Feb. 28, 1933. R. P. LANSING 1,899,812

ENGINE STARTER

Original Filed Nov. 16, 1925 2 Sheets-Sheet 1

Fig. 1.

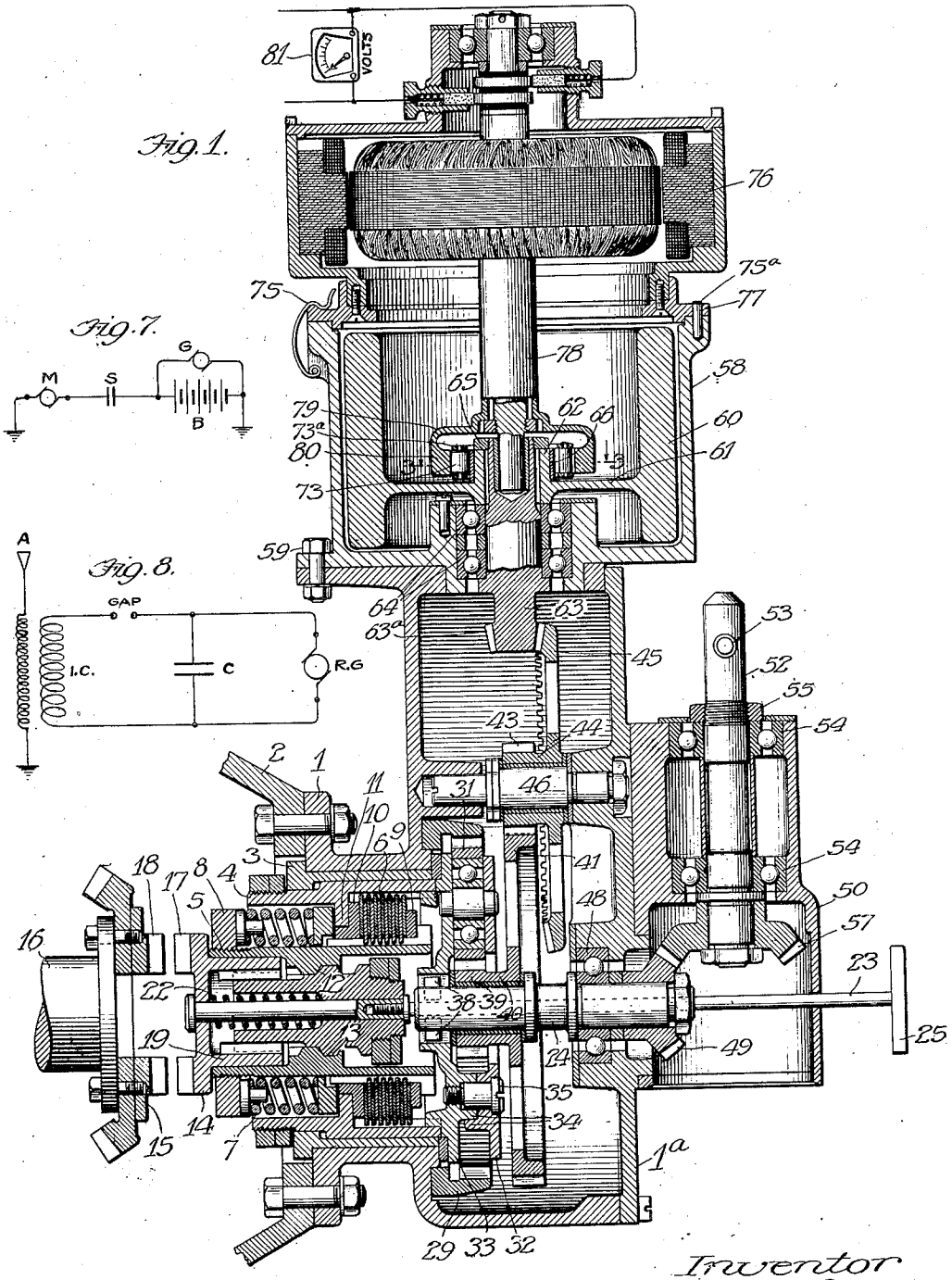

Fig. 7.

Fig. 8.

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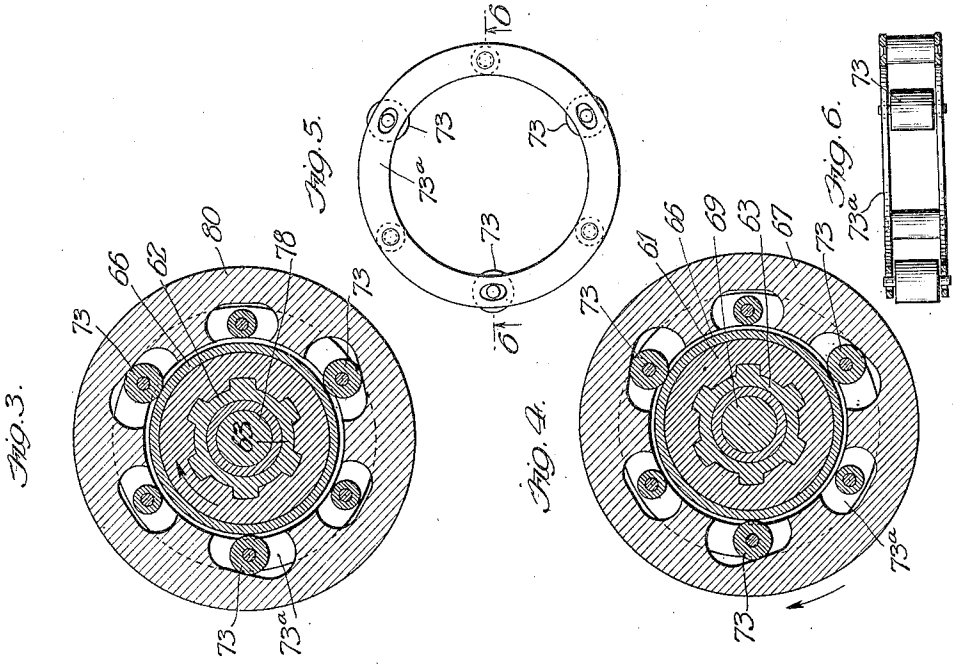

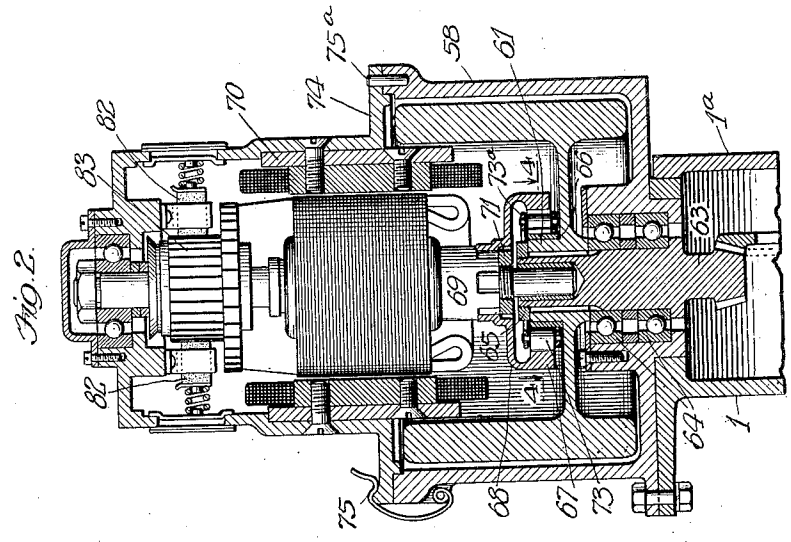

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UNITED STATES PATENT OFFICE

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ENGINE STARTER

Application filed November 16, 1925, Serial No. 69,534. Renewed June 16, 1931.

My invention relates to engine starting apparatus for the starting of engines, such as internal combustion engines, and more particularly, but not necessarily, airplane engines and the object thereof is to provide a simple, efficient and reliable apparatus capable of either manual or power operation or both and characterized by the provision of a radio generator interchangeable with the power means, such as an electric motor, and adapted to be operated by the manual means so that when the apparatus is used in connection with airplanes and in the event that the fuel supply of the airplane has become exhausted and no power can be derived from the engine, the radio generator may be substituted for the electric motor and may be operated manually in order to provide the electric current for the radio or wireless signals for the purpose of giving the location of the airplane and obtaining assistance.

In the drawings, Figure 1 is a vertical section of my apparatus (on an irregular section line) showing the generator in position in connection with the engine starting apparatus and showing the manual means at right angles to its normal position; Fig. 2 a vertical section of the starting motor in position on the starting apparatus, a part only of which is shown; Fig. 3 a horizontal section on the line 3—3 or Fig. 1; Fig. 4 a horizontal section on the line 4—4 of Fig. 2; Figs. 5 and 6 detail views of the clutch rollers and cage; and Figs. 7 and 8 wiring diagrams.

My starting apparatus comprises a transmission or drive including a driving member adapted to engage a member of the engine to be started and power means, such as an electric motor, and manually operated means. The power means and the manual means are here shown combined in the same apparatus and usable separately or conjointly if desired, and such motor is so mounted and connected with the starting apparatus that it is readily detachable for the purpose of enabling the radio generator to be substituted and to be actuated by the starting apparatus by the manipulation of the manual means. The driving member and the transmission or actuating means between it and the motor and the manual means may be of any suitable construction and in their details constitute no part of the present invention, but I prefer to employ the practical construction of this apparatus as shown in the drawings whose description is as follows:

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

The shell 5 is provided with internal long lead threads 12 on which is threaded a screw shaft 13 constituting the main portion of the driving member whose other principal portion is a clutch member 14 that is adapted to engage the engine member, such as the corresponding clutch element 15 forming a part of or secured to a rotatable part of the engine, such as the crank shaft 16 thereof. The clutch element 14 is a disk having clutch jaws 17 adapted to engage complementary clutch jaws 18 on the engine member and provided with a hub or sleeve portion 19 which has a bearing fit within shell 5 and which is splined on the exterior of the screw shaft 13 whereby the clutch element 14 and such shaft 13 have a relative longitudinal movement of limited degree independent of each other. The clutch element 14 is held in its outward position with a yielding pressure by a coil spring 22

which bears at its outer end against the bottom of sleeve 19 and at its inner end against the bottom of a socket formed in the outer end of the screw shaft. The driving member is operated and controlled manually by a rod 23 which passes centrally through the driving member and the main supporting shaft 24 of the reduction gearing. This rod terminates in a handle 25 at a point exterior of the apparatus, in the present instance, being located adjacent the exterior of the casing of the manually operated means hereinafter described.

Next describing the reduction gearing, the same is contained within the main casing and a cover plate 1^a by which such gearing is supported and in which it has its bearings. A main stationary internal gear 29 is secured to the casing 1 and with the same meshes a series of planetary gears 31 journaled between two parallel plates 32 and 33 which are spaced apart by suitable lugs 34 and held together by screws 35. The inner plate 33 is connected with the driving barrel 4, in the present instance by being splined thereto. This plate 33 has a hub provided with longitudinal grooves adapted to receive oppositely extending pins 38 whereby such shaft and plate are drivingly but detachably connected together.

The pinions or gears 31 mesh with a central pinion 39 here formed as a part of the hub 40 of a gear 41 mounted to rotate freely upon the shaft 24. This gear 41 meshes with a pinion 43 which is here formed upon the hub 44 of a bevel gear 45 which is mounted to rotate freely upon the shaft 46.

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

Next describing the inertia means, the same comprises a flywheel and operating connections with the bevel gear 45 and with the prime mover which is here an electric motor, such inertia means being contained within and supported by a casing 58 which is detachably secured to main casing 1 in suitable manner as by screws 59. The flywheel comprises a rim 60 having the predetermined or desired mass or weight, a web 61 and a hub 62. This hub is drivingly secured as by splining to a vertical shaft 63 which is journaled in bearings 64 in the casing 58 and has a bevel pinion 63^a meshing with gear 45. The flywheel is held in proper position on its shaft and with respect to its bearings by a nut 65.

The electric motor will first be described in connection with the starting apparatus as shown in Fig. 2, and then the radio generator will be described in connection with such apparatus as shown in Fig. 1. The outer surface of the hub 61 forms one of the members of a one-way or overrunning clutch, but by preference the same is constituted by a hardened steel ring 66 pressed thereupon. The other rotatable membr 67 of this clutch is formed on the inner circumference of a shell 68 secured in suitable manner as by splining to the extended armature shaft 69 of an electric motor 70 and held in place thereon by the nut 71. The lower end of the armature shaft extends downwardly into the shell 68 and is received by a socket in the upper end of shaft 63 acting as a bearing therefor. The clutch may be of any desired type, but in the present instance it is of the friction roller type in which rollers 73 located in recesses in the clutch element 67 are employed to frictionally engage and grip the outer circumference of the other clutch element 66. As shown in Figs. 5 and 6, these rollers 73 are contained within and have their bearings in a cage 73^a whereby the position of such rollers may be maintained when the other clutch element 67 is removed as hereinafter explained.

The electrc motor frame has an annular flange 74 which is adapted to rest upon and to be secured detachably to the casing 58 in suitable manner as by means of the latch 75 and dowel-pins 75^a. Upon the releasing of the latch 75, the motor may be withdrawn bodily from the starting apparatus and the outer member 67 of the friction clutch will be withdrawn therewith inasmuch as it forms a component part of the electric motor structure. It will be understood from consideration of Figs. 2 and 4 that the provision of this friction clutch permits of the transmission of torque from the motor to the starting apparatus, but automatically disconnects such motor therefrom when the manual means is operated. The direction of rotation of the outer member of the clutch is indicated in Fig. 4 by the arrow.

Next describing the radio generator and its operative connection with the starting apparatus and its interchangeability with the electric motor, a typical form of such generator is indicated at 76 and the same is provided with a frame having an annular flange 77 of such size that it may be mounted upon and be secured to the casing 58 by the same latch 75 and pins 75^a that secure the motor to such casing. This generator has an ex-

tended armature shaft 78 which as shown in Fig. 1 has its bearings in the upper end of the shaft 63 in the same manner as the armature shaft 69 of the motor. To the lower end of this shaft 78 there is secured as by splining a shell 79 having on its interior the outer rotatable clutch element 80 of a friction clutch which is similar to the other one-way clutch already described except that it acts in the opposite direction as will be apparent from an examination of Fig. 3 from which it will be seen that there can be transmission of torque only in the direction from the starting apparatus to the generator and not in the opposite direction with the result that when the manual means is operated the generator is rotated.

Upon the release of the latch 75, the generator may be readily removed from its operative connection with the starting apparatus, and in such withdrawal, the outer clutch member 80 is removed as it forms a component part of such generator, leaving as the permanent part of the clutch the inner clutch member and the rollers ready to receive the electric motor when it is desired to restore the power means to the starting apparatus after the generator has been operated and has served its desired purpose.

By preference, I employ in connection with the generator a voltmeter 81 shown diagrammatically in Fig. 1 so that the operator in hand cranking the apparatus and generator may be enabled to maintain a substantially constant speed of the generator which in practical use will cause the voltmeter to indicate about 200 volts.

Describing a cycle of operation of the apparatus, such as shown in Fig. 2, that is with the electric motor operatively connected with the starting apparatus and beginning with the utilization of the motor as the source of energy, when the motor is energized the shaft 63 will be rapidly rotated through the overrunning clutch which is adapted to transmit torque in one direction only, that is from the motor to the shaft 63 and to the succeeding elements in the train of the transmission. The flywheel is consequently rapidly rotated and when its R. P. M. reaches a predetermined figure, such as in practice from 15,000 to 20,000, the current if desired may be switched off from the electric motor and thereupon the rod 23 is manually moved inwardly, that is to the left of Fig. 1 and the screw shaft and its clutch element 14 are moved longitudinally and such element is thereby advanced and brought into engagement with the other clutch element 15 and the engine is thereby cranked in view of the fact that the clutch element 14 is being rotated through the transmission by means of the inertia flywheel. Such rotation will continue as long as there is sufficient energy left in the flywheel for that purpose or until the engine operates under its own power and the driving member is thereupon disconnected from the engine.

Describing the transmission of torque from shaft 63 and through the reduction gearing and drive proper, the rotation of shaft 63 will rotate gears 45 and 41 whereupon pinion 39 will be rotated and consequently the planetary pinions 31. These latter pinions by reason of their meshing with the internal stationary gear 29 will cause the entire frame by which they are supported consisting of plates 32 and 33 to be rotated. Inasmuch as plate 33 is drivingly connected to barrel 4, the latter will be rotated and consequently the shell or nut 5 will be rotated through friction clutch 6. Although shaft 13 is screw threaded to the now revolving nut 5 it will not advance longitudinally, but will rotate with such shell and consequently clutch element 14 will likewise be rotated. However, at this time such element is in normal position, that is out of engagement with the engine clutch element 15, but when rod 23 is moved to the left (Fig. 1) as hereinbefore explained the screw shaft will be moved longitudinally whereby such clutch elements will be brought into engagement and the torque of the accumulated energy of the inertia means or flywheel will be transmitted to the engine to crank the same.

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

Next describing the manual means as the source of energy, an ordinary hand crank is applied to the cranking shaft 52 and rotated by the operator first slowly until the flywheel gathers speed and thereupon more rapidly until the desired or predetermined R. P. M. of the flywheel is reached. In this operation, the torque is transmitted from shaft 52, through pinions 57 and 49 to shaft 24 and thence through the frame of the planetary pinions 31 to the gears 40 and 45 and thence to the shaft 63 and finally to the flywheel 60. When the manual means is thus in use and owing to the presence of the one-way clutch 66—67, the torque is not transmitted to the motor but such motor is disconnected from the shaft 63 and will thereupon remain idle whereby the considerable load occasioned by the pressures of the brushes 82 upon the commutator 83 is removed from the cranking operation. The flywheel having now been rotated to the proper speed, the rod 23 is manipulated and the engine cranked in the same manner as above explained.

Now assuming that it is desired to broadcast messages for assistance in the event of accident or forced landing of an airplane,

for instance, particularly in case of the exhaustion of the engine fuel, the motor is removed from the starting apparatus in the manner hereinbefore explained and the radio generator is substituted in place thereof. This generator carries its own special outer member of the roller clutch for the transmission of torque in the proper direction and the same readily fits upon and cooperates with the permanently remaining parts of the friction clutch, such as the inner member 66 and the rollers. After the generator has been secured in place by the same devices 75, 75a that had held the motor in place, the manual means is operated with the result that the torque is transmitted through the friction clutch to the generator whose proper speed of rotation is maintained substantially constant by the operator through his observance of the desired indication upon the voltmeter 81. In the broader aspect of my invention, it is not necessary to employ the inertia means but I prefer to operate such generator in combination therewith, in order that the constant speed of the generator may be the more readily maintained and fluctuations in speed of the generator through uneven hand cranking may be avoided.

Fig. 7 shows the wiring diagram when a starting motor is used, according to which the motor is indicated diagrammatically at M; the starting switch at S, the battery at B, and the grounds in the usual manner. The battery in the present instance is shown as charged by a generator indicated at G which generator is not otherwise shown but may be the usual battery charging generator driven in the usual manner by the engine, although a precharged battery, that is a battery charged otherwise than by such engine and generator may be used.

Fig. 8 is a diagram of a simple form of apparatus and wiring when a radio generator is used, according to which diagram the antennae or aerial is indicated at A, the induction coil at I. C., the condenser at C, the radio generator at R. G., and the spark gap at GAP. It will be understood that the current produced by this generator may be used for other purposes than for radio or wireless apparatus, such as electric signals of different kinds.

I claim:

1. In apparatus of the character described, a gear train adapted to constitute a drive for an internal combustion engine starter, manually operable means for driving said train, a machine to be driven, a flywheel driven by said gear train, and means associated with said flywheel for connecting said machine thereto to be driven thereby.

2. In apparatus of the class described, a step-up gear train adapted for use as a drive for an internal combustion engine starter of the inertia type, means for actuating said train, a flywheel permanently connected to said train and adapted to be driven thereby, a readily removable and replaceable dynamo electric machine, and clutch means operatively connected to said flywheel for readily connecting the dynamo electric machine thereto.

3. In apparatus of the class described, a step-up gear train having high and low speed ends adapted to constitute a drive for an inertia type engine starter, manually operable means for rotating the gear train at the low speed end, a flywheel drivably connected to the high speed end of said gear train, a generator, and means carried by said flywheel for readily and drivably connecting the generator thereto to be driven thereby.

4. In apparatus of the class described, a generator, a flywheel, clutch means for drivably connecting the flywheel and generator, a set-up gear train having high and low speed ends, the high speed end thereof drivably connected to the flywheel, and manual means for rotating the elements of the gear train at the low speed end whereby the generator may be driven at high speed.

5. In apparatus of the class described, a gear train having high and low speed ends, manually operable means connected to the low speed end of the gear train for driving the same, a flywheel connected to the high speed end of said gear train and adapted to be driven thereby, a generator, and means for drivably and detachably connecting said generator and flywheel including clutch elements carried by the flywheel, and a member operatively connected to the generator and adapted for detachable engagement with said clutch elements.

6. In apparatus of the class described, a generator and means for driving said generator at a uniform and high rate of speed including a flywheel, clutch elements carried by the flywheel and a clutch element carried by the generator and adapted for detachable telescopic engagement with said flywheel clutch elements.

7. In apparatus of the class described, a generator having a rotor, a clutch element carried thereby, a flywheel, a plurality of clutch rollers carried by the flywheel, said rollers and clutch element being adapted for ready connection and disconnection whereby a driving connection may be established between the flywheel and rotor, a step-up gear train having high and low speed ends, the high speed end thereof drivably connected to said flywheel, and manually operable means connected to the low speed end of the gear train for actuating the latter whereby said rotor may be driven at a rapid uniform speed.

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