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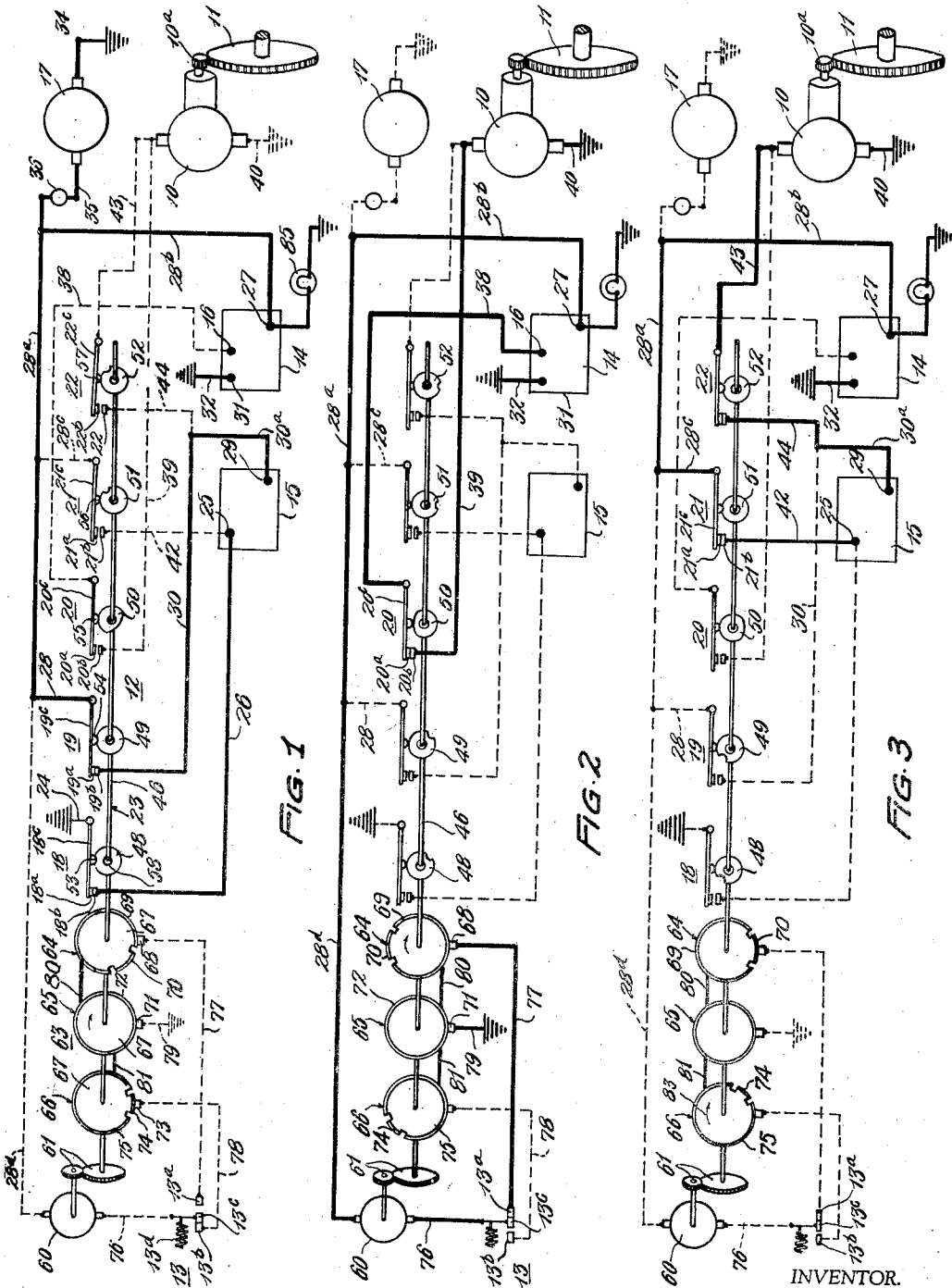


FIG. 1

FIG. 2

FIG. 3

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ENGINE CRANKING SYSTEM

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This invention relates to engine cranking systems, and as its principal object aims to provide an improved system of this kind which will function more efficiently and reliably than the cranking systems heretofore used.

Another object of my invention is to provide an improved cranking system having means for supplying energizing current to the cranking motor, first, at a relatively low voltage for initially energizing the motor and engaging the cranking pinion and subsequently at a relatively higher voltage for carrying out the cranking operation, and in which control switches are operated automatically in sequence for supplying the energizing current to the cranking motor at such different voltages.

A further object of my invention is to provide an improved cranking system, of the character referred to, in which an electric driving means is employed for producing the sequential actuation of the switches.

Still another object of my invention is to provide an improved cranking system, of this character, in which the control for the electric driving means includes a manual switch for initiating the operation of the driving means and other switch means for insuring the completion of the cycle of operation of the sequentially actuated switches and the automatic stopping of such driving means upon the completion of the cycle.

Another object of my invention is to provide an improved engine cranking system, of the character referred to, wherein the current supply means comprises batteries having terminal connections affording the relatively low and relatively higher cranking voltages and in which a generator for charging the batteries is adapted to be connected therewith or disconnected therefrom by the actuation of the sequentially operated switches.

Yet another object of my invention is to provide an improved engine cranking system having motor driven switch means for energizing the cranking motor at relatively low and high voltages in succession and in which the control for the switch motor prevents the operator from stopping the cranking operation while the cranking motor is being energized at low voltage and also causes the system to be automatically restored to a condition of readiness upon completion of the cranking operation.

Other objects and advantages of my invention will be apparent from the following description when taken in conjunction with the accompanying sheet of drawings, in which:

Fig. 1 is a diagram illustrating an engine cranking system embodying my invention and in which the active circuits are shown in full lines and the inactive circuits are shown in dotted lines;

Figs. 2 and 3 are diagrammatic views of the same system, but showing the same at different intervals in the cycle of operation and also illustrating by full and dotted lines the active and inactive circuits.

Further reference will now be made to the accompanying drawing for the purpose of describing the novel arrangement of apparatus and improved functioning obtained in my cranking system and although detailed reference will be made for this purpose to the specific form of cranking system shown in the drawing, it will be understood, of course, that my invention is not to be regarded as limited to this particular system, but can be embodied in various other similar cranking systems and arrangements.

In the embodiment of my cranking system illustrated in Fig. 1, I show a cranking motor 10, which may be of any suitable construction, and may be adapted for releasable driving connection with an internal combustion engine to be cranked. Such releasable driving connection may comprise the pinion and gear arrangement usually employed for this purpose in which a pinion 10a is automatically moved into mesh with the flywheel gear 11 upon energization of the cranking motor and is automatically disengaged from the gear and returned to an inoperative position upon starting of the engine.

I find it desirable to initially energize the cranking motor 10 at a relatively low voltage so as to engage the pinion 10a with the gear 11 without a slamming action or a clashing of the gear teeth, and to thereafter energize the cranking motor at a relatively higher voltage for effectively carrying out the cranking operation. For thus energizing the cranking motor at such low and high voltages in succession, I provide a current supply or source affording the desired different voltages, and a switch mechanism 12 for controlling the supply of energizing current to the cranking motor which includes a manually operable switch 13 for initiating the cranking operation.

The current supply means may comprise a storage battery, or preferably, a pair of storage batteries such as the batteries 14 and 15 shown in this instance. Although I do not wish to be limited to the use of storage batteries as the source of energizing current for the cranking mo-

tor 10, nor to any particular battery arrangement, I find it desirable to use six-volt current for initially energizing the cranking motor to engage the pinion 10a with the gear 11 and to thereafter supply twenty-four-volt current to the cranking motor for carrying out the cranking operation. These voltages can be made available by employing two twelve-volt batteries which are connected in series for the full or twenty-four-volt energization of the cranking motor, as will be explained hereinafter, and at least one of which, in this instance the battery 14, has a tap or terminal 16 for taking off six-volt current for initially energizing the cranking motor. The two twelve-volt batteries 14 and 15 can be charged in parallel by a twelve-volt generator 17, as will be explained hereinafter, and which can be driven by the internal combustion engine being served by the cranking motor 10.

The switch mechanism employed for controlling the charging of the batteries 14 and 15 and the operation of the cranking motor 10 may comprise, in addition to the manual switch 13, a plurality of pairs of cooperating contacts or individual switches 18, 19, 20, 21 and 22 and a switch operating means 23 for producing a timed or sequential automatic actuation of such individual switches. The manual switch 13 may comprise a pair of spaced stationary contacts 13a and 13b and a movable contact 13c which can be moved into engagement with the contact 13a to initiate the operation of the cranking system, as shown in Fig. 2 and to be explained hereinafter, but is normally held in an "off" position in engagement with the contact 13b by a tension spring 13d, as shown in Fig. 1.

The switches 18 and 19 control the charging circuit for the batteries 14 and 15, and as will be explained hereinafter, are actuated to open the charging circuit before the cranking motor 10 is energized by the actuation of the switches 20, 21 and 22. The switch 18 comprises a pair of cooperating movable and stationary contacts 18a and 18b, the former of which is carried by the arm 18c and is connected to ground by the conductor 24. The stationary contact 18b is connected with the terminal 25 of the battery 15 by the conductor 26. The switch 19 also comprises cooperating movable and stationary contacts 19a and 19b of which the movable contact 19a is carried by the arm 19c and is connected with the terminal 27 of the battery 14 by the conductors 28, 28a and 28b. The stationary contact 19b is connected with the terminal 29 of the battery 15 by the conductors 30 and 30a. The other terminal 31 of the battery 14 is connected to ground by the conductor 32.

The generator 17 for charging the batteries 14 and 15 has one terminal thereof connected to ground by the conductor 34 and the other terminal connected with the conductors 28a and 28b through the conductor 35 and a cut-out device 36. This cut-out may be of a conventional form and operates to automatically connect the generator 17 with the charging circuit when the speed at which the generator is driven increases above a predetermined value and to disconnect the generator from the charging circuit so as to prevent a reverse-flow of current from the batteries to ground through the generator.

When my cranking system is inoperative or in a condition of readiness, such as that represented in Fig. 1 in which the cranking motor 10 is deenergized, the switches 18 and 19 are closed and a parallel charging circuit is established for

the batteries 14 and 15 and, if the generator 17 is being driven at a charging speed, the batteries will be charged thereby in parallel. To render this condition of the system more readily apparent and understandable, Fig. 1 has been drawn with the active charging circuit in full lines and the other inactive circuits in dotted lines. This charging circuit can be readily traced from the generator 17 through conductor 35, cut-out 36 and conductor 28b to terminal 27 of the battery 14. The return portion of the charging circuit for the battery 14 extends through conductor 32, and through ground and the conductor 34 back to the generator. The parallel portion of this charging circuit for serving the battery 15 extends through conductors 28a and 28, switch 19 and conductor 30 to the terminal 29 of the battery. The return portion of this circuit extends from terminal 25, through conductor 26, through switch 18 and conductor 24 to ground and then through conductor 34 back to the generator.

The switch 20 controls the low or six-volt energization of the cranking motor 10 and comprises a pair of cooperating movable and stationary contacts 20a and 20b, the former of which is carried by a movable arm 20c and is connected with the six-volt tap 16 of the battery 14 by the conductor 38. The stationary contact 20b is connected with one terminal of the cranking motor 10 by the conductor 39. The other terminal of the cranking motor may be connected to ground by the conductor 40.

Fig. 2 of the drawing shows the condition of the system just after the operator has started or initiated the cranking operation by movement of the contact 13c of the switch 13 into engagement with the contact 13a and shows the active circuits in full lines and the inactive circuits in dotted lines. In the condition of the system here shown the switches 18 and 19 have been opened to disconnect the battery charging circuit and the switch 20 has been closed and the six-volt energization of the cranking motor 10 has just begun. This six-volt circuit can be traced from the tap or terminal 16 of the battery 14 through conductor 38 and the contacts 20a and 20b of the switch 20 and conductor 39 to the terminal of the cranking motor 10. The return portion of this circuit extends through conductor 40, through ground and conductor 32, back to the terminal 31 of the battery 14.

The switches 21 and 22 control the energization of the cranking motor 10 at its full voltage, that is, twenty-four volts in this instance. The switch 21 comprises cooperating movable and stationary contacts 21a and 21b, the former of which is carried by a movable arm 21c and is connected with the conductor 28a by the conductor 28c. The stationary contact 21b is connected with the terminal 25 of the battery 15 by the conductor 42. The switch 22 also comprises a pair of movable and stationary contacts 22a and 22b of which the contact 22b is carried by a movable arm 22c and is connected with a terminal of the cranking motor by the conductor 43. The stationary contact 22a is connected with the terminal 29 of the battery 15 through the conductor 44 and the conductor 30a.

The circuit for energizing the cranking motor 10 at full voltage is established when the switches 21 and 22 are closed, whereupon the batteries 14 and 15 are connected in circuit with the cranking motor in series relationship to each other and supply twenty-four-volt current to the cranking motor. Fig. 3 of the drawing illustrates

this condition of the system in which the switches 21 and 22 are closed and the cranking motor is being energized at full voltage, the active full voltage cranking circuit being shown in full lines and the inactive circuits being shown in dotted lines. This full voltage cranking circuit can be traced from the terminal 27 of the battery 14 through conductor 28b, conductors 28a and 28c, and then through contacts 21a and 21b of the switch 21 and through conductor 42 to the terminal 25 of the battery 15. Continuing from the terminal 29 of the battery 15, this circuit extends through conductors 30a and 44, and then through the contacts 22a and 22b of the switch 22 and through the conductor 43 to the cranking motor 10. The return portion of this circuit extends from the cranking motor through the conductor 40 and ground, and then through the conductor 32 back to the terminal 31 of the battery 14.

I have already indicated that the switches 18 and 19 which control the parallel charging circuit for the batteries 14 and 15 are opened before the actuation of the switches 20, 21 and 22, and also that the switch 20, which controls the low or six-volt energization of the cranking motor is closed prior to the closing of the switches 21 and 22 which control the full or twenty-four volt energization of the cranking motor. It may also be conveniently mentioned at this time that it is desirable to keep the switches 18 and 19 open for the completion of the cranking operation and then close these switches to enable the batteries to be charged by the generator 17 after the engine has been started. It should also be mentioned at this point that the switches 21 and 22 should be maintained open during the time that the switch 20 stays closed for producing the six-volt energization of the cranking motor and should be closed to produce the full or twenty-four-volt energization of the cranking motor substantially simultaneously with, or immediately after, the opening of the switch 20.

To obtain this desired sequence or timed actuation of the switches 18, 19, 20, 21 and 22, I may employ as the switch operating means 23, a rotatable shaft 46 having cams 48, 49, 50, 51 and 52 thereon for cooperation, respectively, with cam followers 53, 54, 55, 56 and 57. These cam followers may be of rounded or other suitable shape and are connected, respectively, with the movable arms 18c, 19c, 20c and 22c of the corresponding control switches. The actuating cams may be appropriately shaped and are mounted on the shaft 23 in a relative angular relation such that as the cams are rotated through one revolution the above-explained timed or sequential actuation of the switches 18, 19, 20, 21 and 22 will take place. The cams are insulated from the shaft 23 by insulating bushings 58 or other appropriate means.

The shaft 23 may be rotated by any suitable device or means, and preferably, by a small electric motor 60 which may be connected with this shaft either directly or through reduction gearing 61. The motor 60 may be one designed to operate on twelve-volt current which may be conveniently supplied thereto from the battery 14, as will be presently explained.

In addition to producing a timed or sequential actuation of the switches 18, 19, 20, 21 and 22, it is also desirable to control the operation of these switches, so that when the cranking operation is initiated or started by the operator the complete cranking cycle will be carried through and, upon starting of the engine and release of the contact

13c by the operator, the system will be automatically restored to its initial condition of readiness shown in Fig. 1. In other words, it is desirable to have the switch operating means 23 function in a manner such that when the driving motor 60 is started by the operator by the closing of the contacts 13c and 13a of the manual switch 13, it will result in the desired actuation of switches 18 and 19 to open the charging circuit, followed by a closing of the switch 20 to produce the six-volt energization of the cranking motor and this, in turn, followed by the opening of the switch 20 and the closing of the switches 21 and 22 to produce the full-voltage energization of the cranking motor. After the full or twenty-four volt energization of the cranking motor has continued for the necessary or desired interval of time and the operator permits the contact 13c of the switch 13 to reengage the contact 13b, the motor 60 will cause the switches 21 and 22 to be opened and the system will automatically restore itself to the condition of readiness, shown in Fig. 1, including the closing of the switches 18 and 19 to reestablish the battery charging circuit, and the stopping of the motor 60 with the apparatus in such condition that when the contacts 13c and 13a are again closed another cranking cycle will be started.

For the accomplishment of the automatic control or operation just explained for the switch operating motor 60, I provide automatically operated switch means 63 which will now be described. This automatic switch means 63 may comprise cam actuated contacts or preferably, as shown in this instance, an arrangement of commutator-like switches 64, 65 and 66 each of which includes one or more contacts mounted on a disk or hub of insulating material 67 connected with the shaft 46 to be driven thereby. The contacts of the switch 64 comprise a stationary contact or brush 68 and an interrupted movable contact ring carried by the disk or hub 67 and formed by the ring sections or segments 69 and 70. The contacts of the switch 65 comprise a stationary contact or brush 71 and an interrupted contact ring 72 carried by the insulating disk or hub 67. The contacts of the switch 66 likewise comprise a stationary contact or brush 73 and an interrupted contact ring carried by the insulating disk or hub 67 and formed by the ring sections or segments 74 and 75.

The circuit connections for the motor 60, which are controlled by the manual switch 13 and the automatic switch means 63, may include a conductor 28d which is a continuation of the conductors 28a and 28b and connects the terminal 27 of the battery 14 directly with one terminal of the motor 60. The other terminal of the motor 60 is connected with the movable contact 13c of the manually operable switch 13 by the conductor 76. The stationary contact 13a of the switch 13 is connected with the stationary contact 68 of the switch 64 by the conductor 77 and the stationary contact 13b is connected with the stationary contact 73 of the switch 66 by the conductor 78. The stationary contact 71 of the switch 65 is connected to ground by the conductor 79. The segment 69 of the switch 64 is connected with the ring contact 72 of the switch 65 by the conductor or internal connection 80 and the segment 75 of the switch 66 is also connected with the ring contact 72 of the switch 65 by a conductor or internal connection 81.

As above indicated, Fig. 1 shows my charging system in its normal condition with the batteries

14 and 15 connected with the generator 17 for charging in parallel and at this time the movable contact 13c of the switch 13 is in its "off" position, that is, in engagement with the stationary contact 13a where it may be normally held by the tension spring 13d. When the operator wishes to crank the engine he shifts the contact 13c into engagement with the stationary contact 13b and thereupon starts the switch operating motor 60 which causes rotation of the shaft 46 in a clockwise direction, as indicated by the arrow 83. The energizing circuit thus established for the motor 60 by the closing of contacts 13c and 13b is shown in full lines in Fig. 2. and may be traced from the terminal 27 of the battery 14 through conductors 28b, 28a and 28d to the motor 60 and then through conductor 76 and movable and stationary switch contacts 13c and 13b and through conductor 77 to the stationary contact 68 of the switch 64. At this time the segment 69 is in engagement with the stationary contact 68 and hence the circuit being traced will extend through conductor 80, ring contact 72 of the switch 65 and then through conductor 79 to ground and back to the terminal 31 of the battery 14 through the conductor 32.

The clockwise rotation of the shaft 46 by the motor 60 promptly causes the switches 18 and 19 of the battery charging circuit to be opened and shortly thereafter causes switch 20 to be closed for the six-volt energization of the cranking motor 10 through the circuit previously traced. Continued rotation of the shaft 46 causes opening of the switch 20 of the six-volt circuit and closing of the switches 21 and 22 for the establishment of the previously traced twenty-four-volt energizing circuit for the cranking motor. At about the same time as, or just after the switches 21 and 22 are closed, the dead segment 70 of the switch 64 arrives at the stationary contact or brush 63, and the circuit for the motor 60 is thereby opened and this motor comes to a stop with the switches 21 and 22 closed and the cranking motor 10 being energized at full voltage, or in other words, with the system in the condition represented in Fig. 3.

When the cranking of the engine has continued for the desired interval, or upon starting of the engine, the operator releases the contact 13c and permits it to return to its off position in engagement with the contact 13b. This causes the motor 60 to be reenergized and to resume the clockwise rotation of the shaft 46 causing the switches 21 and 22 to be opened and the cranking motor 10 deenergized. The motor 60 will continue to run until the dead segment 74 of the switch 66 arrives at the contact 73 at which time the energizing circuit for the motor 60 will again be opened and the motor stopped with the switch operating means 23 restored to its initial position, as shown in Fig. 1. When the contact 13c is permitted to return to its off position at the completion of the full-voltage cranking operation, as just explained, the energizing circuit for the motor 60 will shift from that above traced through the switch 64 to one extending through the switch 65. This latter energizing circuit for the motor 60 is similar to that traced through the switch 64 except that it now extends from the stationary contact 13b of the switch 13 through the conductor 78 to the contact 73 of the switch 65, through segment 75 of this switch, then through conductor 81 and ring contact 72 of the switch 65 and then through contact 71 and conductor 79 to ground.

With the circuit and switch arrangement above described, it will be seen that from the time the operator closes the contacts 13c and 13a of the switch 13, the cranking cycle will be automatically carried out from the opening of the battery charging circuit to the closing of the twenty-four-volt circuit for the cranking motor 10 and the stopping of the switch operating motor 60 at this point with the cranking motor fully energized. Likewise, it will be seen that when the cranking of the engine has continued for the desired interval, or until the engine starts, and the operator then permits the contact 13c to return to its off position, the switch mechanism 23 will be automatically returned to its initial setting or position, shown in Fig. 1. It will also be seen that the switch and circuit arrangement for controlling the switch operating motor 60 is such that once the operator has started this motor by closing the contacts 13c and 13a, he will be unable to stop the motor 60 at a time when damage might occur, such as when the switch 20 has been closed for the six-volt energization of the cranking motor. If the operator fails for any reason to hold the contact 13c in engagement with the contact 13a until the completion of the cycle or until the engine has been started, no harm will be done to the system because the reengagement of the contact 13c with the contact 13b will permit the motor 60 to continue to run long enough to restore the system to its initial condition of readiness shown in Fig. 1.

It will be understood, of course, that to obtain the system operation above explained, the movable ring sections or segments of the switches 64 and 66 must be of proper angular length and must be mounted on the insulating disk or hub 67 in the proper angular relation to each other and to the switch actuating cams of the shafts 46, such as the relation shown in the drawing. With this arrangement it will be seen that when the system is in its initial position or inoperative condition, as illustrated in Fig. 1, the dead segment 74 of the switch 66 has previously come into engagement with the stationary contact 73 and the leading end of the long segment 69 of the switch 64 has just come into engagement with the stationary contact 68 so that upon closing of the contacts 13c and 13a another cranking cycle can be started or initiated.

One or both of the batteries 14 and 15 may also be used for other purposes than the operation of the cranking motor 10 and the switch operating motor 60, such as the energization of one or more incandescent lamps 85 as might be desirable when my cranking system is applied to a motor vehicle.

From the foregoing description and the accompanying drawing, it will now be readily understood that I have provided an improved cranking system for internal combustion engines in which the cranking motor can be energized by relatively low and relatively high voltages in succession and such energization will be carried out in an efficient and satisfactory manner by a timed or sequential actuation of a novel arrangement of control switches. It will be seen furthermore that with the arrangement of switches and the switch actuating means which I have provided a cycle of operation is obtained in which the low and high voltage energization of the cranking motor can be had for the desired time intervals and thereafter the switch operating means is automatically returned to an initial position corresponding with a condition

of readiness of the cranking system. It will likewise be seen that I have provided a novel control for the means which drives the switch operating means by which the proper energization of the driving means can be established by the operator and will be maintained for the complete cycle regardless of the subsequent actions of the operator.

While I have illustrated and described my improved cranking system in a more or less detailed manner, it will be understood, of course, that I do not wish to be limited to the precise arrangement and functioning herein disclosed, but regard my invention as including such changes and modifications as do not involve a departure from the spirit of the invention and the scope of the appended claims.

Having thus described my invention, I claim:

1. In an engine cranking system, a cranking motor, current supply means having terminals affording a relatively low voltage for initially energizing the cranking motor and a higher voltage for carrying out the cranking operation, circuit connections between said terminals and cranking motor including a plurality of switches for controlling such connections and the energization of the cranking motor at said low and higher voltages in succession, motor-driven means for causing timed actuation of said switches, circuit connections for the motor of said motor-driven means, manually operable switch means in the last-mentioned circuit connections for starting said motor-driven means, and automatically actuated switch means in said last-mentioned circuit connections for stopping said motor-driven means after predetermined operation thereof.

2. In an engine cranking system, a cranking motor, current supply means comprising a plurality of batteries one of which has terminals affording different voltages, a generator for charging said batteries, circuit connections between said generator and batteries and between said batteries and said cranking motor including a plurality of switches operable to control the charging circuit and the energization of the cranking circuit at said different voltages, and motor-driven means for causing timed actuation of said switches.

3. In an engine cranking system, a cranking motor, current supply means comprising storage batteries affording a relatively low voltage for initially energizing the cranking motor and a higher voltage for carrying out the cranking operation, a generator, circuit connections between said batteries and generator and between said batteries and cranking motor including a plurality of switches for controlling such connections, said switches being operable in succession to establish a circuit for energization of the cranking motor at said relatively low voltage, a circuit for energization of the cranking motor at said higher voltage and to establish a circuit for charging the batteries from said generator, means for causing such timed actuation of said switches including an operating means and an electric driving means therefor, and a switch-controlled circuit for energizing said driving means.

4. In an engine cranking system, a cranking motor, current supply means comprising storage batteries affording a relatively low voltage for initially energizing the cranking motor and a higher voltage for carrying out the cranking operation, a generator, circuit connections be-

tween said batteries and generator and between said batteries and cranking motor including a plurality of switches for controlling such connections, said switches being operable in succession to establish a circuit for energization of the cranking motor at said relatively low voltage, a circuit for energization of the cranking motor at said higher voltage and to establish a circuit for charging the batteries from said generator, means for causing such timed actuation of said switches including an operating means and an electric driving means therefor, a circuit for said driving means, and means controlling the last-mentioned circuit and adapted to cause automatic stopping of the driving means after predetermined operation thereof.

5. In an engine cranking system, a cranking motor, current supply means comprising a battery having terminals affording different cranking voltages, a generator for charging said battery, circuit connections between said generator and battery and between said battery and cranking motor including a plurality of switches for controlling such connections, and a motor-driven shaft having cams thereon for causing sequential actuation of said switches.

6. In an engine cranking system, cranking motor, current supply means having terminals affording a relatively low voltage for initially energizing the cranking motor and a higher voltage for carrying out the cranking operation, circuit connections between said terminals and cranking motor including a plurality of switches for controlling such connections, means for causing timed actuation of said switches in a given cycle including an operating means and an electric driving means therefor, a circuit for said driving means, a manually operable switch in the last-mentioned circuit for energizing the same and initiating the operation of said driving means, and other switch means also actuated by said electric driving means and arranged for maintaining the driving means energized until completion of said cycle and thereafter causing automatic stopping of the driving means.

7. In an engine cranking system, a cranking motor, current supply means having terminals affording different cranking voltages, circuit connections between said terminals and cranking motor including a plurality of switches for controlling such connections, a shaft having cams thereon and adapted to be driven for causing actuation of said switches in a predetermined cycle for applying the different cranking voltages to the cranking motor in succession, a second motor for driving said shaft, circuit connections for the second motor including a manual switch for starting the same and other switch contacts driven by the second motor and arranged for maintaining the circuit for said second motor energized until completion of said cycle and thereupon automatically stopping the second motor.

8. In an engine cranking system, a cranking motor, current supply means having terminals affording different cranking voltages, circuit connections between said terminals and cranking motor including a plurality of switches for controlling such connections, a shaft having cams thereon and adapted to be driven for causing sequential actuation of said switches and the return of the cams to an initial position, electric driving means for said shaft, circuit connections for said electric driving means including a switch having a pair of stationary contacts and a con-

tact movable to engage either of said stationary contacts for initiating operation of said driving means, and a pair of movable interrupted timing contacts connected with said stationary contacts and adapted to be driven for causing continued operation of the driving means to complete the sequential actuation of said plurality of switches and the return of said cams to their initial position.

9. In an engine cranking system, a cranking motor, current supply means affording different cranking voltages, circuit connections between said supply means and cranking motor including a plurality of switches for controlling such connections, a shaft having operating connection with said switches and adapted to be driven for causing sequential actuation of said switches and the return of the switches to an initial setting, an electric driving motor for said shaft, circuit connections for said driving motor including a switch having a pair of stationary contacts and a contact movable to engage either of said stationary contacts for initiating operation of said driving motor, and a pair of interrupted timing contacts adapted to be driven by said driving motor and electrically connected with said stationary contacts for causing continued operation of the driving motor to complete the sequential actuation of said plurality of switches and the return of said switches to their initial setting.

10. In an engine cranking system, a cranking motor, current supply means affording a relatively low voltage for initially energizing the cranking motor and a higher voltage for carrying out the cranking operation, circuit connections between said supply means and cranking motor including sequentially operable means for controlling such connections, said sequentially operable means comprising a switch means for establishing a circuit for energization of the cranking motor at a relatively low voltage and

a switch means for energization of the cranking motor at said higher voltage, motor-driven means for actuating said switch means in succession, circuit connections for the motor of said motor-driven means, and switch means of the interrupted contact type included in the last-mentioned circuit connections and actuated by the motor-driven means for timing the operation of the cranking motor at said low and higher voltages.

11. In an engine cranking system, a cranking motor, current supply means comprising storage batteries affording a relatively low voltage for initially energizing the cranking motor and a higher voltage for carrying out the cranking operation, a generator, circuit connections between said batteries and generator and between said batteries and cranking motor including sequentially operable means for controlling such connections, said sequentially operable means comprising a switch means for disconnecting the generator and batteries and subsequently reestablishing a charging circuit therebetween, a switch means for establishing a circuit for energization of the cranking motor at a relatively low voltage and a switch means for energization of the cranking motor at said higher voltage, motor-driven means for causing actuation of said switch means in succession, circuit connections for the motor of said motor-driven means, switch means of the interrupted contact type included in the last-mentioned circuit connections and driven by the motor of said motor-driven means for timing the operation of said cranking motor at said low and high voltages and for stopping said motor-driven means after said charging circuit has been reestablished, and manually operable switch means included in the last-mentioned circuit connections for initiating the operation of said motor-driven means.

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