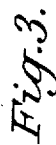


1,368,635.

3 SHEETS—SHEET 1.



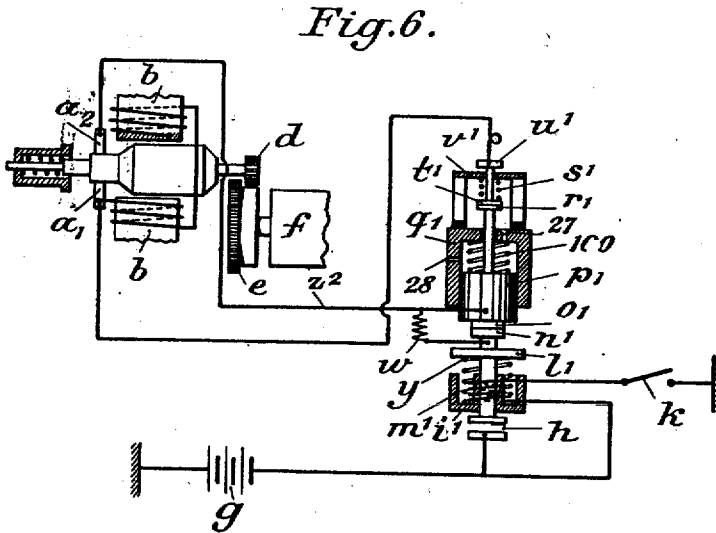
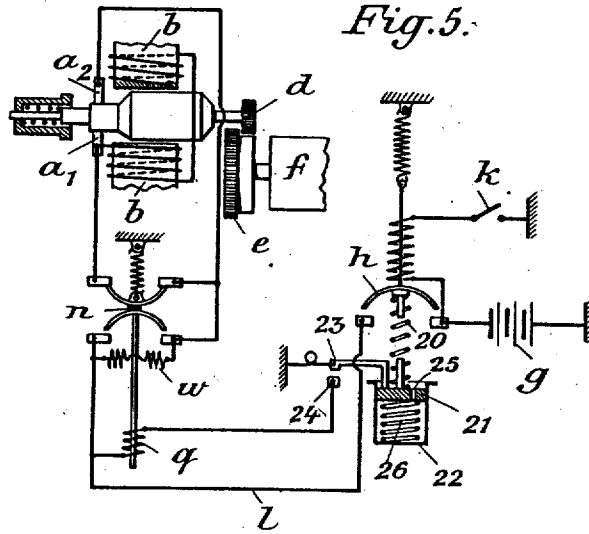
Franz Klatz INVENTORS
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ELECTRIC STARTING SYSTEM FOR INTERNAL COMBUSTION ENGINES.
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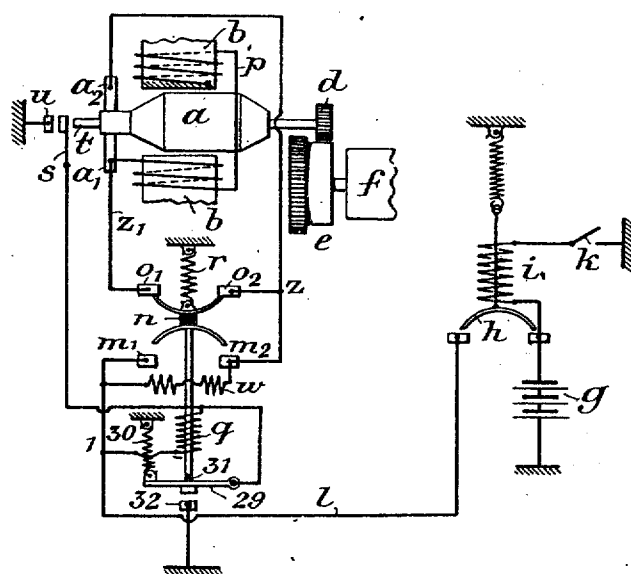
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Fig. 7.



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UNITED STATES PATENT OFFICE.

FRANZ KRATZ AND GOTTLLOB HONOLD, OF STUTTGART, GERMANY, ASSIGNORS, BY
MESNE ASSIGNMENTS, TO AMERICAN BOSCH MAGNETO CORPORATION, OF NEW
YORK, N. Y., A CORPORATION OF NEW YORK.

ELECTRIC STARTING SYSTEM FOR INTERNAL-COMBUSTION ENGINES.

1,368,635.

Specification of Letters Patent.

Patented Feb. 15, 1921.

Application filed August 1, 1918. Serial No. 247,897.

To all whom it may concern:

Be it known that we, FRANZ KRATZ and GOTTLLOB HONOLD, both subjects of the Emperor of Germany, and residents of Stuttgart, Germany, have invented certain new and useful Improvements in Electric Starting Systems for Internal-Combustion Engines; and we 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.

Our invention relates to electric starting systems for internal combustion engines and more particularly to such systems embodying an electric motor having a pinion normally disengaged from the engine gear but adapted upon axial movement of the armature of the motor to its magnetically centered position to engage the pinion with the gear.

In prior systems of this kind, either a foot switch was used to first connect the armature in shunt relation with the field to suck the armature into centered position of the field and thereupon engage the motor pinion with the engine gear, and to then connect the armature in series with the field by a further movement of the switch to start the engine into operation under its own power; or else to utilize the movement of the armature to directly control the circuits after the starting operation is initiated.

In accordance with our invention, the operator merely initiates the starting operation by closing a manually-operated initiating switch, whereas the subsequent changes of the circuits required to first short circuit the armature in series therewith, are effected automatically by means of one or more electromagnetically-operated switches controlled by the initiating switch and, in some cases, by an auxiliary switch operated upon axial movement of the armature or movement of an electromagnetically-operated switch for the motor or the battery. These systems not only operate in proper sequence to effect the automatic result desired, but they are, in some cases, susceptible of a predetermination of the time period to provide for the action of different engines with which they are intended to be associated.

In the accompanying diagrammatic draw-

ings illustrating a number of different embodiments within our invention, Figure 1 55 represents a system in which the manually-operated initiating switch is intended to be kept closed by the operator until the starting operation is completed; Fig. 2 represents a system in which the initiating switch may 60 be opened before the starting operation is completed; Fig. 3 represents a system in which manually-operated means are provided for opening the circuit in case the motor pinion and engine gear do not mesh; 65 Figs. 4 and 5 represent systems in which the battery current is discontinued automatically after a predetermined time, irrespective of the position of the armature; Fig. 6 represents a system in which the battery and 70 motor switches are combined; and Fig. 7 represents a modified arrangement of the motor switch.

In Fig. 1, the armature *a* of the starting motor is displaceable axially within the 75 field magnets *b*, normally being in magnetically decentered position as shown, but capable of being sucked, upon energization of the magnet, against the spring *c* into a magnetically-centered position where the pinion 80 *d* meshes with the flywheel gear *e* of the engine *f* to be started. A battery *g*, having one terminal grounded and the other connected to the battery switch *h*, serves as a source of current for the motor. The bat- 85 tery switch is operated upon energization of the coil *i* from the battery whenever the manually-operated initiating switch *k* is closed.

From the contacts of the battery switch 90 *h*, a wire *l* leads to the contact *m'* of the double-throw motor switch *n* having its contacts *m'*, *m''* connected by the starting resistance *w*. The contact *o'* is connected by wire *z'* to the brush *a'* of the motor, and 95 contact *o''* is connected by wire *z''* to the brush *a''* and by the wire *z* to contact *m''*, the field winding *p* being connected between *a'* and ground. A voltage coil *q*, adapted to pull the switch *n* down across the 100 contacts *m'*, *m''* against the action of spring *r*, is connected between wire *l* and contact *s* which is adapted to be forced by the end *t* of the armature shaft into engagement with the grounded contact *u* when the armature 105 is in magnetically-centered position. The

voltage coil v serves to keep the switch n down after coil q is deenergized, but is unable by itself to pull the switch down.

The operation of this system is as follows:

- 5 To start the engine f into operation under its own power, the switch k is closed, energizing the coil i and causing it to close the battery switch h . Current then flows from battery g to switch h , wire l and resistance
- 10 w to contact m^2 and branching point z . One branch passes over the contacts o^2 , o' and wire z' into the field winding p . Inasmuch as wire z' offers but little resistance, a strong current flows through the field winding to
- 15 the ground, whereas only a small current flows through the other branch including wire z^2 , brush a^2 , and armature a , thereby producing a small turning moment of the armature, but a strong axial pull of the
- 20 magnets on the armature. This movement engages pinion d and gear e , and near its end the shaft t closes the contacts s , u to connect the battery g to coil q . The switch n then closes contacts m' , m^2 , and current flows
- 25 from the battery to switch h , wire l , contact m' , m^2 , and thence directly into the wire z^2 through the armature and field in series. The engine f then rotates with a powerful turning movement sufficient to bring the engine to the proper speed. As soon as the engine is started into operation under its own
- 30 power, the switch k is manually opened, thus disconnecting the battery from the motor and allowing the spring c to disengage
- 35 the pinion d from gear e , if it has not already done so.

In the foregoing arrangement, the switch k must be closed until the entire starting operation is completed, for if it were released before that time, the switch h would interrupt the supply of current prematurely. It is possible, however, to render the starting operation entirely independent of the switch k after it is once closed, by providing

- 40 the battery switch h with another coil i^2 connected between wire l and contact lever 10, as illustrated in Fig. 2. This lever is pressed by spring 12 against a grounded
- 45 contact 13, whenever the insulating pin 11 permits. As long as the pinion d is out of mesh with gear e , the cooperative contacts 10, 13 are separated, but when they are in mesh, those contacts are engaged.

The system of Fig. 2 operates as follows:

- 55 Upon closing the manually-operated initiating switch k , the battery switch h is closed, thus engaging the motor and engine, whereupon contacts 10, 13 are engaged and coil i^2 is energized to keep the switch h closed irrespective of the position of switch k . The starting operation continues as previously described in connection with Fig. 1.

In case the engine does not start, the pinion d remains in mesh with gear e , and

- 65 therefore contacts 10, 13 remain closed.

This may also take place in case the teeth of the pinion and gear clash instead of meshing. In that event, contacts 10, 13 are not separated, and the battery will become exhausted. To prevent this a special hand

- 70 switch 14 may be inserted in the circuit of coil i^2 for opening that circuit, and thereby the battery switch h , at will, as shown in Fig. 3.

In order, however, to automatically provide for this emergency, an air device may be provided on the shaft of the motor or on the battery switch. In Fig. 4, when the pinion d moves toward gear e , the piston 15 of the air device is displaced to the left,

- 80 thereby creating a partial vacuum behind the piston. At the same time the piston 16 is shifted to the left, as a result of the air compression in the space 17, against the action of a weak spring 18. The contacts
- 85 10, 13 thereby close and the coil i^2 is energized. As the pistons are displaced, they pass over openings 19 and 20 of channel 21, so that the evacuated space behind piston
- 90 15 is connected to the space between the pistons. Since channel 21 is very narrow, the pressure in the space 17 is reduced slowly, and in consequence thereof, the piston 16 will, after a time, which may be predetermined, open contacts 10, 13. In this way,
- 95 the battery switch h is opened after a predetermined time independently of the displacement of the armature.

In the modification of Figs. 5 and 6, the second phase of the starting operation is

- 100 controlled by a device brought into action as a result of the first phase.

In Fig. 5 the battery switch h is connected by the spring 20 to the piston of an oil dash pot 22. Along with the piston there

- 105 moves a grounded contact 23 cooperative with contact 24 connected to coil q . The piston 21 has a small adjustable opening 25. A spring 26 of much less strength than spring 20 moves the piston upwardly after
- 110 spring 20 is expanded. When the switch h is closed, the contacts of switch h are bridged and the spring 20 is placed under tension tending to depress piston 21. This piston
- 115 is depressed very slowly, as the oil in the dash pot passes through the hole 25. After a predetermined time, during which the pinion d engages the gear e , the piston 21 has descended far enough to close contacts 23,
- 120 24. This closes the motor switch n so that current flows from the battery through the armature and field in series.

In Fig. 6 the movable contact of the battery switch h is connected with the armature l' of the electromagnet m' . At the opposite

- 125 end of armature l' , a contact n' cooperates with contact o' on piston p' of a dash pot q' . At the other end of piston p' , there is a contact r' against which contact t' is normally pressed by spring s' . To the contact
- 130

5 t' there is connected a plate u' which, on being depressed, rests upon the stationary insulated stop v' . The stationary contact of switch h is connected to battery g . A powerful spring y presses upwardly on the armature l' , the coöperative contacts n' , o' and r' , t' being engaged and switch h being open, as shown. The electromagnet m' is energized by coil i' branched off the main circuit of the battery and adapted to be connected by switch h . The piston p' is connected to brush a^2 and through resistance w to contact n' , the brush a' being connected to contacts u' and t' . The cylinder q' has a pressure valve 27 and a hole 28 adapted to be finely adjusted. In the position shown, the dash pot is under pressure, the piston p' being in its uppermost position. By closing the switch h , armature l' of the electromagnet is pulled down, and the switch h closed. Contact n' is then separated from contact o' , inasmuch as piston p' of the dash pot descends slowly. The current then flows from battery g through switch h , spindle of coil i' resistance w to wire z^2 . From there one branch flows to brush a^2 and through the armature winding to brush a' , where it combines to flow through the closed contacts r' , t' to the brush a' . The strongly energized field then meshes pinion d with gear e . The dash pot acts in such manner that after a predetermined time, the piston p' is allowed to descend, air being slowly drawn into the cylinder q' through the hole 28. While piston p' is thus descending, plate u' is first stopped by stop v' , and contacts t' , r' thereby separated, thus interrupting the branch circuit of the field winding. Only after the piston p' falls further, are contacts n' , o' closed. This causes the resistance w to be cut out and the current to flow from switch h through contacts n' , o' , wire z^2 to the armature and field windings in series. After switch h is opened, the spring y forces up the armature l' and causes the piston p' to return to its initially raised position, the pressure valve 27 allowing the air to escape. A spring 100, weaker than spring y , may be employed for accelerating the descending movement of piston p' .

50 In the modification of Fig. 7, coil q is grounded through contacts s , u , and also through contacts which are closed upon operation of the motor switch n . Thus the closing of the motor switch is secured even when the contacts intended to be closed upon axial movement of the armature to its magnetically-centered position are open, which may happen upon small axial oscillations of the armature. This modification is similar to Fig. 1 excepting that the auxiliary coil n shown there is replaced by contact 29 in coöperation with grounded contact 32. The contact 29 is pulled by spring 30 against the insulated end of spindle 31 of the motor

switch n . This contact is connected with coil q so that when switch n is closed by engaging contacts s , u , it engages contacts 29, 32, in consequence of which the coil q is grounded independently of the separation 70 of contacts s , u .

It is obvious that the arrangements of Figs. 2, 3 or 4 may be substituted for the corresponding parts of the systems of Figs. 1, 5 or 7.

Having thus described our invention, what we claim is:

1. The combination with an internal combustion engine having a gear and an electric starting motor for the engine having a pinion normally disengaged from the gear but adapted upon axial movement of the motor armature to engage the gear, of apparatus for supplying current to the motor, comprising a battery, a manually-operated initiating switch, an electromagnetically-operated battery switch having an energizing winding controlled by the initiating switch, an electromagnetically-operated motor switch having an energizing winding controlled by said battery switch, and an auxiliary switch operable by said armature upon the axial movement of the latter, said motor switch having an energizing winding controlled by said auxiliary switch.

2. The combination with an internal combustion engine having a gear and an electric starting motor for the engine having a pinion normally disengaged from the gear but adapted upon axial movement of the motor armature to engage the gear, of apparatus for supplying current to the motor, comprising a battery, a manually-operated initiating switch, an electromagnetically-operated battery switch having an energizing winding controlled by the initiating switch, an auxiliary switch, automatically operated by the armature during the axial movement thereof and an electromagnetically-operated motor switch having an energizing winding controlled by the auxiliary switch.

3. The combination with an internal combustion engine having a gear and an electric starting motor for the engine having a pinion normally disengaged from the gear but adapted upon axial movement of the motor armature to engage the gear, of apparatus for supplying current to the motor, comprising a battery, a manually-operated initiating switch, an electromagnetically-operated battery switch having an energizing winding controlled by the initiating switch, an auxiliary switch which is opened when the pinion is disengaged from the gear and closed when the pinion is engaged with the gear, and an electromagnetically-operated motor switch having an energizing winding controlled by the auxiliary switch.

4. The combination with an internal combustion engine having a gear and an electric

starting motor for the engine having a pinion normally disengaged from the gear but adapted upon axial movement of the motor armature to engage the gear, of apparatus for supplying current to the motor, comprising a battery, an electromagnetically-operated switch, electrical connections therefor, said electromagnetically-operated switch in one position short circuiting the armature of the motor and in the other position connecting the armature and field in series, and an auxiliary switch movable by said armature connected in circuit with the energizing winding of the electromagnetically-operated switch.

5. The combination with an internal combustion engine having a gear and an electric starting motor for the engine having a pinion normally disengaged from the gear but adapted upon axial movement of the motor armature to engage the gear, of apparatus for supplying current to the motor, comprising a battery, an electromagnetically-operated battery switch and having an energizing winding connecting the battery to the motor, a manually-operated initiating switch connected in the energizing circuit of the electromagnetically-operated battery switch, an electromagnetically-operated motor switch having an energizing winding, and a supplementary switch operable by said armature during the axial movement thereof connected in an electrical circuit of the energizing winding of the electromagnetically-operated motor switch and being arranged

to have an open position when the pinion is disengaged from the gear and to have a closed position when the pinion is engaged with the gear.

6. The combination with an internal combustion engine having a gear and an electric starting motor for the engine having a pinion normally disengaged from the gear but adapted upon axial movement of the motor armature to engage the gear, of apparatus for supplying current to the motor, comprising a battery, an electromagnetically-operated battery switch connecting the battery to the motor, a manually-operated initiating switch connected in an energizing circuit of the electromagnetically-operated battery switch, an electromagnetically-operated motor switch having an energizing winding, a supplementary switch connected in an electrical circuit of the energizing winding of the electromagnetically-operated motor switch and being movable by the armature during the axial movement thereof to have an open position when the pinion is disengaged from the gear and to have a closed position when the pinion is engaged with the gear, and a manually-operated switch in the circuit of the supplemental switch.

In testimony whereof we affix our signatures in presence of two witnesses.

FRANZ KRATZ,
GOTTLLOB HONOLD.

Witnesses:

PAUL WOLFART,
ADOLF LEBHERZ.