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SELF STARTER OR THE LIKE.

APPLICATION FILED FEB. 7, 1917.

1,389,701. **Patented Sept. 6, 1921.**

Fig. 1

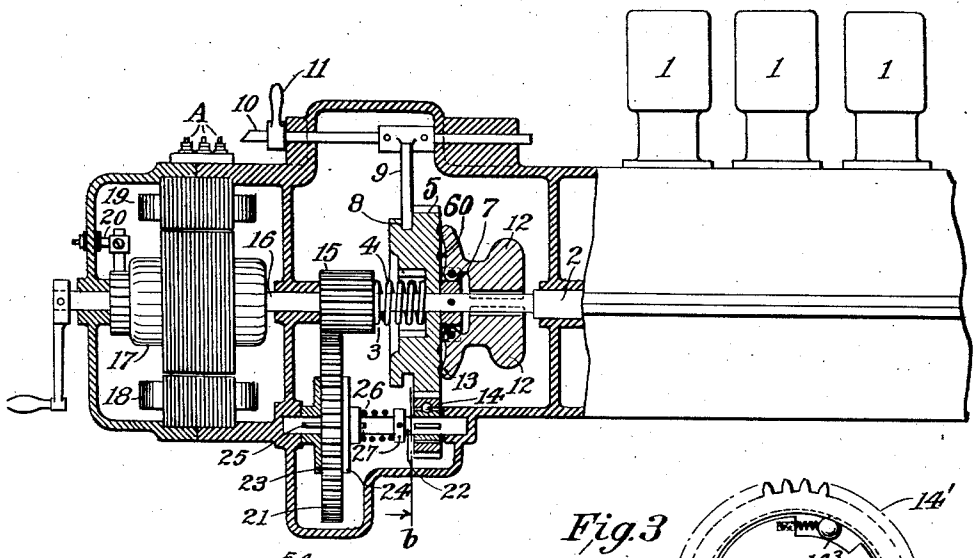
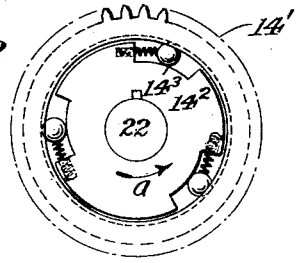


Fig. 3



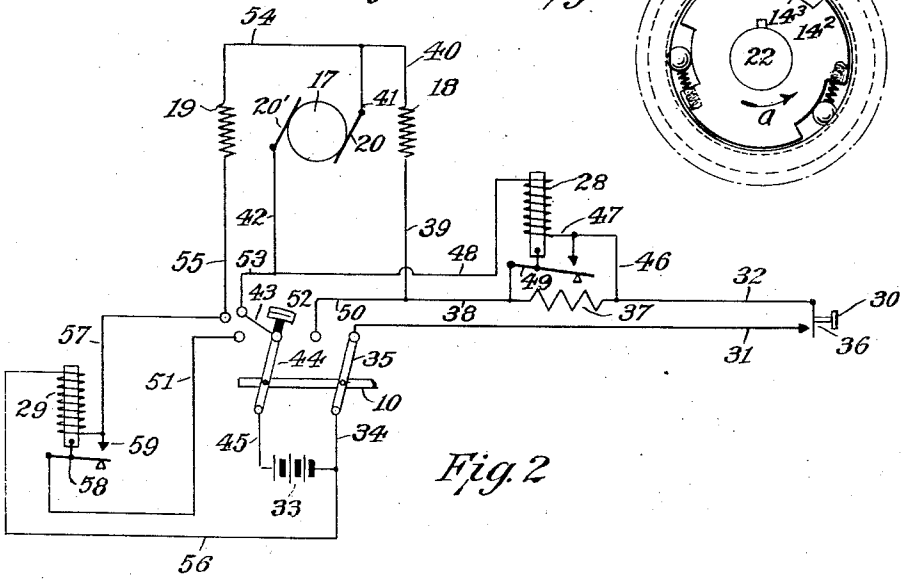


Fig. 2

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SELF-STARTER OR THE LIKE.

1,389,701. Specification of Letters Patent. Patented Sept. 6, 1921.

Application filed February 7, 1917. Serial No. 147,224.

To all whom it may concern:

Be it known that I, OSCAR A. ROSS, a citizen of the United States, residing in the city, county, and State of New York, have invented new and useful Self-Starters or the like, of which the following is a specification.

This invention relates to that form of starting devices for internal combustion engines particularly known as "self starter", or "electric starter".

The primary object of the invention is the production of a starter and mechanism associated therewith of such construction that a minimum of mental and physical effort will be required to start an internal combustion engine by means of the starter, and so arranged that the mechanism will automatically cause the starter as the driving element to become the driven element, acting as a generator when the speed of the engine started has arrived at a predetermined high speed, also inversely automatically causing said generator to become the driving element when the speed of the engine has been reduced to a predetermined low speed.

Another object of the invention is to produce a starter whereby the starting motor, or generator is arranged in substantial alinement with the crank shaft of the engine whereby as the motor is transformed into a generator it becomes directly connected to said crank shaft reducing transmission losses to a minimum.

Other objects and advantages will appear as the description of the invention progresses, and the novel features of the invention will be particularly pointed out in the claims appended hereto.

In describing the invention in detail, reference is had to the accompanying drawings, wherein I have illustrated a preferred physical embodiment of my invention, and wherein like characters of reference designate corresponding parts throughout the several views, and in which,

Figure 1, is an elevational view partly in section of an internal combustion engine with my starting device connected thereto.

Fig. 2, is a schematic view illustrating diagrammatically other preferred mechanism, employed with my starting device, together with the preferred manner and mode of electrically interconnecting the various electrical parts.

Fig. 3, is a detail view of a clutch mechanism employed in my invention, looked at in the direction of arrow *b*, Fig. 1.

1, designates cylinders of an internal combustion engine of which the crank shaft is designated by 2, terminating at one end in a plate 3, against which one end of spring 4, bears.

The shaft 2, carries slidably mounted thereon the internally and externally toothed gear wheel 5. The wheel 5, is constrained to turn with the crank shaft 2, at all times by means of a key (not shown), and is limited in its movement longitudinally on shaft 2, in one direction by collar 7, pinned to the shaft, and is prevented by means of the spring 4, from moving in the other direction longitudinally of the shaft unless considerable force is exerted upon the wheel to move it against the action of the spring. The wheel 5, also bears circumferential groove 8, into which is inserted a finger 9, which is rigidly connected to the longitudinally slidable rod 10, which carries handle 11. As will be readily seen any longitudinal movement of wheel 5, along the shaft 2, imparts a corresponding movement to rod 10.

The collar 7, pinned to the shaft 2, is provided with diametrically opposite notches in which the centrifugal weights 12, are pivoted. Said weights normally rest in the position shown, bearing against the shaft 2, with the projections 13, resting in a groove in wheel 5. While the armature 17, of the self starter is operating to crank the engine the speed of crank shaft 2, is low, in actual practice running from 100 to 200 revolutions per minute. At this speed the centrifugal action is not sufficient to impart enough power to weights 12, to move projections 13, from the rest position groove. However as the engine begins to operate under its own fuel, its speed becomes very high as compared to the cranking speed and at such time sufficient centrifugal action is obtained in the weights 12, to force projections 13, from the rest position groove and, as the resistance of forcing projections 13, from said groove is overcome, said projections immediately move to the inner, or running position groove 60, thereby forcing wheel 5, against and com-

pressing spring 4, so that the external teeth upon wheel 5, move out of mesh with clutch pinion 14, and the internal teeth move into mesh with the teeth of pinion 15.

The inner groove 60, on wheel 5, is of such construction that after projections 13, are seated in said groove they cannot be removed by a further rise in the speed of the crank shaft and further, they will remain in said groove on reductions of speed of abnormal amounts, only leaving said groove as the engine speed nearly approaches zero, at which time the weights 12, make a quick movement again permitting wheel 5, to engage gear 14, and arranging other coöperating parts to cause the generator to act as a motor whereby mere pressing of button 30, will again automatically crank the engine.

Pinion 15, is preferably rigidly attached to the shaft 16, which forms the shaft of armature 17, of a motor, having field coils 18, and 19, and brushes, as 20, only one of which is shown as the motor is in section. To the outer end of the shaft 16, a manually operated starting crank may be connected as shown, or any of the well known forms of manually operated starting means may be connected thereto. The terminals of the motor are designated collectively by A.

A gear wheel 21, is revolubly mounted on shaft 22, journaled in the casing of the motor and engine. The shaft carries two disks 23, and 24, which act as friction means for rotating gear 21. Disk 23, is constrained to revolve with shaft 22, by means of key 25, and is also rigidly secured to said shaft by means of a pin, not shown. Disk 24, is likewise constrained to revolve with shaft 22, by means of key 25, but however has longitudinal movement thereon and is pressed toward the gear wheel 21, by spring 26, which bears against collar 27, pinned to shaft 22. This construction allows slipping between shaft 22, and gear 21, when any excessive tendency exists for another force to drive gear wheel 21, in the direction opposite to normal, but at the same time allows pinion 15, to normally drive shaft 22.

The shaft 22, also carries the clutch pinion 14, shown in detail in Fig. 3. The pinion proper is an annulus having teeth formed in its periphery, designated 14^1. Within the annulus and surrounded by it, is a ball carrier 14^2. This ball carrier has notches cut in its periphery at intervals as shown which are of such depth at one end that a ball as 14^3, placed therein will not extend beyond the periphery of the member 14^2, when located in that end of the notch which is deepset but will extend beyond the periphery when located in the other end of the notch, consequently when member 14^2, is rotated in the direction of arrow *a* by a rotation of shaft 22, the balls will all be moved to the shallow part of the notch and thereby motion will be transmitted to annulus 14^1. If annulus 14^1, is itself moved in the direction of arrow *a* by the engine no motion will be transmitted to member 14^2, and shaft 22, consequently the engine may acquire a speed much greater than that of the motor without transmitting motion to the motor until pinion 15, and internally toothed gear wheel 5, mesh into each other.

In Fig. 2, 28, designates a slow acting relay. 29, is a relay which requires a certain fixed difference of potential across its terminals before it will raise its armature.

Assume it is desired to crank engine by means of the self starter. Button 30, is pressed which completes a circuit from wire 31, to 32, thus causing current to flow in the following path; positive terminal of battery 33, wire 34, lever 35, of the double arm switch operated by rod 10, wire 31, switch 36, wire 32, resistance 37, wires 38, and 39, series field 18, wires 40, and 41, brush 20, armature 17, the other brush 20′, wires 42, 53 and 43, arm 44, and wire 45, to the negative terminal of battery 33. Resistance 37, serves to prevent excess flow of current as the circuit is closed through the stationary armature 17, but is cut out immediately after the said armature has started rotating, by means of armature 49, of the slow acting relay 28.

The motion of the armature 17, is transmitted through shaft 16, pinion 15, gear wheel 21, shaft 22, member 14^2, balls 14^3, pinion 14^1, gear wheel 5, and shaft 2, to the engine 1, whereby if proper fuel and igniting means are present the engine will start.

As soon as the engine assumes the load under its own fuel, its speed increases rapidly and over runs the motor, however as hereinbefore explained it does not transmit motion thereto by means of pinion 14^1; however the weights 12 move away from shaft 2, thereby forcing projections 13, from the outer groove to inner groove 60, in wheel 5, in this manner moving said wheel from engagement with pinion 14^1, into mesh with pinion 15, in this manner driving armature 17, directly from the crank shaft 2, without any intervening gearing.

Simultaneous with the movement of wheel 5, into mesh with pinion 15, rod 10, is moved thereby causing the upper ends of levers 35, and 44, to move to the left and contact with wires 50, and 51. The first result of this movement is to cause the generator acting on its own residual magnetism to build up a greater flux density of the fields. The circuit through the shunt field by which this is accomplished is as follows; right hand brush 20, wires 41, and 54, shunt field 19, wire 55, bridge 52, wires 53, and 42, left hand brush 20′, thence through the armature winding to the other brush. By reason of the direction of winding of the shunt

field the direction of the magnetic flux generated by the shunt field is in the same direction as the flux generated in the fields by the starting current which flowed through the motor from battery 33, so that the action of the shunt field is to build up rather than oppose the residual flux caused by the starting current.

Simultaneously with building up the flux by the shunt field, a current also flows in the series field as follows; right hand brush 20, wires 41, and 40, series field 18, wires 39, and 50, arm 35, wires 34, and 56, high voltage relay 29, wire 57, bridge 52, wires 53, and 42, left hand brush 20, and thence by the armature winding to the other brush 20. When the armature 17, has acquired sufficient speed, a sufficient voltage is generated to cause relay 29, to raise armature 58, in this manner causing said generator to charge the battery 33, through the following circuit; right hand brush 20, wires 41, and 40, series field 18, wires 39, and 50, arm 35, wire 34, battery 33, wire 45, arm 44, wire 51, armature 58, wires 59, and 57, bridge 52, wires 53, and 42, left hand brush 20, and thence by the armature to right hand brush 20.

It should be observed that the generator is not connected across the battery terminals until it has built up its voltage, due to relay 29, sufficient to overcome the counter-electromotive-force of the battery.

It should also be observed that the starting current flows through series field coil 18, in an opposite direction to that in which the generated current which acts to charge battery 33, flows, and further, that the shunt field acts to generate a magnetic flux in the fields in the same direction as the flux generated by the starting current, consequently, it will be seen that the flux generated by the series field when acting as a generator is opposite to the flux generated by the shunt field. The result of such a construction is that when the generator attains a speed greater than a fixed minimum, the battery is not subjected to a greater and greater potential across its terminals, but is still subjected to a certain fixed minimum potential difference only, because all speeds above a certain fixed maximum by tending to increase the density of magnetic flux caused by series field 18, by just that amount decrease the effective flux caused by shunt field 19, and so decrease the ability of the generator to increase the potential difference at its terminals, and the result thereby is such that battery 33, can never, no matter what the speed of engine may be, be damaged by too high difference of potential impressed across its terminals.

Although I have particularly described the construction of one physical embodiment of my invention, and explained the operation and principle thereof; nevertheless I desire to have it understood that the form selected is merely illustrative, but does not exhaust the possible physical embodiments of the idea of means underlying my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a device of the kind described, an internal combustion engine, a dynamo connected therewith, a source of energy therefor, means controlling the relation of said source of energy to said dynamo, means including gearing for effecting a change of speed relation between said engine and said dynamo, and means affected by the speed of said engine for simultaneously controlling said means controlling the relation of said source of energy to said dynamo, and said means for affecting a speed relation between said engine and said motor-generator.

2. In a device of the kind described, an internal combustion engine, a dynamo connected therewith, reduction gearing interposed therebetween, means including a centrifuge operable at a predetermined speed to exclude said gearing, and at a predetermined lower speed to include said gearing said means remaining inoperative to include or exclude said gearing between said speeds, and means for direct connecting said internal combustion engine and said dynamo when said gearing is excluded.

3. In a combined starter and generator, in combination: a shaft of an internal combustion engine; a dynamo having a shaft; gearing including a gear mounted on the dynamo shaft connecting the shaft of the dynamo and the shaft of the internal combustion engine, including a one way clutch whereby the dynamo shaft may turn the engine shaft but the engine shaft cannot turn the dynamo shaft and including a gear slidably mounted on the engine shaft, a centrifuge driven by the engine shaft and having a part bearing against the said slidable gear whereby when the engine shaft attains a certain speed the slidable gear will be moved bodily and into operative engagement with the gear mounted on the dynamo shaft; a source of electro-motive force; circuit connections between the said source and the dynamo including switching devices; means for closing a circuit through the dynamo causing it to act as a motor supplied with energy from the said source and means governed by the slidable gear for changing the circuit between the dynamo and the said source whereby the dynamo will act as a generator and supply energy to said source.

4. In a combined starter and generator, in combination: an engine shaft; a slidable gear mounted on the engine shaft; means responsive to a certain engine shaft speed for moving the slidable gear; a dynamo; means governed by the slidable gear for

causing said dynamo to function as a generator and for driving said dynamo.

5. In a combined starter and generator, in combination: an engine shaft; a slidable gear mounted on the engine shaft; means responsive to a certain engine shaft speed for moving the slidable gear in one direction; means for moving the slidable gear in another direction upon the engine shaft speed decreasing to a certain minimum; a dynamo; a normally open circuit including a source of electro-motive force including a manually operable circuit closer and a switching device; and means operable by said slidable gear for operating said switching device whereby said dynamo functions as a motor upon operation of said manually operable circuit closer.

6. In a combined starter and generator, in combination: an engine shaft; a slidable gear mounted on the engine shaft; means for moving the slidable gear in one direction upon the engine shaft attaining a certain speed; means for moving the slidable gear in another direction upon the engine shaft speed decreasing to a certain minimum; a dynamo; normally open circuits including a source of electro-motive force and including a manually operable circuit closer and a switching device; means operable by said slidable gear for operating said switching device whereby said dynamo functions as a generator in one position of the slidable gear and whereby said dynamo functions as a motor upon operation of said manually operable circuit closer in the other position of the slidable gear.

7. In a combined starter and generator; in combination; an engine shaft; a slidable gear upon the engine shaft; a resilient means for moving said gear in one direction; a centrifuge for moving said gear in an opposite direction and means whereby the said centrifuge moves said gear when the engine shaft has attained a predetermined definite speed in increasing from zero speed, and whereby the said centrifuge will cause said gear to remain in moved position until the engine shaft speed has nearly approached zero speed when the engine speed decreases from a speed higher than the said predetermined definite speed.

In testimony whereof, I, OSCAR A. ROSS, have signed my name to this specification this 5th day of February, 1917.

OSCAR A. ROSS.