown. It is to be understood that various other changes may be made in the construction, arrangement and inter-relation of the parts constituting the invention without departing from the spirit thereof, the extent of the permissible variations being ascertainable by reference to the appended claims.

What is claimed is:

1. In an electric motor-driven starter for internal combustion engines, the combination of a motor, a shaft to transmit the power from said motor to a member of the engine to be started, an engine-engaging member adapted to be driven by said shaft, and electro-magnetic means for moving said engine-engaging member into engagement with said engine member, said electro-magnetic means including a manually operable member movable upon energization of said electro-magnetic means, and said manually operable member also constituting the means for energizing said electro-magnetic means.

2. In an engine starting mechanism of the type employing a motor-driven engine-engaging member movable into engagement with a member of the engine to be started, the combination with said engine member and engine-engaging member of an electric motor having a driving connection with said engine-engaging member, means for manually shifting said engine-engaging member along said driving connection, and electro-magnetic means for producing a further shift thereof into engagement with said engine member.

3. In an engine starting mechanism of the type employing a motor-driven engine-engaging member movable into engagement with a member of the engine to be started, the combination with said engine member and engine-engaging member of an electric motor having a driving connection

with said engine-engaging member, means for manually shifting said engine-engaging member along said driving connection, and electro-magnetic means for producing a further shift thereof into engagement with said engine member, said last named means being rendered effective automatically in response to operation of said manual shifting means.

4. In an engine starting mechanism of the type employing a motor-driven engine-engaging member movable longitudinally into engagement with a member of the engine to be started, the combination with said engine member and engine-engaging member of a shaft having a splined connection with said engine-engaging member, means for manually shifting said engine-engaging member along said splined connection, and electro-magnetic means for producing a further shift thereof into engagement with said engine member.

5. In an engine starting mechanism of the type employing a motor-driven engine-engaging member movable into engagement with a member of the engine to be started, the combination with said engine member and engine-engaging member of an electric motor drivably associated with said engine-engaging member, means for energizing said electric motor comprising a circuit thereto, a switch in said circuit, a plunger adapted to close said switch when moved a predetermined distance, means operable upon further movement of said plunger to produce movement of said engine-engaging member into engagement with said engine member, and manual means, alternatively operable, for producing such further movement of said plunger.

6. In an engine starting mechanism of the type employing a motor-driven engine-engaging member movable into engagement with a member of the engine to be started, the combination with said engine member and engine-engaging member of an electric motor drivably associated with said engine-engaging member, means for energizing said electric motor comprising a circuit thereto, a switch in said circuit, a pair of coils, a plunger associated with said coils and adapted to close said switch when moved a predetermined distance, means operable upon further movement of said plunger to produce movement of said engine-engaging member into engagement with said engine member, and alternatively operable manual and electro-magnetic means for producing such further movement of said plunger, said electro-magnetic means including one of said coils.

7. In starting mechanism of the class described, the combination with an engine member and a driven member engageable therewith, a manually operable member for moving the driven member to engaging position, and electrical means for moving said manually operable member through a portion of its range of movement.

8. In an electric motor-driven starter for internal combustion engines, the combination of a motor, a shaft to transmit the power from said motor to a member of the engine to be started, an engine-engaging member adapted to be driven by said shaft, electro-magnetic means for moving said engine-engaging member into engagement with said engine member, said electro-magnetic means including a manually operable member movable upon energization of said electro-magnetic means, and said manually operable member also constituting the means for energizing said electro-magnetic means, and alternatively operable means for energizing said electro-magnetic means.

RAYMOND P. LANSING.