No. 755,793. PATENTED MAR. 29, 1904.

H. G. REIST & A. W. HENSHAW.

# STARTING DEVICE FOR INDUCTION MOTORS.

APPLICATION FILED JUNE 27, 1902.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 2.

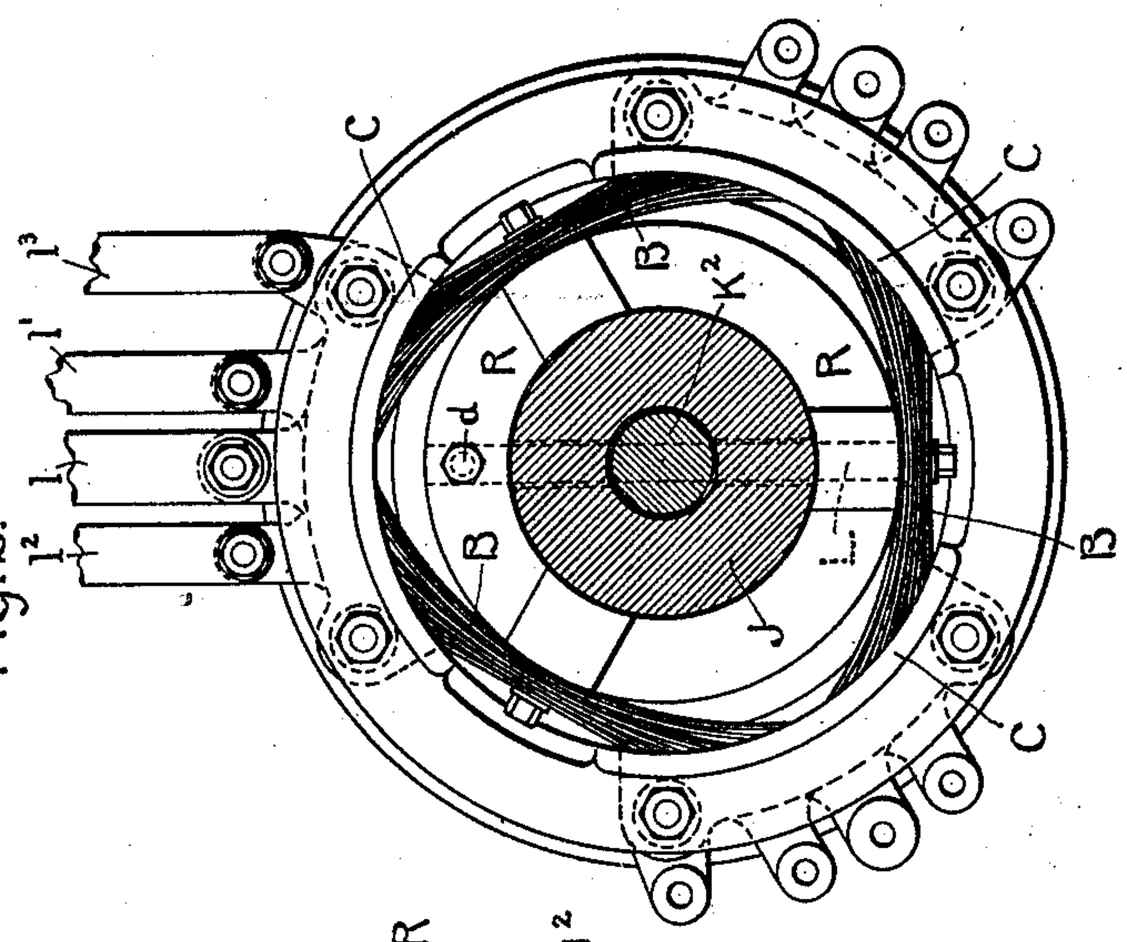
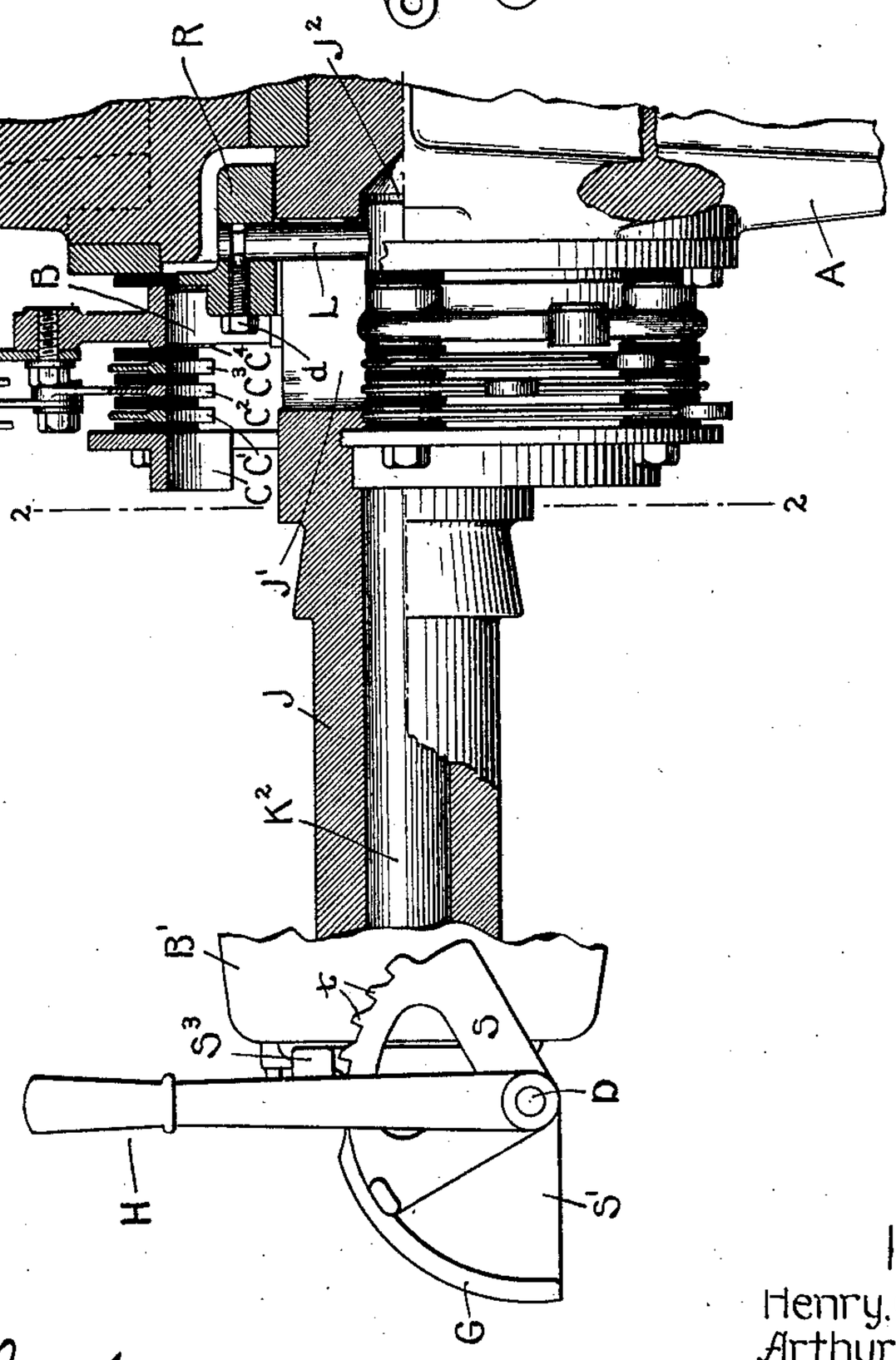



Fig. 1.

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NO MODEL. 4 SHEETS—SHEET 2.

Fig. 3.

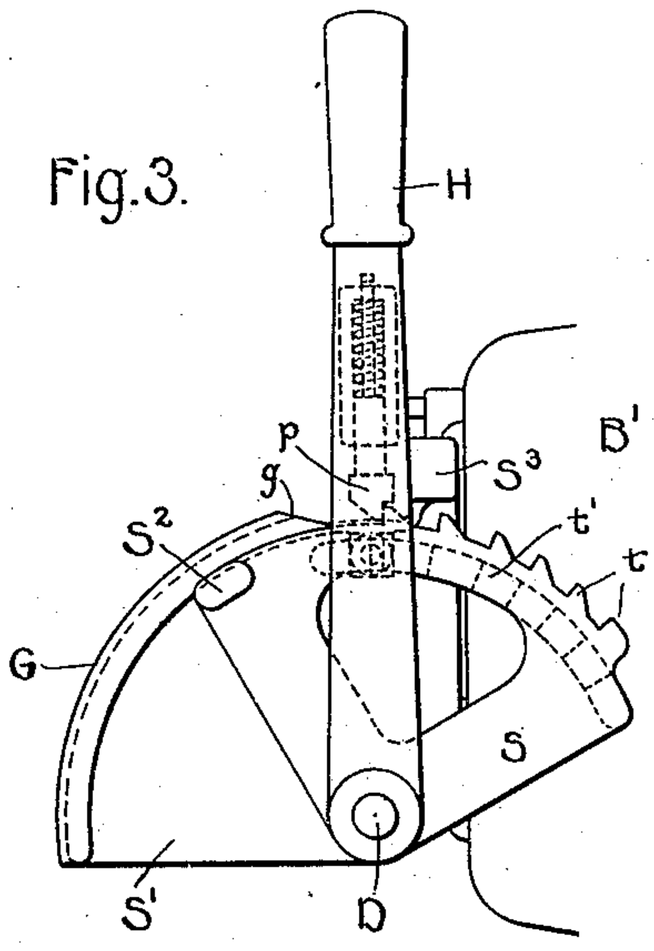



Fig. 6.

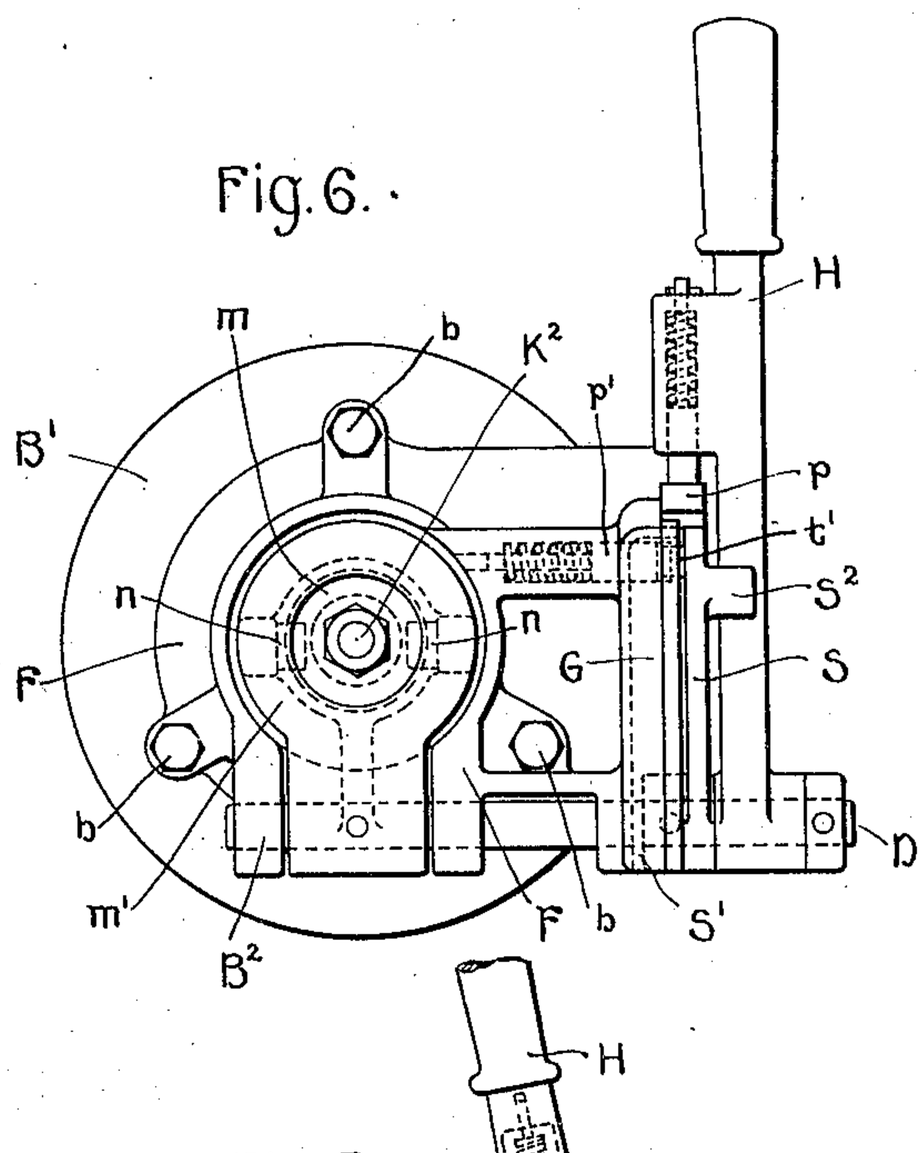



Fig. 4.

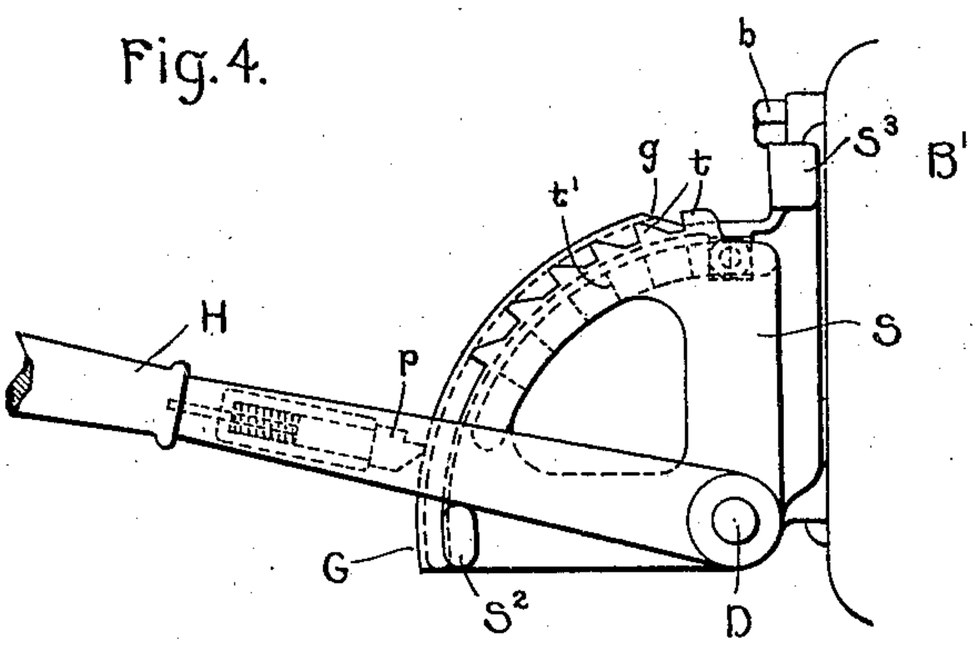



Fig. 5.

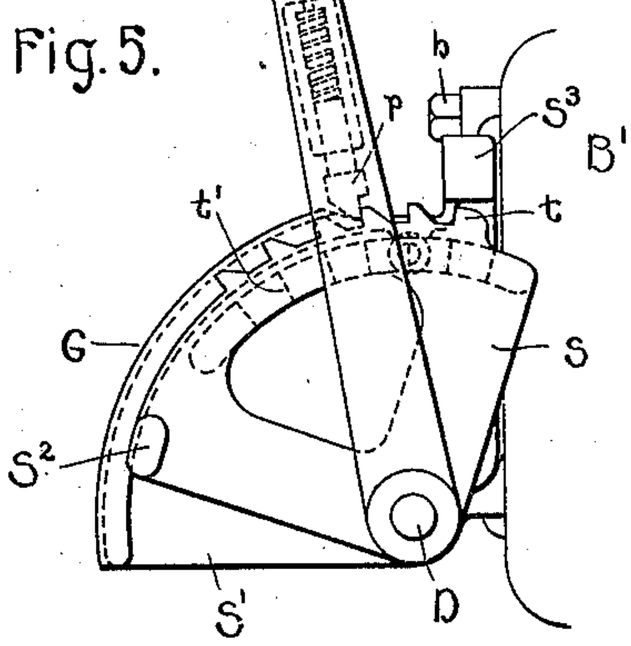
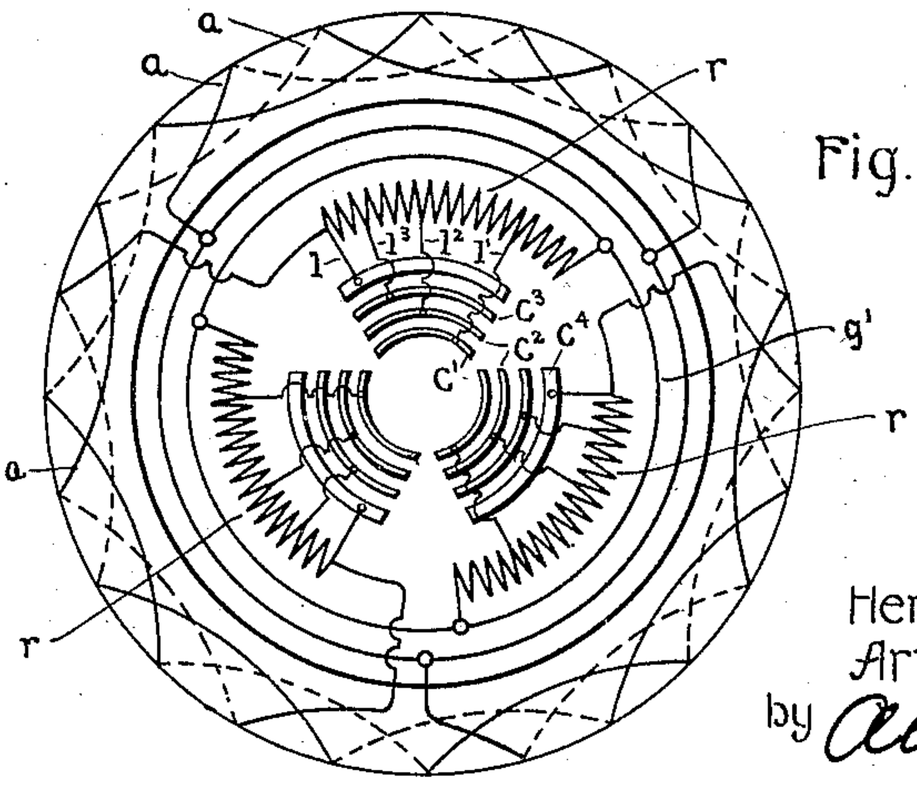



Fig. 7.

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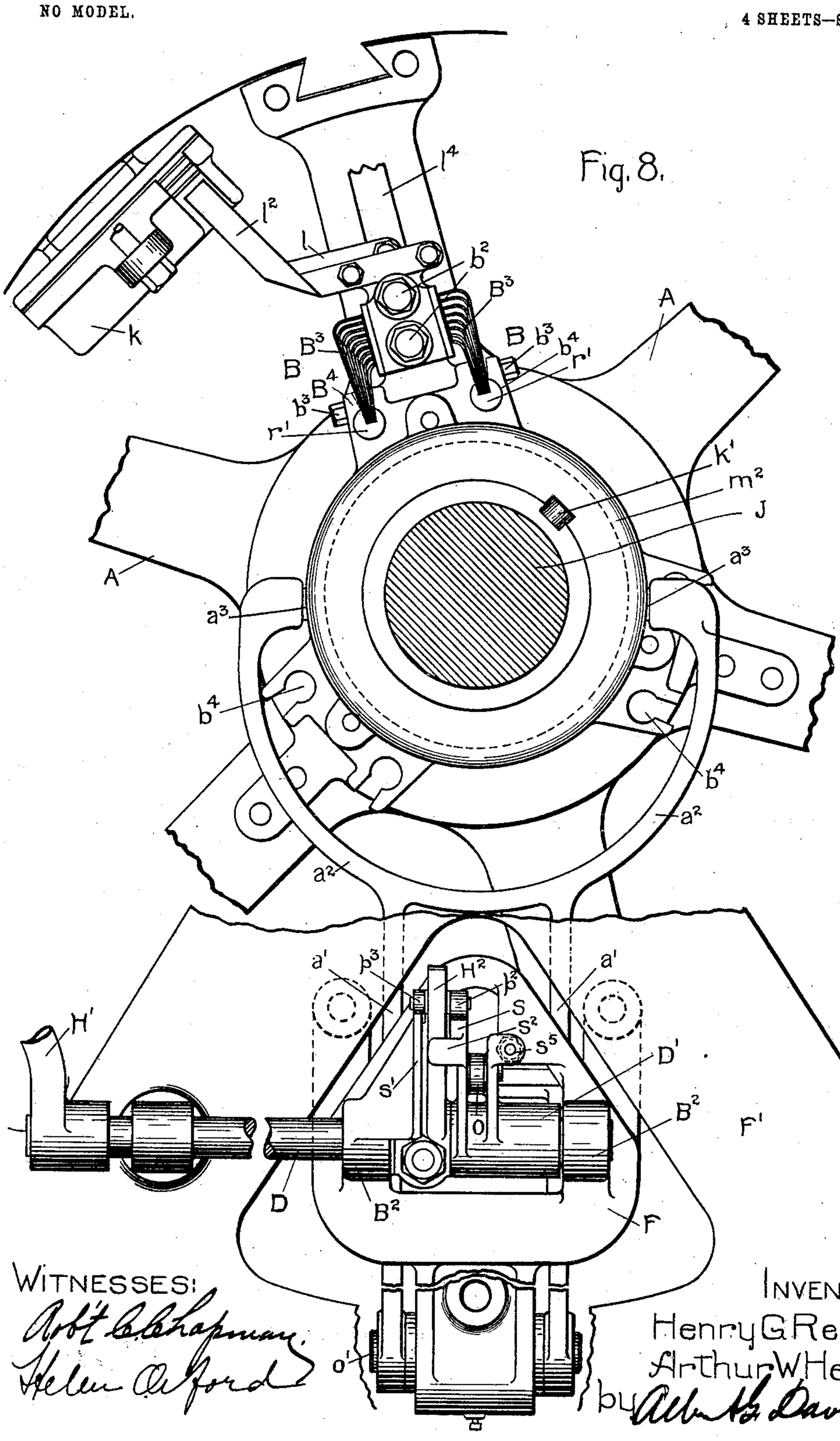
NO MODEL. 4 SHEETS—SHEET 3.

Fig. 8.

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STARTING DEVICE FOR INDUCTION MOTORS.

APPLICATION FILED JUNE 27, 1902.

NO MODEL. 4 SHEETS—SHEET 4.

Fig. 9.

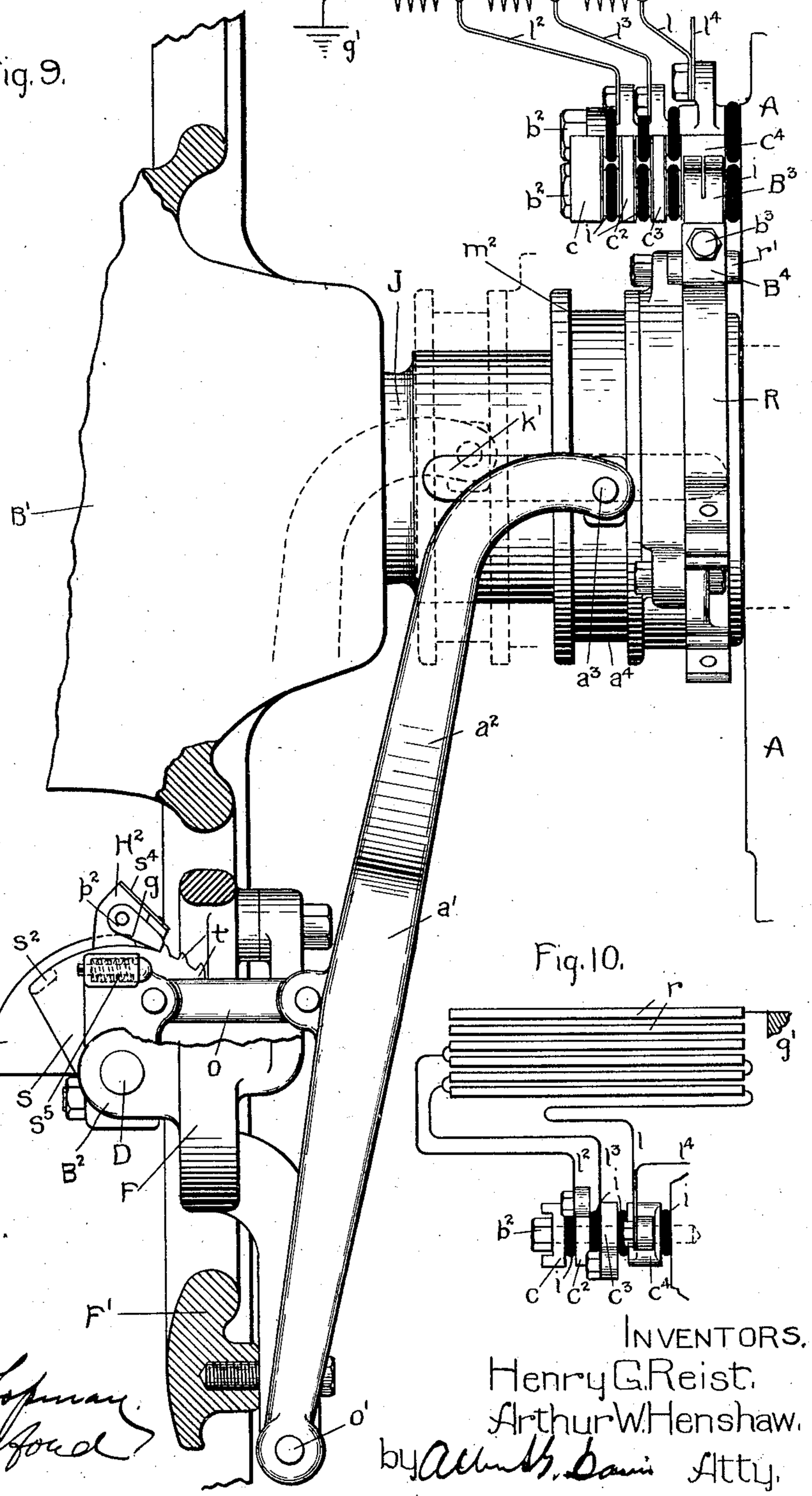


Fig. 10.




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# UNITED STATES PATENT OFFICE.

HENRY G. REIST AND ARTHUR W. HENSHAW, OF SCHENECTADY, NEW YORK, ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## STARTING DEVICE FOR INDUCTION-MOTORS.

SPECIFICATION forming part of Letters Patent No. 755,793, dated March 29, 1904.

Application filed June 27, 1902. Serial No. 113,460. (No model.)

*To all whom it may concern:*

Be it known that we, HENRY G. REIST and ARTHUR W. HENSHAW, citizens of the United States, and residents of Schenectady, in the county of Schenectady and State of New York, have invented certain new and useful Improvements in Starting Devices for Induction-Motors, of which the following is a specification.

Our present invention relates to improvements in motor-starting devices, and more particularly to means for varying the resistance in the secondary member or rotor of an alternating-current induction-motor.

Our invention further relates to improvements in the contact-blocks and brush-holder used in connection with the switch for cutting out the starting resistances.

Broadly stated, our invention consists of a motor-starting device comprising a starting-switch having contacts carried by the rotatable member of the motor and an operating mechanism for said switch constructed and arranged to secure an intermittent or step-by-step movement of said switch in one direction, the mechanism being preferably arranged to permit a continuous movement in the reverse direction.

More specifically stated, our invention consists of a motor-starting device comprising a ratchet mechanism which by a reciprocatory movement of a handle is adapted to move a switch-contact forward step by step over a plurality of fixed contact-blocks mounted in line and electrically connected to the sections of a starting resistance, thereby cutting out said resistance-sections step by step in starting the motor, and means whereby said ratchet device is positively prevented from moving said contact more than a predetermined distance during one forward movement of the operating-handle, whereby but a predetermined amount of resistance can be cut out of circuit at one time. Means are also provided for cutting in any number of resistance-sections by a single backward movement of the operating-handle.

The invention further comprises improvements in the construction of the starting-switch and in the mounting of the same. According to this feature of our invention the fixed contacts of the starting-switch are bolted to the outside of the armature-spider instead of being carried within the same, so that they are in view of the operator and are readily accessible for cleaning or for repairs in case any of the parts become injured. Each of the movable brushes of the starting-switch is constructed of two opposing sections arranged to engage the fixed contacts of the corresponding set on both sides, thus securing good contact between the fixed and movable members of the starting-switch without pressure on the contact-supports. Adjusting means are also provided for regulating the pressure of the brushes on the contacts.

In the drawings, Figure 1 is an elevation, partly in section, of a common type of alternating-current motor-starting switch, showing the manner in which our switch-operating device may be attached thereto. Fig. 2 is a section of the same along the line 2 2 of Fig. 1. Figs. 3, 4, and 5 are side elevations of the switch-operating device, showing different operative positions of the operating-handle. Fig. 6 is an end view of the motor-shaft with the switch-operating device attached thereto. Fig. 7 is a diagrammatic representation of the connections between the armature-windings and the starting resistances of the machine shown in Fig. 1. Figs. 8 and 9 are respectively end and side elevations, partly in section, of our improved starting-switch, showing the manner in which the switch-operating device may be attached thereto; and Fig. 10 is a plan view of the fixed contacts of the improved switch, showing diagrammatically the connections to the starting resistances.

In all the figures the corresponding parts are similarly lettered.

Referring now to the structures shown in Figs. 1 and 2, A indicates the spider or frame of an armature or rotor, within which are mounted the resistances, usually in the form of grids, which are used in starting the motor. A plurality of brushes B, electrically connect-

ed to each other and movable over the contact-blocks C, C′, C², C³, and C⁴, serve to control the resistance connections. The resistances are connected to the contact-blocks through the leads *l*, *l′*, *l²*, and *l³*. The brushes B are carried by the ring R, surrounding the shaft J, and movable longitudinally thereon. The ring is prevented from rotating about the shaft by the cross-bar L, to which it is attached by means of the set-screw *d*. The cross-bar is constrained to rotate with the armature-shaft, but is capable of a movement longitudinally thereof in the slot J′. It is secured in any suitable manner to one end of a rod K², which is adapted to reciprocate in a hole J², drilled concentric with the shaft J and extending into the same a distance slightly beyond the slot J′.

The device for operating the starting-switch is shown in detail in Figs. 3 to 6, inclusive. Attached to the armature-shaft bearing B′ by means of the bolts *b* is a frame F, in the bearings B² of which is mounted the rock-shaft D. The sector S, on which the ratchet-teeth *t* are formed, is keyed to the rock-shaft D. Also keyed to the shaft D is an arm *m′*, carrying the pins *n*, which operate in an annular groove in the member *m*, secured to the end of the rod K². The handle H, which carries the spring-pressed pawl *p*, is pivoted on the shaft D. Rigidly attached to the frame F is a sector S′, the periphery G of which forms a cam-surface with which the pawl *p* coacts in certain positions of the handle H. The spring-pressed plunger *p′*, also carried by the frame F, has a round nose, which coacts with the teeth *t* (shown in dotted lines) on the face of the sector S, so as to maintain the said sector S in any position it may have been placed by the operation of the lever-arm H.

The operation of the switch-actuating device is as follows: In starting the motor, when the switch in the primary or main circuit is closed the starting device should be in the position shown in Fig. 4, with the switch-brushes B in contact with the contact-blocks C, Fig 1. As the lever-arm H is moved forward into the position shown in Fig. 5 the pawl *p* rides on the sector-face G and is prevented from coacting with the ratchet-teeth *t* until the incline *g* at the inner end of said face G is reached. A further forward movement of the handle H to its extreme forward position against the stop S³ causes a movement of the sector S forward a distance of one tooth, thereby moving the switch-brushes B, through the agency of the shaft D, arm *m′*, and rod K², on to the contacts C′ and cutting out a predetermined amount of the resistance. The sector S′ therefore forms the means for rendering the ratchet-and-pawl mechanism inoperative to move the brushes B forward when the handle is in certain positions. In order to bring the brushes B into contact with the contact-blocks C², it is necessary to move the arm H back over one of the teeth *t*, the sector S being meantime held in its forward position by the plunger *p′*, which coacts with one of the teeth *t′* and then returns the arm H to its position against the stop S³. A continuation of the reciprocatory movement of the arm H cuts out the resistance step by step until the brushes B rest on the contact-blocks C⁴, at which time all the resistance is short-circuited and the starting-switch-operating device assumes the position shown in Fig. 3. In order to restore the starting-switch to its initial position, the arm H is moved into the position shown in Fig. 4, carrying with it the sector S, the lug S², carried by said sector, coacting with said handle to accomplish this object.

Since the width of each of the brushes B is substantially equal to that of the short-circuiting contact-block C⁴, which block is considerably wider than each of the blocks C′, C², and C³, respectively, and since the teeth of the sector S are so spaced that a movement from one tooth to the next corresponds to a movement from one contact-block, such as C′, to the next, such as C², it will be seen that it will require more than one forward movement of the arm H to move the brush B from the contact C³ to its position completely on the block C⁴. For this reason more teeth *t* are provided on the sector S than correspond to the number of contact-blocks of the starting-switch.

In the diagrammatic representation of the connections, (shown in Fig. 1,) *a* represents the armature-windings; C′, C², C³, and C⁴, the contact-blocks with which the brushes B coact; *l*, *l′*, *l²*, and *l³*, the leads from said contact-blocks to the resistances *r*, and *g′* represents a ground connection for the resistances *r*.

In Figs. 8 and 9, which show our improved starting device in connection with the new starting-switch which we have devised, A, as before, represents the armature-spider; B′, the bearing in which the armature-shaft J rotates; R, the ring which carries the brushes B of the starting-switch, and C′, C², C³, and C⁴ the contact-blocks against which the brushes B rest. The contact-blocks formed with opposing contact-faces, as clearly shown in Figs. 8, 9, and 10, are assembled with the insulating-pieces *i* between them and are bolted directly to the armature-spider A by means of the bolts *b²*. The contact-blocks are electrically connected by means of the leads *l*, *l²*, and *l³* to the resistance *r*, carried in the casings *k*, which are bolted to the armature, as shown in Fig. 8. The resistances *r* are grounded in the armature-frame at *g′*. (Shown diagrammatically in Figs. 9 and 10. The leads *l⁴* connect the short-circuiting contact-blocks *c⁴* directly with the armature-winding. The brushes B of this modification comprise the two opposing sections B³, built up of laminated strips of conducting material mounted on a common support B⁴, which in this case is

formed integral with the ring R. The laminated strips forming each of the opposing sections $B^3$ are mounted in slots in the short cylindrical pieces $r'$, which are inserted in the openings $b^4$ of the common support $B^4$. The said cylindrical pieces $r'$ are rotatable in the openings $b^4$. Bolts $b^3$ are used for retaining the brush-section-holding means in place and also for varying the pressure exerted by said brush-sections against the contact-blocks. The said brush-sections engage the contact-blocks with a clamping action in such a manner as to remove from the bolts $b^2$ all strain due to the pressure of said brush-sections against the contact-faces. The pressure of one brush-section counteracts the pressure of the opposing section of said brush. Splined to the shaft J at $k'$ and rigidly attached to the ring R is a sleeve $m^2$, in which is formed the annular groove $a^4$. Coacting with said groove $a^4$ are the pins $a^3$, mounted at the upper ends of the arms $a^2$ of the Y-shaped lever-arm $a'$, which is pivoted at $o'$ in the frame F, bolted to the head F′ of the motor-casing. The rock-shaft D is mounted in the bearings $B^2$, carried by the frame F, as before, and is operated by the handle or lever arm H′, which in this modification is placed at one side of the motor-casing. The movable sector S, carrying the teeth $t$, is rigidly attached to the sleeve D′, which is rotatably mounted on the shaft D. A link $o$ connects the sector S with the lever-arm $a'$, and the sector is limited in its forward movement by the frame F, against which a spring-pressed stop $S^5$, carried by said sector strikes. The sector S′ is rigidly attached to frame F, as before. Mounted on the upper end of the lever-arm $H^2$, which corresponds to the arm H in the modification above described and which is rigidly fastened to the rock-shaft D between the movable sector S and the fixed sector S′, is a double pawl $p^2$ $p^3$. In operation the part $p^2$ of the double pawl coacts with the teeth $t$, and the part $p^3$ on the opposite side of arm $H^2$ coacts with the cam-face of the sector S′, riding up on the incline $g$ to raise the part $p^2$ out of engagement with the teeth $t$; otherwise the operation of this device is the same as before described with reference to Figs. 1 to 6, inclusive. A reciprocating movement of the arm or handle H′ reciprocates the arm $H^2$, which carries the double pawl, the said pawl coacting with the ratchet-teeth $t$ and the sector S′ to impart a step-by-step forward movement to the brushes or movable members B of the starting-switch. A backward movement of the handle H′ causes the arm $H^2$ to engage with the stop $S^2$, carried by the sector S, thus returning the brushes B to their normal inoperative position on contact-blocks C.

While we have herein shown and described preferred forms of devices embodying our invention, we do not intend to limit ourselves to any specific construction, as many modifications could be made by persons skilled in the art without departing from the spirit and scope of our invention. Neither do we intend to limit the application of our improved starting device to alternating-current motors in which the resistance used for obtaining the required torque at starting is carried by the rotatable part of the motor. Our starting-switch-operating mechanism is equally applicable to motors having a variable electromotive force impressed upon the primary circuit and also to motors of the direct-current type.

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

1. In a motor-starting device, a starting-switch comprising contacts carried by the rotatable member of the motor, a relatively movable contact adapted to engage said contacts, and means for moving said relatively movable contact in a step-by-step manner.

2. In a motor-starting device, a starting-switch comprising contacts carried by the rotatable member of the motor, a relatively movable contact adapted to engage said contacts, and a ratchet-and-pawl mechanism for moving said relatively movable contact in a step-by-step manner.

3. In a motor-starting device, a starting-switch having contacts carried by the rotatable member of the motor, a relatively movable contact adapted to engage said contacts, and means for moving said relatively movable contact in a step-by-step manner, said means comprising a member having ratchet-teeth formed thereon, a member carrying a pawl which is adapted to coact with said ratchet-teeth, and means whereby each movement of the pawl-carrying member will cause the movable contact to be moved through a portion only of its full range of movement.

4. In a motor-starting device, a starting-switch having contacts carried by the rotatable member of the motor, a relatively movable contact adapted to engage said contacts, and means for moving said relatively movable contact in a step-by-step manner longitudinally of the shaft of the rotatable member, said means comprising a member having ratchet-teeth formed thereon, a member carrying a pawl which is adapted to coact with said ratchet-teeth, means whereby each movement of the pawl-carrying member will cause the switch to be moved through a portion only of its full range of movement, and means for retaining the toothed member in any position into which it may have been moved by the pawl-carrying member.

5. In a motor-starting device, a starting-switch having relatively fixed contacts mounted in line, a relatively movable contact adapted to engage said fixed contacts, means for moving said movable contact in a step-by-step manner over said fixed contacts, said means comprising a member having ratchet-teeth

formed thereon, a member carrying a pawl which is adapted to coact with said ratchet-teeth, and means whereby each movement of the said pawl-carrying member to its limiting position in one direction will cause the switch to be moved through a portion only of its full range of movement.

6. In a motor-starting device, a starting-switch having relatively fixed contacts mounted in line, a relatively movable contact adapted to engage said fixed contact, means for moving said movable contact in a step-by-step manner over said fixed contacts, said means comprising a member having ratchet-teeth formed thereon, a member carrying a pawl which is adapted to coact with said ratchet-teeth, means whereby each movement of the said pawl-carrying means to its limiting position in one direction will cause the switch to be moved through a portion only of its full range of movement, and means whereby a movement of the said pawl-carrying means to its limiting position in the reverse direction will cause the switch to be moved back to its initial position.

7. In a motor-starting device, a starting-switch, operating mechanism for said switch comprising a pivoted sector having ratchet-teeth formed thereon, a pivoted lever-arm carrying a pawl which is adapted to coact with said teeth when the said pivoted arm is in certain operative positions, a fixed sector mounted parallel to and of slightly greater radius than said pivoted sector and against the periphery of which the pawl operates, thereby preventing said pawl from engaging with the said ratchet-teeth when the pivoted arm is moved into certain other operative positions, and means for limiting the movements of said lever-arm.

8. In a motor-starting device, a starting-switch, operating mechanism for said switch comprising a movable toothed sector operatively connected with the movable member of said switch, a pivoted arm carrying a pawl which is adapted to coact with the teeth of said sector when the said arm is in certain operative positions, means for preventing said pawl from engaging with said teeth when the pivoted arm is in certain other operative positions, and means for maintaining the movable member of said switch in any one of its operative positions after it has been moved into said position by the said ratchet-and-pawl mechanism, said means comprising teeth carried by said pivoted sector and a plunger carried by said fixed sector for engaging with said teeth.

9. In a motor-starting device, a starting-switch, operating mechanism for said switch comprising a movable toothed sector operatively connected with the movable member of said switch, a pivoted arm carrying a pawl which is adapted to coact with the teeth of said sector when the said arm is in certain operative positions, a fixed sector mounted parallel to and of slightly greater radius than said pivoted sector and against the periphery of which said pawl operates to prevent the latter from engaging with said teeth when the pivoted arm is in certain other operative positions, and means for maintaining the movable member of said switch in any one of its operative positions after it has been moved into said position.

10. In a motor-starting device, a starting-switch, means for operating said switch, said operating means comprising a pivoted sector operatively connected with the movable member of said switch, ratchet-teeth carried by said sector, a lever-arm pivoted concentrically with said sector, a pawl carried by said arm and adapted to coact with said ratchet-teeth in certain positions of said arm, means for preventing said pawl from engaging with said ratchet-teeth when said arm is moved into certain other positions, said means comprising a fixed sector mounted parallel to and of slightly greater radius than said pivoted sector and against the periphery of which said pawl operates, and means for maintaining said switch in certain operative positions, said means comprising teeth carried by said pivoted sector and a plunger carried by said fixed sector for engaging with said teeth.

11. The combination in a switch, of a series of contact-blocks mounted in line and having contact-faces on opposite sides thereof, and a movable brush comprising two opposing sections mounted on a common support and arranged to engage the said contact-faces.

12. The combination in a switch, of a series of contact-blocks mounted in line and having contact-faces on opposite sides thereof, a movable brush comprising two opposing sections mounted on a common support and arranged to engage the said contact-faces, and adjusting means for regulating the pressure of the brushes on the said contact-faces.

13. The combination in a switch, of a series of contact-blocks mounted in line and having contact-faces on opposite sides thereof, a movable brush comprising two opposing sections mounted on a common support and arranged to engage the said contact-faces, and means for giving said movable brush an intermittent forward movement over said contact-blocks.

14. The combination in a switch, of a series of contact-blocks mounted in line and having contact-faces on opposite sides thereof, and a movable brush comprising two opposing sections formed of laminated conducting-strips adjustably mounted on a common support and arranged to engage said contact-faces.

15. The combination in a switch, of a series of contact-blocks mounted in line and having contact-faces on opposite sides thereof, a brush comprising two opposing sections mounted on a common support and arranged to engage the said contact-blocks with a clamping action,

the ends of said brush-sections resting against the contact-faces whereby the pressure of one brush-section against one contact-face counteracts the pressure of the opposing brush-section against the opposite contact-face.

16. In a motor, the combination of a plurality of contact-blocks mounted so as to project from one end of the rotatable member and adapted to be electrically connected to the sections of a starting resistance, with a plurality of contact-brushes mounted so as to engage said blocks, and means for moving said brushes in a step-by-step manner over said contact-blocks.

17. In a motor, the combination with a rotatable member, of a plurality of resistances, contact-blocks attached to one end of said rotatable member, projecting outwardly therefrom and electrically connected to said resistances, contact-brushes mounted so as to engage said contact-blocks, and means for moving said brushes in a step-by-step manner over said contact-blocks.

18. In a motor, the combination of a plurality of contact-blocks mounted on the end of the rotatable member of the motor and adapted to be electrically connected to a starting resistance, with a contact-brush so constructed and arranged that it will move over the contact-surfaces of said contact-blocks to successively engage the same, and means for moving said brush over said contact-blocks.

19. In a motor, a plurality of contact-blocks mounted in groups and projecting from one end of the rotatable member with the corresponding contact-faces of the blocks of a single group located in the same plane, the said contact-blocks being adapted to be electrically connected to the sections of a starting resistance, in combination with a plurality of contact-brushes mounted so as to engage the contact-faces of said blocks, and means for moving said brushes over said contact-faces.

20. In a motor, the combination with the rotatable member, of a plurality of resistances, contact-blocks attached to one end of said rotatable member, projecting outwardly therefrom and arranged in groups with the contacts of a single group mounted in line and electrically connected to certain of said resistances, contact-brushes each mounted so as to engage the contact-blocks of a single group, and means for moving said brushes over said contact-blocks.

21. In a motor-starting switch, the combination with the frame of the rotatable member, of a series of contact-blocks mounted on the said frame and projecting outwardly therefrom, said blocks having opposing contact-faces, a brush comprising opposing sections adapted to engage said opposing contact-faces, a brush-holding device mounted on the rotatable member, and means for moving said brush-holding device.

22. In a motor, the combination with the revolving member, of contact-blocks each having opposing contact-faces, said blocks being attached to one end of said revolving member projecting outwardly therefrom and adapted to be connected electrically to starting resistances, a brush comprising opposing sections so constructed and arranged as to engage the opposing contact-faces of said blocks, and means for moving said brush over said contact-blocks.

23. In a motor, the combination with the revolving member thereof, of a plurality of resistances carried by said revolving member, contact-blocks each having a pair of opposing contact-faces, said blocks being attached to said revolving member and electrically connected to said resistances, and a contact-brush slidably mounted on the shaft of the motor and adapted to engage the opposing contact-faces of said blocks.

24. In a motor, the combination with the revolving member, of contact-blocks each having opposing contact-faces, said contact-blocks being attached to said revolving member and adapted to be connected electrically to starting resistances, a contact-brush mounted upon the revolving member and adapted to engage the opposing contact-faces of the contact-blocks, and means for adjusting the pressure of said brush on said contact-blocks.

25. In a motor, the combination with the revolving member, of contact-blocks each having opposing contact-faces, said blocks being attached to one end of said revolving member and projecting outwardly therefrom, a contact-brush comprising two opposing sections mounted on a common support so as to engage the opposing contact-faces of said blocks, and means for adjusting the pressure of the opposing sections of said brush on said contact-blocks.

In witness whereof we have hereunto set our hands this 25th day of June, 1902.

HENRY G. REIST.
ARTHUR W. HENSHAW.

Witnesses:
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HELEN ORFORD.