Sept. 4, 1928. 1,683,280

J. L. ARTHUR

VARIABLE RESISTANCE SWITCH

Filed Oct. 29, 1925 2 Sheets-Sheet 1

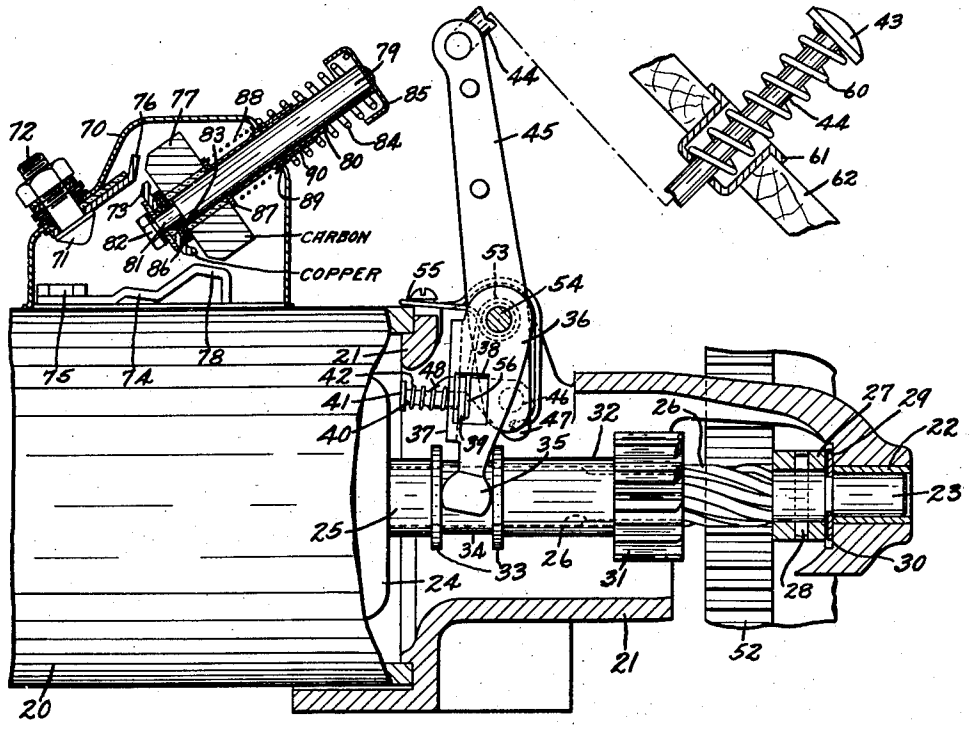


Fig. 1

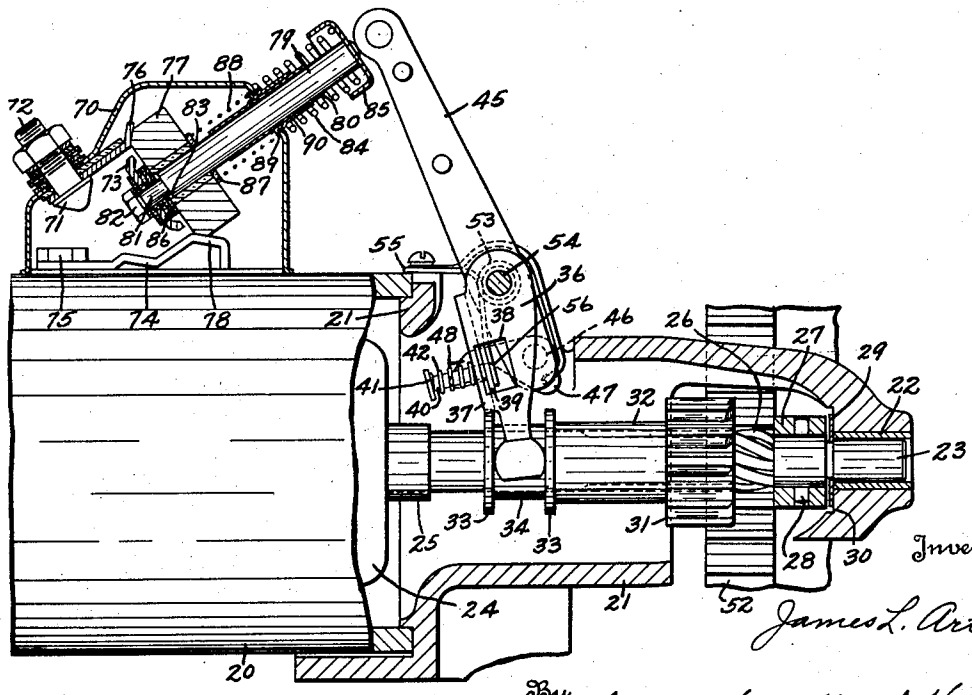

Fig. 2

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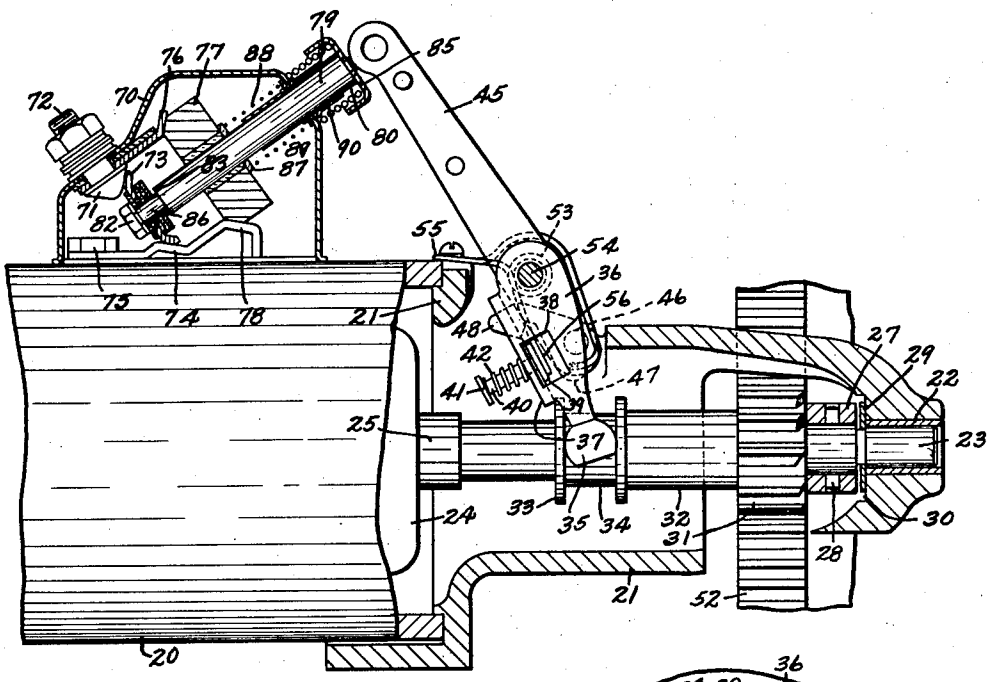


Fig. 3

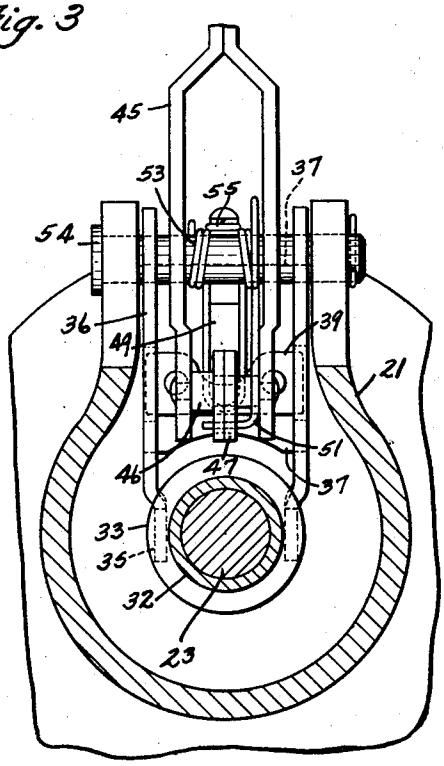


Fig. 4

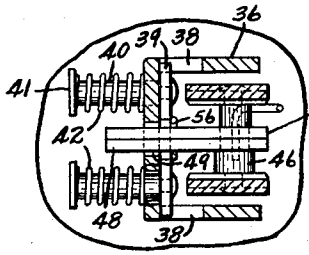


Fig. 5

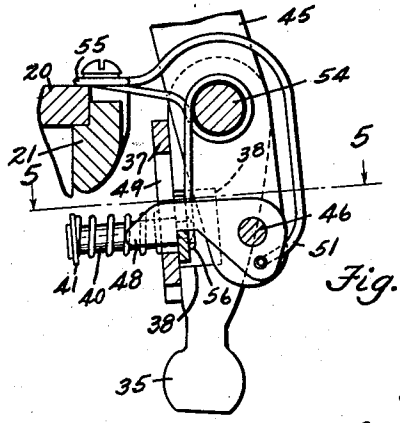


Fig. 6

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# UNITED STATES PATENT OFFICE.

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## VARIABLE-RESISTANCE SWITCH.

Application filed October 29, 1925. Serial No. 65,670.

This invention relates to electrical starting apparatus for internal-combustion engines and particularly to the type of apparatus which comprises an electric motor, a spirally-splined shaft driven by the motor, and a pinion screw-threaded upon said shaft and adapted to move endwise along the shaft into engagement with a gear of an engine to be started. The pinion is moved into partial engagement with the engine gear by manual operation and then the motor turns the splined shaft in a direction to cause the pinion to be threaded into full engagement with the engine gear and into contact with a stop whereupon the pinion drives the engine gear to crank the engine. After the engine becomes self-operative the pinion is automatically disconnected from the engine. In devices of this sort it is desirable that the motor be operated only with partial power until the pinion is substantially fully in mesh with the engine gear at which time the full power of the motor may be applied to crank the engine. Such an arrangement practically eliminates breakage of gear teeth due to full power operation of the motor while the gears are being meshed.

One of the objects of the present invention is to provide for this type of apparatus an improved motor-controlling switch which will cooperate with the apparatus, so that the pinion will be operated first with low speed and power to facilitate gear meshing by manual operation, and further and more complete engagement of the pinion with the engine gear by motor operation, said controller being adapted to apply the full power of the motor after the meshing of the gears is substantially completed.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Figs. 1, 2 and 3 are side views partly in section of a starting apparatus embodying the present invention and showing the apparatus in three different positions of operation.

Fig. 4 is a sectional view on the line 4—4 of Fig. 1.

Fig. 5 is a sectional view on the line 5—5 of Fig. 4.

Fig. 6 is a sectional view on the line 6—6 of Fig. 5.

Referring to the drawings, 20 designates a field frame of an electric motor which is supported by a gear housing 21 which is adapted to be attached to the frame of an engine to be started. The housing 21 provides a bearing 22 for the armature shaft of the motor, the other bearing being provided with an end frame (not shown), secured to the other end of the motor frame 20. The shaft 23 supports an armature 24 and is provided with a shouldered portion 25 and with a spirally-splined portion 26. A thrust collar 27 is secured to a shaft by pin 28 and bears against a thrust washer 29. This in turn bears against a finished surface 30 of the gear housing 21. A pinion 31 is threadedly connected with the spline 26 so as to move endwise along the shaft 23 and turn with the shaft after the pinion has been moved against the collar 27. In order to move the pinion endwise, the pinion is provided with a hub 32 provided with spaced flanges 33 defining an annular groove 34. The groove 34 receives the arms 35 of a bifurcated pinion-shifting lever 36 having a yoke 37. The arms 35 are provided with rectangular openings 38 for receiving and guiding the ends of a latch plate 39. The latch plate 39 is connected with studs 40 which pass freely through openings in the yoke 37 and carry at their outer ends washers 41. Springs 42 are located between the washers 41 and yoke 37; thus, it will be seen that if the latch plate 39 is moved to the right, motion will be transmitted through the spring 42 through the yoke 37.

The mechanism for moving the yoke 37 and latch plate 39, includes a pedal 43 connected by pedal rod 44 with a pedal lever 45 which carries at its lower end a rod 46 providing a pivot for a latch 47 which is provided with a hook 48 for engaging the latch plate 39. The yoke 37 is provided with an opening 49 for receiving the hook 48. The latch 47 is held normally in the position shown in Fig. 1 by a spring 50 having one end connected by screw 51 with the housing 21 and having the other end bent, as indicated in Fig. 6 by numeral 51, so as to ex-

tend through a hole in latch 47 located below the pivot rod 46. The spring 50 is biased so that, normally, it will urge the latch in a counterclockwise direction when the pedal is in the position shown in Fig. 1. By moving the pedal downwardly, so that the pinion 31 is brought into partial engagement with the engine gear 52, the spring 50 will be reconditioned so that it will tend to urge the latch in a clockwise direction relative to its pivot rod 46. The latch does not start to move into a counterclockwise direction as soon as the spring 50 is reconditioned to produce this result, since the spring is resisted by pressure between the hook of the latch and the latch plate, due to pressure upon the pedal 43. However, when the pinion 31 is moved endwise into mesh with the gear 52 due to the operation of the motor independent of the pedal 43, this pressure will be released, so that when the pinion is in full engagement with the engine gear, as shown in Fig. 3, the latch will be entirely disengaged from the latch plate. This mechanism has been provided in order that the pinion may be demeshed automatically regardless of failure of the operator to release the pedal 43.

By a controlling apparatus associated with the pedal lever 45, the motor is caused to turn slowly at first to facilitate meshing the pinion 31 with the gear 52, and to operate with low torque but which is sufficient to cause the pinion to be threaded from the position in Fig. 2 to the full-mesh position shown in Fig. 3. Then the controller is moved to cause the motor to operate with full power, in order to crank the engine. After the engine becomes self-operative, the pinion is demeshed and returned to the position shown in Fig. 1 although the pedal lever 45 may remain in the position shown in Fig. 3. A spring 53 having an intermediate portion coiled upon the rod 54 which supports the levers 45 and 36 and having its end portions bearing respectively against the housing 21, as indicated at 55, and against the latch plate 39, as indicated at 56, causes the arms 35 to be urged in a clockwise direction so that the pinion hub 32 will be maintained against the shoulder 25. After the pedal 43 is released a spring 60 located between the pedal 43 and a cup-shaped member 61 attached to the floorboard 62 of the vehicle causes the pedal 43 and lever 45 to return to the position shown in Fig. 1. During the return movement of the lever 45, the latch 47 moves through the yoke 37 of the lever 36 and snaps into position over the latch plate 39 as shown in Figs. 1 and 5.

The controller for controlling the motor circuits comprises main and auxiliary switches which are housed within a case 70 mounted upon the frame 20 of the motor. The main switch includes a contact provided by the head 71 of a main switch terminal bolt 72 which is insulatingly supported by the case 70, and a movable contact 73 which is adapted to connect the contact 71 with a stationary contact 74 attached to the terminal screw 75 of the motor. The auxiliary switch includes a stationary contact 76 connected with the bolt 72 and insulated from the case 70, a movable contact 77 and a stationary contact 78 which is integral with the part which forms the contact 74. The contact 73 is made of a low resistance material such as copper, and the contact 77 is made of a relatively high resistance material such as carbon. These contacts are insulatingly supported upon a plunger 79 which is supported and guided by a sleeve 80 carried by the switch case. The contact 73 is located loosely on the reduced lower end 81 of the plunger 79 and is free to move sidewise between a nut 82, attached to the plunger 79, and a shoulder 83 of the plunger. In this way the contact 73 is free to accommodate itself to the surface of the contacts 71 and 74. The carbon contact 77 is swingingly supported by the plunger 79 so that contact 77 may tilt slightly to accommodate itself to the contacts 76 and 78. A spring 84, located between the case 70 and a flange or button 85 attached to the plunger 79, yieldingly maintains the contact 73 in engagement with nonconducting washers 86 which in turn bear against the carbon contact 77 and cause it to bear against an insulating washer 87 which bears against the lower end of the sleeve 80. The spring 84 is opposed by a weaker spring 88 located between the washer 87 and a flange 89 of a tube 90 which receives and supports the sleeve 80. The spring 88 yieldingly urges the contact 77 toward the contact 73.

The first operation of the pedal lever 45 upon the control switch is to cause the auxiliary switch contact 77 to move into the position shown in Fig. 2 thereby causing a current source to be connected with the motor through the high resistance contact 77. The motor will therefore operate with relatively low speed and torque so as to facilitate meshing of the pinion with the engine gear and to cause the motor to operate with no more power than required to effect the threading of the pinion along the shaft into engagement with the stop collar 27. Continued pressure upon the pedal 43 will cause the main switch to be closed by the time the gears are substantially fully meshed. Then the motor may operate with full power to crank the engine without danger of breaking gear teeth.

As stated before failure to release the pedal 43 when the engine becomes self operative does not prevent demeshing of the gears since the latch is disconnected from the latch plate and the pinion shifting lever is free to move toward the left.

Release of the pedal 43 causes the spring 60 to restore the pedal lever 45 to the position shown in Fig. 1, and release of the plunger 79 allows the spring 80 to return the movable switch parts into the position shown in Fig. 1.

In case the engine should fail to start after the gears have been meshed and the switches have been closed, the pedal 43 may be released and spring 60 will cause the pedal to move upwardly first to permit the opening of the main switch and then to cause the pedal lever 45 to push the latch 47 and hence the lever 36 to the left (in the drawings) to demesh the gears and to open the auxiliary switch.

While the form of embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. An electric switch comprising a rod, a case supporting and guiding the rod, a relatively low total resistance contact mounted adjacent one end of the rod, a relatively high total resistance contact slidable upon the rod, a pair of contacts located in the path of movement of the high resistance contact and relatively near thereto in the normal switch-open position of the rod, and a pair of contacts located in the path of movement of the low resistance contact and relatively remote therefrom in the normal position of the rod, a spring urging the high resistance contacts toward the contacts bridged thereby, and a spring urging the rod in a direction for separating the movable contacts from the stationary switch contacts.

2. An electric switch comprising pairs of stationary contacts, a rigid, high total resistance contact for bridging one pair of stationary contacts, a low total resistance contact for bridging the other pair of contacts, a spring urging the high resistance contact toward switch-closing position, an operating member movable in one direction for retaining the high resistance contact in switch-open position and movable in the other direction first to permit said high resistance contact to be moved by said spring into switch-closing position and then to move the low resistance contact into switch-closing position, and a spring for resisting the last described movement of the operating member.

In testimony whereof I hereto affix my signature.

JAMES L. ARTHUR.