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ELECTRIC MOTOR STARTING DEVICE FOR INTERNAL COMBUSTION ENGINES.

APPLICATION FILED AUG. 20, 1919.

1,414,653. Patented May 2, 1922.

Fig. 2.

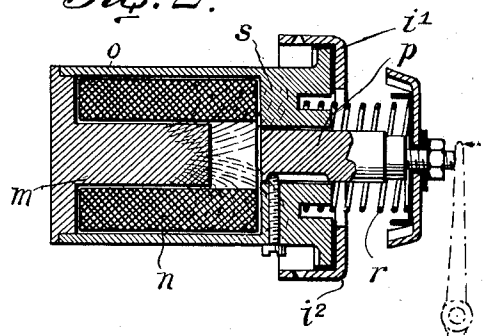


Fig. 3.

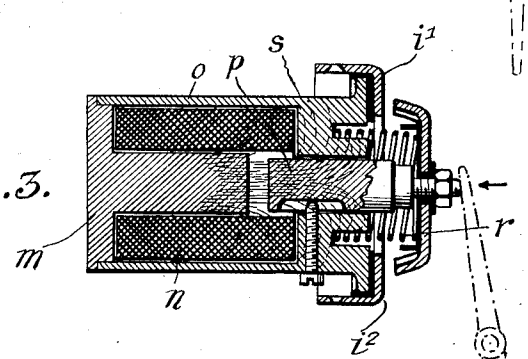
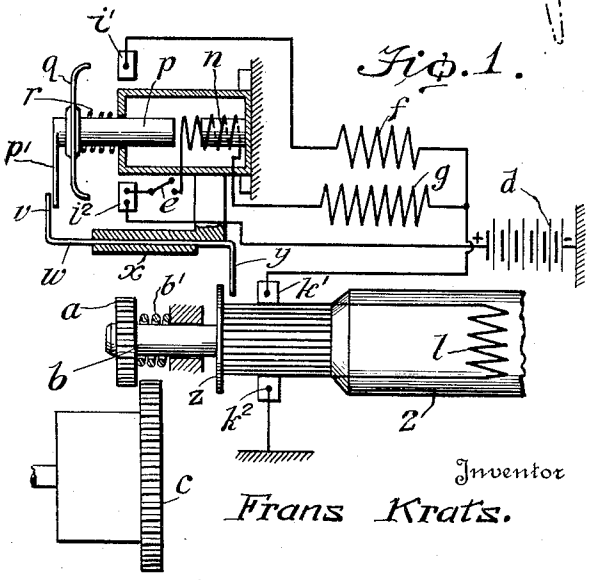


Fig. 1.



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ELECTRIC-MOTOR-STARTING DEVICE FOR INTERNAL-COMBUSTION ENGINES.

1,414,653. Specification of Letters Patent. Patented May 2, 1922.

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To all whom it may concern:

Be it known that I, FRANZ KRATZ, a citizen of Germany, residing at and whose post-office address is Stuttgart, Militärstrasse 2[d], Germany, have invented certain new and useful Improvements in Electric-Motor-Starting Devices for Internal-Combustion Engines, (for which I have filed applications in Germany March 5, 1918, March 5, 1918; Germany April 16, 1918, April 16, 1918; Germany October 11, 1918, October 11, 1918; Germany February 10, 1919; Austria March 26, 1919; Sweden March 31, 1919; Switzerland April 1, 1919; Italy April 9, 1919; the Netherlands April 9, 1919, and France April 16, 1919;) and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The present invention relates to an electrical starting device for internal combustion engines, and has to do particularly with that type of starting apparatus in which an electrical motor provided with an automatically adjustable coupling member is caused to rotate at first slowly and with small torque and, after the beginning of the coupling operation, to rotate more rapidly and with a greater torque, the two periods of rotation being produced by dividing the exciting winding of the motor into one section of high resistance and one section of relatively low resistance.

It is an object of the present invention to provide a starting apparatus for internal combustion engines which may conveniently be actuated from a point at some distance from the engine by means of a small electrically conducting wire having a minimum number of branches.

It is a further object to provide an apparatus of this type in which the conducting parts carrying the main motor current are short and may conveniently be mounted in small compass in the proximity of the starting motor.

It is also an object to provide a starting device of this type in which the contact switch carrying the main motor current during the second period of rotation is automatically maintained closed until after opening of the switch which controls the first period of rotation, so that upon the automatic separation of the coupling between the starting motor and the internal combustion engine an accidental reengagement with consequent damage to the parts of the apparatus is prevented.

More specifically, it is an object of the invention to attain the above results by means of a switch provided in connection with the electric starting motor and controlled electro-magnetically through a manually operated switch in series with that portion of motor field winding of high resistance, by reason of which construction the movable contact of the electro-magnetic switch is brought nearly to its final position by the lateral shifting of the coupling member of the motor, and is then brought to its final position by a vigorous movement imparted to it due to the attraction of the electro-magnet which serves to maintain the switch closed until the magnet winding is deenergized by opening the switch which controls the first period of rotation.

I have illustrated by way of example a preferred embodiment of my invention in the accompanying drawings, in which Figure 1 is a view, largely diagrammatic, of a starting apparatus for internal combustion engines embodying my invention; Fig. 2 is a longitudinal sectional view of my improved automatic switch in normal position; and Fig. 3 is a similar view illustrating the switch in the position assumed during the coupling operation.

In Fig. 1 b is the shaft of the armature 2 of the electric starting motor, which shaft is capable of longitudinal movement. By its movement it moves a pinion a into contact with a gear c direct connected to the internal combustion engine. The brush k^2 of the electric starting motor is connected directly to ground, while the second brush k^1 is connected to the portions f and g of the motor field winding, the portion f constituting the principal series winding of the motor, while the portion g is a high resistance winding. The opposite end of the winding f is connected to a stationary contact i^1, while the free end of the high resistance winding g leads to the exciting winding n of an electro-magnet, and from thence through a switch e to a second sta-

tionary contact i^2. The switch e may be of any desired type but inasmuch as the currents carried by it are small, it may conveniently be a push button located at any desired point and supplied with current through wires of small size.

The longitudinally movable member p which constitutes a portion of the core of the electro-magnet is provided at its outer end with an electrical conducting bridge q insulated from the metal of the core p. It is evident that when this core is drawn inwardly against the reaction of the coil spring r by the attracting force of the electro-magnet n, the ends of the insulated bridge q will be brought into engagement respectively with the stationary contacts i^1 and i^2, thereby completing a circuit through battery d, series winding f, and the motor armature. At the outer end of the core p there is provided an extension or arm p' positioned to engage with a co-operating extension v on a rod w mounted for longitudinal movement in a part x of the apparatus housing. The opposite end of the rod w carries an extension y in position to engage with a flange z formed upon the armature shaft b of the starting motor.

In order to operate the starting device, the switch e is closed manually. As a result, current flows from the battery d, one terminal of which is grounded, to the contact i^2, from it through the switch e and the magnet winding n to the field winding g, from whence it passes to the brush k^1, through the armature winding l to the brush k^2 and then to ground. Due to the high resistance of the winding g the current is small, and as a result of its large number of turns the winding g generates a strong magnetic field. This field strongly attracts the motor armature 2, and because of the low current strength it can impart to the armature only a slight rotational movement. The longitudinal displacement of the motor shaft b causes the pinion a to be brought into contact with the gear c, and at the same time the slight rotational movement of the motor shaft causes the teeth of the pinion to come into mesh with the teeth on the gear.

The winding n of the electro-magnet is traversed by the same current which flows through the field winding g and is consequently energized. The movable core p of the magnet, however, is positioned at such distance from the energized winding n as not to be displaced due to the attraction of the magnet. Upon the initial shifting of the armature of the starting motor during the first switch step or period of slow rotation, the flange z and consequently the armature p of the electro-magnet are shifted. When the teeth of the pinion a come into mesh with the teeth of the gear c the armature p is moved so near to the winding n that it is acted upon by the attraction of the magnet sufficiently to bring it to its final position with a vigorous movement, with the conducting bridge q in engagement with the contacts i^1 and i^2.

The making of this contact serves to complete a circuit comprising the battery d, the main series winding f of the motor, and the motor armature. A strong current will consequently flow and the starting motor will be rotated with sufficient force to turn the shaft of the internal combustion engine. It is evident that a current will still traverse the winding n of the electro-magnet and serve to maintain the bridge q in engagement with its cooperating contacts.

As soon as the internal combustion engine is accelerated and begins to operate under its own power, the counter electro-motive force developed in the starting motor will react against the attractive force of the field windings f and g. This attractive force will no longer be sufficient to maintain the pinion a in engagement with the gear c, and the coil spring b' will effect disengagement of the pinion and return the motor armature to its normal position Inasmuch as current still continues to traverse the exciting winding n of the electro-magnet, the conducting bridge q will continue to maintain the main motor circuit closed with the result that the first switch step or period of slow rotation will not again be entered into. The motor will continue to rotate at full speed and there will consequently not be a sufficient attractive force exerted on the motor armature to move it longitudinally against the action of the spring r. This is in contrast to the operation which would occur in the ordinary apparatus not embodying my invention unless the motor circuit were manually interrupted at substantially the same time at which the internal combustion engine begins to operate under its own power. The motor circuit can only be interrupted by opening the switch e which first deenergizes the magnet winding n and consequently allows the conducting bridge q to return to its open position.

For the purpose of rendering the action of the conducting bridge q in closing the main motor circuit as nearly independent as possible of the variations in attractive force of the electro-magnet due to changes in battery voltage, or the like, and variations in strength of the coil spring r, I preferably employ a switch of the construction illustrated in Figs. 2 and 3. In this embodiment of the switch the electro-magnet consists of a core m and energizing winding n together with a housing o which also comprises a portion s serving as a closure for the end of the element. The core p is so constructed that it does not pass out from within the closure s of the housing before the pinion a and gear

c of the coupling mechanism come into engagement. Further longitudinal movement of the motor shaft causes the core p to be displaced into the position shown in Fig. 3, in which position it is traversed by lines of force emanating from the energized winding of the electro-magnet and is powerfully attracted and brought to its final position with a vigorous movement. The attractive power of the magnet acts suddenly at the particular position in which the armature p passes out from the portion s of the housing which, until this time, acts as a magnetic shield. The attractive force upon the core p then depends primarily upon its position relative to the portion s of the housing rather than the strength of the electro-magnet or the strength of the spring r, and the closing of the motor circuit is effected with a corresponding independence of variations in the strength of the magnet or spring.

While I have described a preferred embodiment of my invention, it is to be understood that changes in the details of construction and arrangement of parts may be made within the full scope of the appended claims.

I claim:

1. In a starting device for internal combustion engines, the combination of a driving member for the engine, a movable coupling member adapted to engage said driving member, an electric motor for rotating and shifting said member, and means for first obtaining a period of slow rotation of said coupling member and, after the beginning of engagement between said coupling member and said driving member, a period of more rapid rotation, said means comprising a field winding on said motor subdivided into a portion of higher resistance and a portion of lower resistance, and suitable connections therefor, said connections including an electro-magnet and a switch connected in series with said portion of the field winding of higher resistance, and a contacting device, actuated by said movable member and held in closed position by said electro-magnet, and effecting the connection of said portion of the field winding of lower resistance in parallel with said series circuit, for producing said period of more rapid rotation.

2. In a starting device for internal combustion engines, the combination of a driving member for the engine, a movable coupling member adapted to engage said driving member, an electric motor for rotating and shifting said coupling member, and means for first obtaining a period of slow rotation of said coupling member and, after the beginning of engagement of said coupling member with said driving member, a period of more rapid rotation, said means comprising a field winding on said motor subdivided into a portion of higher resistance and a portion of lower resistance, and suitable connections therefor, said connections including an electromagnet and a switch connected in series with the portion of the field winding of higher resistance, said electro-magnet having a part of its core movable, and a contacting device comprising a conducting bridge carried by the movable part of said core and normally held insulated by means of a spring, said bridge being actuated by said movable coupling member and held in closed position by said electro-magnet in such manner as to establish the proper electrical connection for producing said period of rapid rotation of the motor armature.

3. In a starting device for internal combustion engines, the combination of a driving member for the engine, a movable coupling member adapted to engage said driving member, an electric motor for rotating and shifting said coupling member, and means for first obtaining a period of slow rotation of said coupling member and, after the beginning of engagement of said coupling member with said driving member, a period of more rapid rotation, said means comprising a field winding on said motor subdivided into a portion of higher resistance and a portion of lower resistance, and suitable connections therefor, said connections including an electromagnet and a switch connected in series with the portion of the field winding of higher resistance, said electro-magnet having a part of its core movable, and a contacting device comprising a conducting bridge carried by the movable part of said core and normally held insulated by means of a spring, a rod with ends bent at an angle of ninety degrees, and a flange provided on the said movable member, the flange engaging the bent end of said rod and causing said bridge to be moved and held in closed position by said electro-magnet in such manner as to establish the proper electrical connection for producing said period of rapid rotation of the motor armature.

4. In a starting device for internal combustion engines, the combination of a driving member for the engine, a movable coupling member adapted to engage said driving member, an electric motor for rotating and shifting said coupling member, and means for first obtaining a period of slow rotation of said coupling member and, after beginning of engagement of said coupling member and said driving member, a period of more rapid rotation, said means comprising a field winding on said motor subdivided into a portion of higher resistance and a portion of lower resistance, suitable connections therefor, said connections including an electromagnet and a switch connected in series with the portion of the field winding of higher resistance, said electro-magnet having a part of its core movable and of such construction that said movable portion is

withdrawn from the attraction of the stationary portion until such time as the said coupling members become engaged, and a contacting device, actuated by said movable element and held in closed position by said electro-magnet, and effecting the connection of said portion of the field winding of lower resistance in parallel with said series circuit for producing said period of more rapid rotation.

In testimony whereof I affix my signature, in presence of two witnesses.

FRANZ KRATZ.

Witnesses:
ADOLF LEBHERF,
HERMANN SCHNEIDER.