

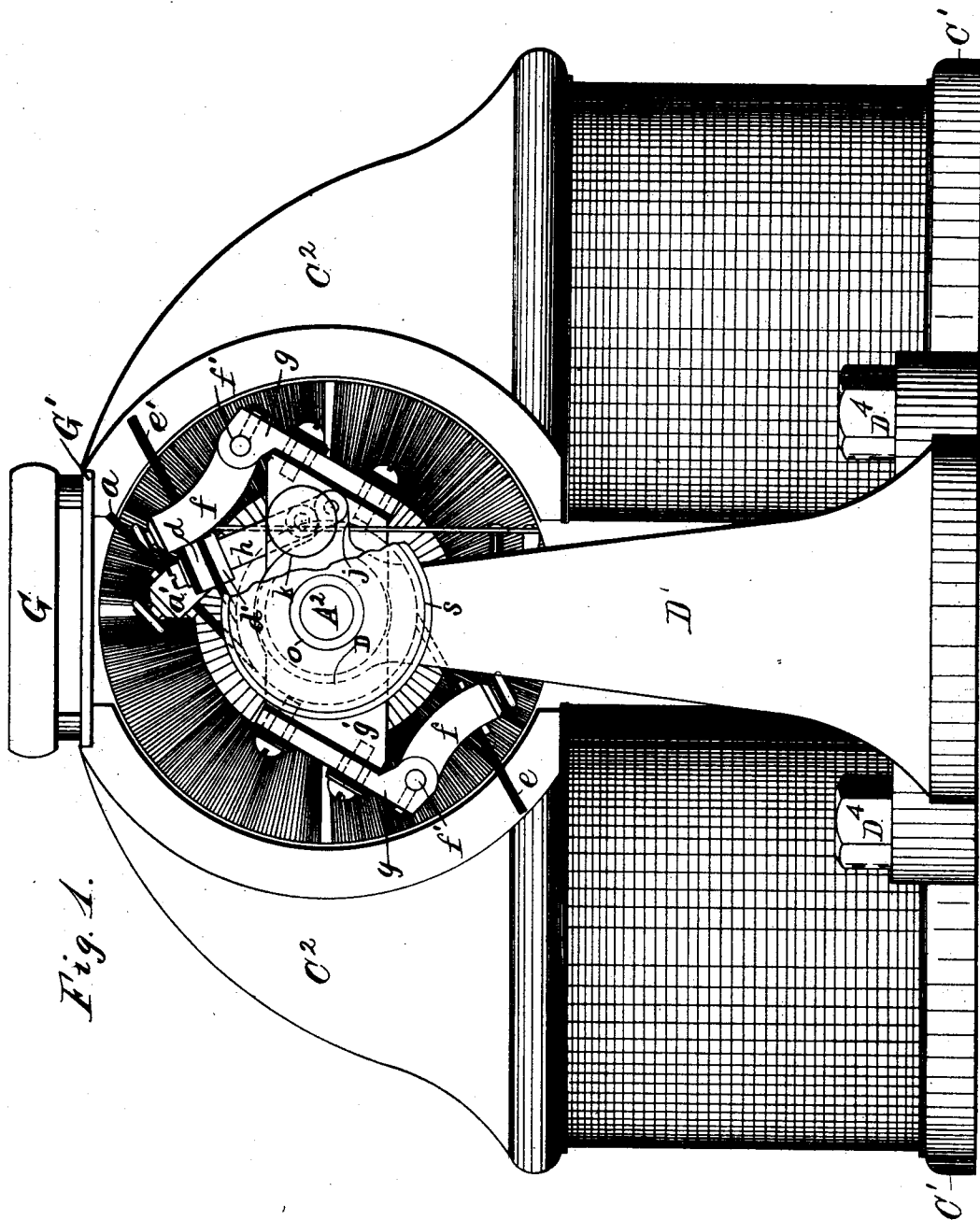
(No Model.)

5 Sheets—Sheet 1.

W. BAXTER, Jr.
CONSTANT CURRENT MOTOR.

No. 423,897.

Patented Mar. 25, 1890.



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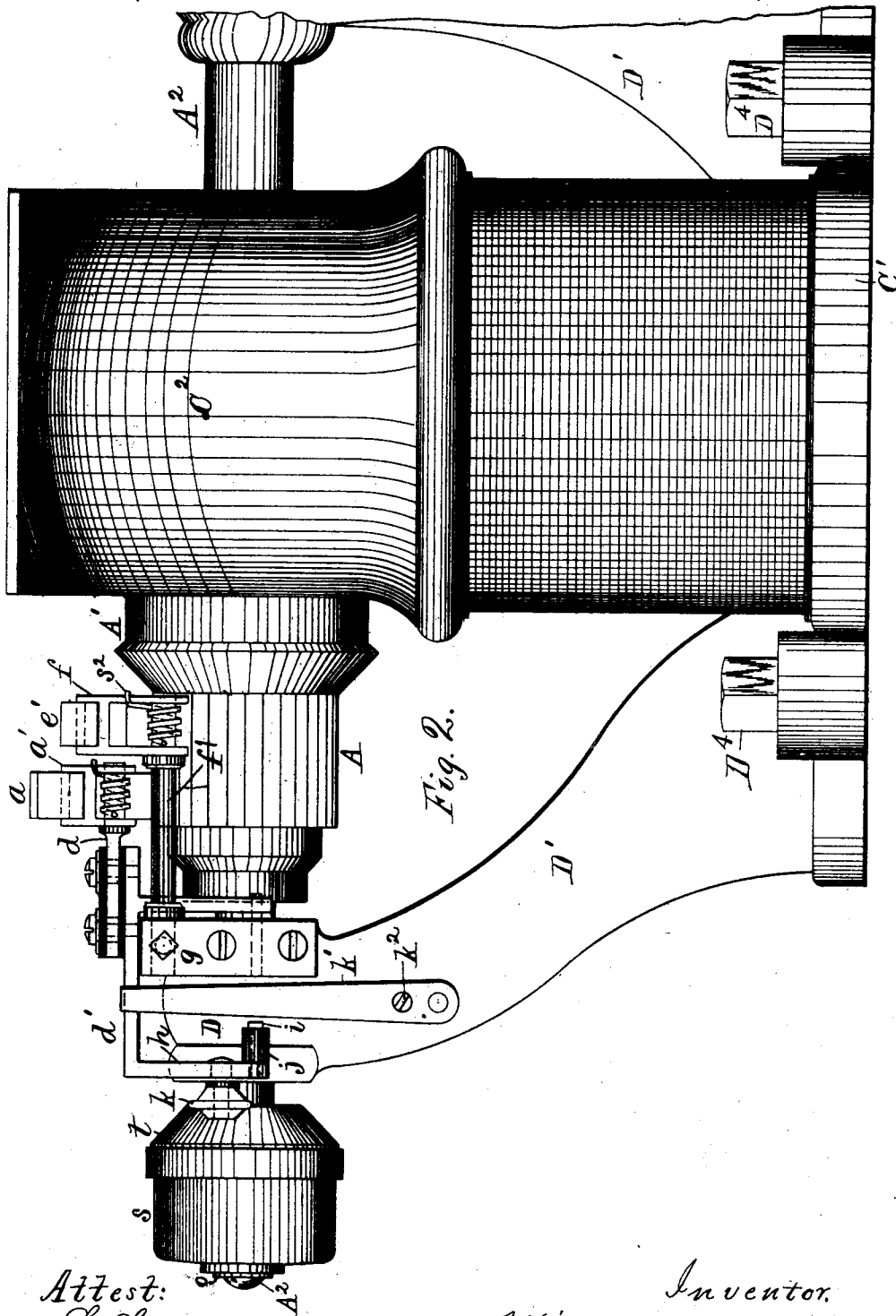


Fig. 2.

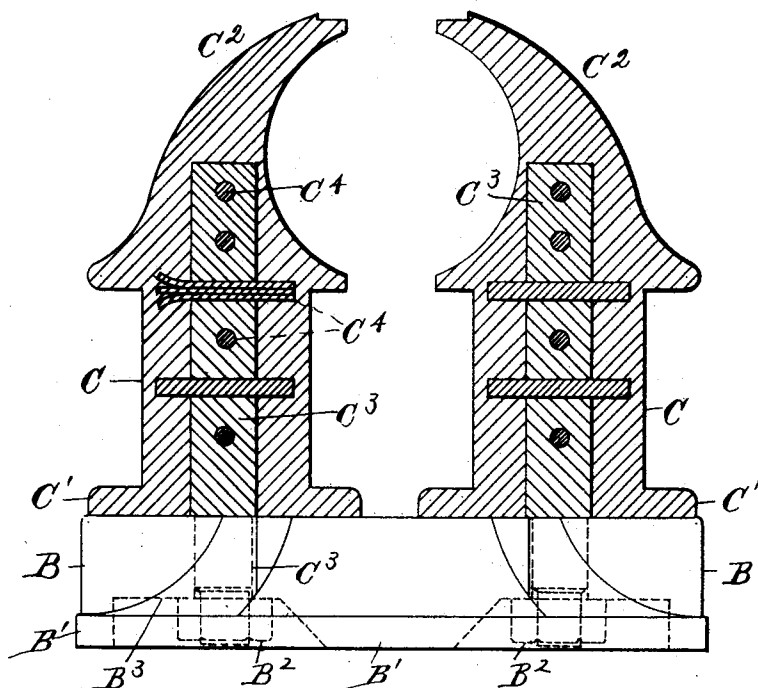
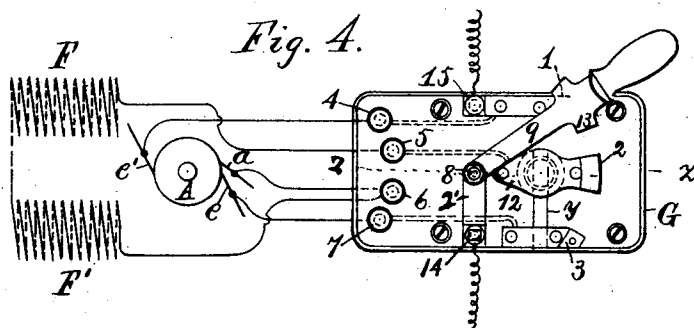
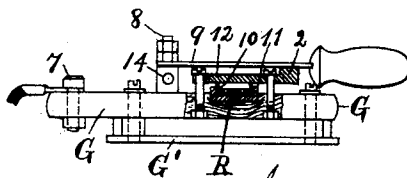
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Fig. 3.*Fig. 4.**Fig. 5.*

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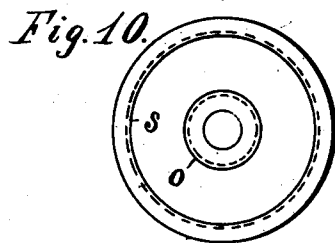
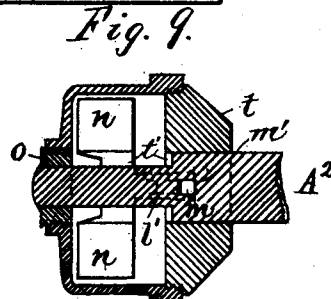
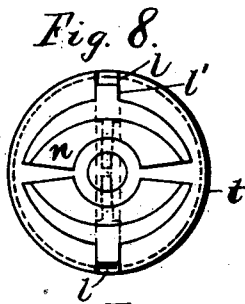
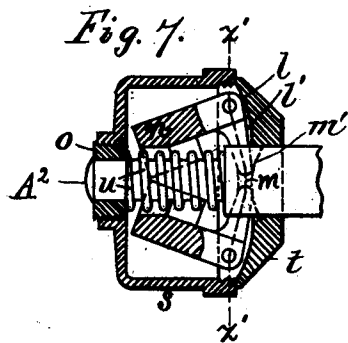
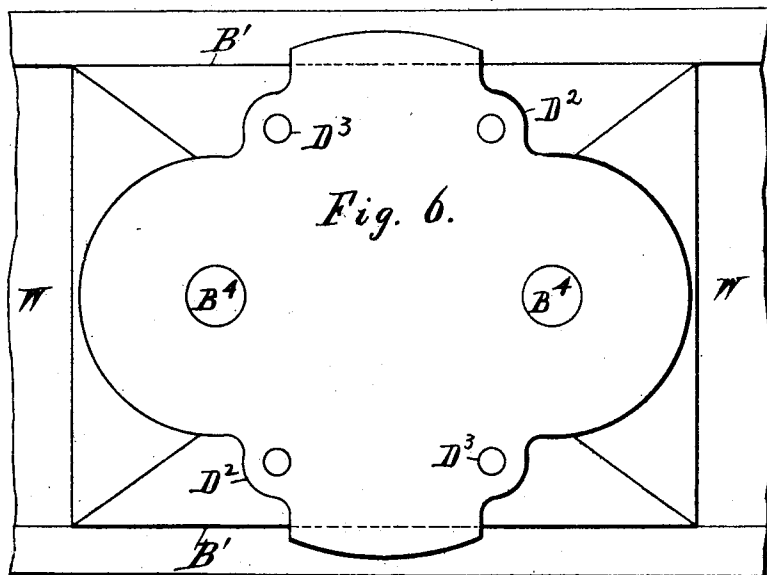


Fig. 11.

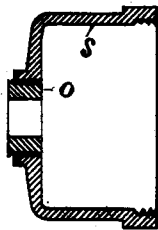
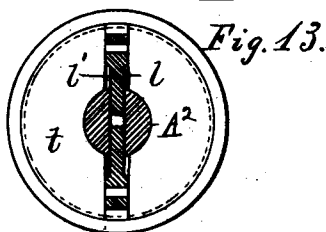
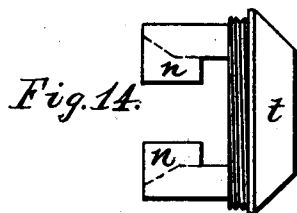
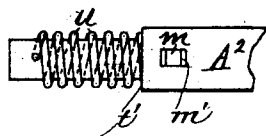


Fig. 12.



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Fig. 15.

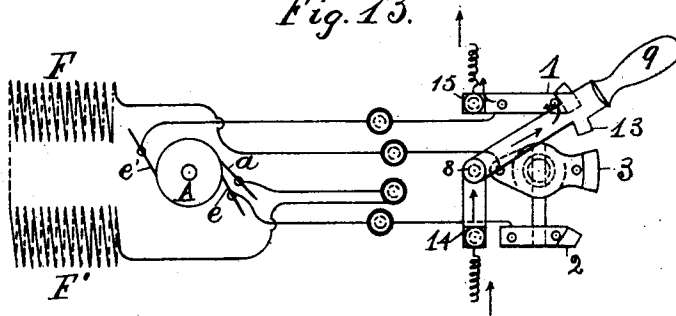


Fig. 16.

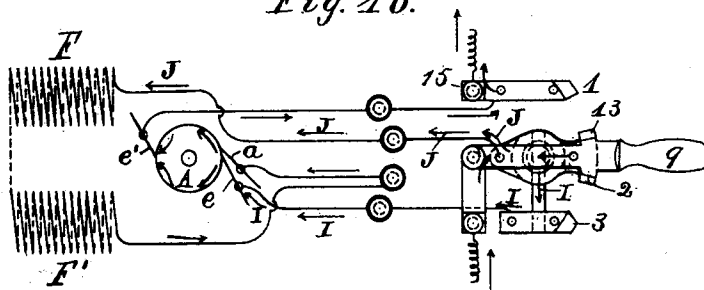
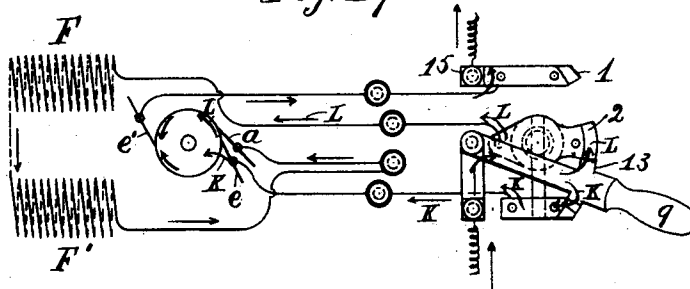


Fig. 17.



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UNITED STATES PATENT OFFICE.

WILLIAM BAXTER, JR., OF BALTIMORE, MARYLAND.

CONSTANT-CURRENT MOTOR.

SPECIFICATION forming part of Letters Patent No. 423,897, dated March 25, 1890.

Application filed March 22, 1889. Serial No. 304,025. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM BAXTER, Jr., a citizen of the United States, residing at Baltimore, Maryland, have invented certain new and useful Improvements in Constant-Current Motors, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

The object of this invention is partly to furnish an improved method and means for regulating a constant-current motor having the field magnetized by a current shunted from the surface of the commutator.

The invention consists in a constant-current motor having the field magnetized by a current shunted from the commutator through two brushes attached to the terminals of the field-coils and adapted for changing the electrical relation of the brushes to one another automatically by a centrifugal governor rotated in unison with the motor-armature, and therefore affected by the load upon the motor.

The invention also consists in the combination, with the commutator, the field-coils, and the brushes combined therewith, as just described, of a peculiarly-constructed switch required for operating a motor of this class.

Heretofore it has been common in constant-current dynamo-electrical machines to employ various arrangements of brushes in which one or more adjustable brushes have been combined with one or more fixed brushes to shunt a variable current from the surface of the commutator through the field-coils for maintaining a constant current in the armature-circuit under a variable resistance. In such case the speed of the machine is supposed to be uniform at all times, being governed exclusively by the motive power applied to rotate the armature, and not affected in any manner by variations in the field-circuit or the armature-circuit. Any of the various arrangements heretofore used for shunting a current from the surface of the commutator may be employed in practicing my invention; but I prefer the arrangement in which one terminal of the field is attached to one of the stationary brushes and the other is attached to a movable brush.

As a governor is essential to my present invention, and as the governor is employed to vary the electrical relation of the brushes

to which the terminals of the field-coils are attached, it is obvious that it involves less mechanical complication to use but a single movable brush and to actuate the same by the governor.

My improvements will be understood by reference to the annexed drawings, in which—

Figure 1 is an end elevation of a motor having the switch-board fixed upon a bridge between the pole-pieces; but the switch-lever and fixtures are omitted for want of room upon the drawings. Fig. 2 is a side elevation of the same parts with the switch and switch-board removed from the pole-pieces and the bearing for the armature-shaft broken off at the right-hand end. Fig. 3 is a central vertical section of the magnet-cores and pole-pieces transverse to the axis of the armature, with the bed (not in section) attached to the bases of the magnet-cores. Fig. 4 is a plan of the switch, with a diagram of the armature and the field-coils and their connections. Fig. 5 is a side elevation of the switch and the bridge by which it is attached to the pole-pieces, with the resistance-box and its contacts in section on line $z z$ in Fig. 4. Fig. 6 is a plan of the bed with the motor detached therefrom. Fig. 7 is a vertical section of the governor, taken on its center line. Fig. 8 is a view of the outer end of the governor with the shell removed. Fig. 9 is a plan of the governor in section at its center line. Fig. 10 is an inside view of the governor-shell; and Fig. 11 is a section of the same similar to that shown in Fig. 7, but detached from the governor-head. Fig. 12 is a plan of the governor-shaft viewed as in Fig. 9, but not in section. Fig. 13 is an inside view of the governor-head, with the shaft in section on line $z' z'$ in Fig. 7, and Fig. 14 is a side view of the governor-head detached. Figs. 15, 16, and 17 are diagrams of the switch and circuit connections.

In the motor, C are the magnet-cores, C' flanges at their bases, and C² the pole-pieces. The cores are projected vertically from the bed B, which is shaped upon the top to fit the flanges C' and the feet of the standards D' for the armature-bearings. The top of the bed is therefore of rounded outline at the points where the flanges C' are secured; but the bed is provided at the bottom with lateral flanges B', having parallel edges to adapt the

bed for sliding in the ways W, to which such motor-beds are fitted to render them movable for tightening the attached belt. The parallelism of the opposite sides of the bed at the lower edge is an essential part of my construction, while the form at the top of the bed is immaterial. The cores C are secured to the bed by studs C³, extended up into the pole-pieces and provided at various points with transverse pins C⁴. The lower end of the stud is projected below the flange B' a suitable distance to pass through the web of the bed and receive a screw-thread and nut B² upon its lower end. The studs are secured within the cores by supporting the studs in a mold and pouring the melted iron into the mold around the stud, the pins C⁴ serving to hold the stud securely within the casting, which cannot always be effected by the mere shrinkage of the cast metal upon the stud. Holes B⁴ are formed in the bed to receive the studs, and the under side of the bed is provided with recesses B³ to contain the nuts B².

A' is the armature, A² the armature-shaft, and A the commutator adjacent to the armature-bearing D. The shaft is extended through the bearing and provided with a governor of unusually small dimensions contained within a shell s, secured by a screw-thread upon the periphery of a head t, and both the head and shell being movable longitudinally upon the shaft. The armature-circuit brushes e and e' are shown mounted in swinging holders f, pivoted upon lugs g, which are secured upon and insulated from ears g' upon the bearing D. The movable brush a is carried in a holder a', pivoted upon a stud d, which is fixed by insulated fastenings upon a swinging frame pivoted at one side of the bearing D. The frame is formed with a seat d' and arms h, mounted upon pivots i, fitted in ears j, one at the inner and one at the outer side of the bearing D, and the frame is provided with a roller k, adapted to bear upon the conical back of the head t. The brush a is mounted to bear upon the commutator adjacent to the brush e', and these two brushes are connected, respectively, with the terminals of the field-magnet coils. A spring k' operates upon the frame to press the roller k toward the shaft A², and the longitudinal movement of the governor upon the shaft toward the roller presses the conical face of the head against the roller and forces it outward from the shaft. Such outward movement of the frame shifts the movable brush a nearer to the brush e, and, as the potential varies upon the surface of the commutator between the two brushes, such movement produces a variation in the current shunted from the commutator through the field-coils and affects the strength of the field in the desired manner.

The head of the governor t has a groove l slotted radially across its inner surface, and arms l' are pivoted in the outer ends of such groove with their inner ends fitted to a hole

or slot m, forming abutments m' in the armature-shaft. The arms are provided with weights n, projected at right angles to the arms, and thus moved to and from the shaft by a vibration of the arms upon their pivots. The shell incloses the weights and arms and is provided at its outer end with a bush o, fitted to a thread in the end of the shell, so as to be adjustable to and from the head t. A shoulder l' is formed upon the shaft adjacent to the hole m by reducing the size of the shaft from that point outward through the bush o, and a spiral spring u is fitted between the bush and the shoulder to push the governor normally toward the end of the shaft. The weights n are curved externally to closely fit the interior of the shell s and are notched internally to fit closely around the spring to secure the maximum of weight within the desired compass. The head t is movable longitudinally upon the shaft, but is rotated therewith by the engagement of the arms l' with the abutments m' in the hole m, and the expansion of the weights when rotated therefore operates to change the annular position of the arms in relation to the hole, and by the resultant pressure upon their pivots forces the head toward the roller k in opposition to the tension of the spring u. The spring k' is provided with an adjusting-screw k², by which its pressure upon the frame that carries the brush a may be varied at pleasure, so as to increase or decrease the tension with which the roller k resists the longitudinal movement of the governor. The bush o, when adjusted in the outer end of the shield, also serves to vary the tension of the spring u, and to thus vary the speed at which the governor would act upon the frame of the brush a. By the adjustment of these two springs u and k' it is possible to regulate the governor so as to operate upon the brush a at any velocity at which it may be desired to run the motor, and also to adjust the proportion of the centrifugal force of the governor that is to be resisted by either one of the springs. These adjustments are of great value, because it is frequently desired to vary the normal velocity of the machine, and also because it is necessary that the spring k', which presses against the brush-frame, should have enough tension to press the brush forward, and at the same time not have too much, because the tension of this spring as it pushes against the conical surface of the governor results in moving the whole shaft endwise, and thus imposes a certain thrust upon some of the shaft-bearings and produces an unnecessary amount of frictional resistance to the rotation of the armature.

In a motor of this class, unless some artificial resistance is used in that portion of the motor-circuit which is shunted to the field when the motor starts, it would be impossible to set it in motion unless running free or with a very light load. This is due to the fact that the portion of the armature-coils that is shunted

by the field is very small, its resistance is very low, and the current that it would shunt through the field when unaided by its counter electro-motive force would not therefore be sufficient to produce the strength of field necessary to make the armature rotate. To introduce such resistance in the proper manner, I have devised a special construction of switch provided with three contacts, a resistance, and a movable lever. When the lever is moved from the first contact to the second, it closes the circuit through the motor and interposes a resistance in that portion of the armature-circuit which is shunted by the field. This causes a large current to pass through the field and to magnetize it sufficiently to set the armature in motion under any suitable load. As soon as the armature has assumed a speed sufficient to give it the requisite counter electro-motive force to maintain the current in the field the lever is moved farther, so as to reach the third contact while remaining upon the second. In this position it establishes a direct connection between the second and third contacts and short-circuits the resistance previously in the circuit. I use for the resistance in this switch a compact cylindrical case 11, of metal, in which is inclosed a block or mass of lamp-black R, or any other substance of high resistance. This is simply for the purpose of making it compact. It is evident, however, that if neatness and compactness were not considered any substance whatever that would offer resistance to the current would answer the purpose. The switch is shown in Figs. 4 and 5, in which G is a bed-plate attached to a bridge G', secured between the two pole-pieces, as shown in Fig. 1.

Binding-posts 4 5 6 7 are provided near one end of the bed-plate, with the posts 4 and 7 connected with the armature-brushes *e* and *e'*. The post 5 is connected with one of the field-coils F, and the other field-coil F' is connected with the movable brush *a* through the binding-post 6. A stud 8 is mounted near the center of the bed to serve as a pivot for the lever 9, and is connected by strip 2' and binding-post 14 with one of the line-conductors. Contacts 1 and 3 at opposite sides of the bed are arranged in the path of a cross-head 13, formed upon the switch-lever 9. Contact 1 is connected with the other line-conductor by post 15, and with brush *e'* through post 4, and contact 3 is connected with brush *e* through post 7. A central contact 2 is arranged in the path of the cross-head intermediate to the contacts 1 and 3, and the cross-head is made wide enough to overlap two of the contacts at once. The contact 2 is in direct connection with the field-coils F and F', and also through the resistance R with the brush *e*, by the conductor *y* connecting the resistance with the contact 3. The contact 1 being connected with the negative pole of the line-circuit and the stud 8 with the positive pole, the current then passes directly from the positive to the negative line-conductor when the switch-lever

is placed upon contact 1, as shown in Figs. 4 and 15. The motor therefore receives no current until the lever is moved to contact 2 in circuit with the resistance, as shown in Fig. 16. Were the resistance not interposed in the connection from this contact to the brush *e*, the entire current would flow through the armature, and the field would not be sufficiently magnetized to start the motor under a load. The resistance, however, causes the current to divide, one part, as indicated by the arrows J, going to the field-coils F F' and brush *a*, while the other part, as indicated by the arrows I, passes through the resistance to contact 3 and brush *e*. In this position of the lever the field shunts the resistance R and the resistance is in series with the portion of the armature thus shunted.

In the third position of the lever shown in Fig. 17, to which position the lever is moved when the motor is fully under way, the resistance is wholly cut out by the contact of the cross-head 13 with contacts 2 and 3, and the current divides in leaving the lever according to the resistances of the field and armature coils, a portion of the current passing directly to the brush *e* by arrows K and a portion to the field-coils by arrows L. In this third position of the switch-lever the field shunts that portion of the armature-coils included between the commutator-sections with which the brushes *a* and *e'* are in contact, and the counter electro-motive force of such portion of the armature-coils determines the proportion of current that is shunted by the field.

An increase of load upon the motor causes a temporary decrease in the speed of the same, thereby causing the governor to move the brush *a* nearer the brush *e*. Such operation of the governor causes an increase in the strength of the field, thereby bringing the speed of the motor up to that acquired before the increased load was applied.

It will be understood from the above description that it is necessary for the positive line-conductor to be connected with the field-coils at all times when the motor is in operation, and that the cross-head 13, which conveys the current from such line-conductor, must therefore be so constructed that it may remain upon contact 2 after it is shifted to contact 3, for which reason the cross-head is made of suitable width to reach from one contact to the other. The whole lever may be made of suitable width and no cross-head be employed. For the same reason the contact 2 is connected directly to the field-coils, and indirectly, through the resistance R, to the fixed commutator-brush *e*, so that the current may always find a course without intermediate resistance to the field-coils, while it is unable to pass directly to the brush *e* until the cross-head is moved to the contact 3. The essential feature of my switch construction is, therefore, the combination of the contact 2, connected directly to the field-coils and

through the resistance to the brush *e*, with the contact 3, connected directly to the said brush, the whole operating to throw a great proportion of the current into the field in starting the motor and to cut out the resistance when the switch-lever is shifted to the contact 3 after the motor is fully started. It will also be seen from the above description that the operation of my construction differs essentially from that of a dynamo-electric machine, in which the speed is controlled and kept uniform by forces wholly outside of the electrical conditions, and the strength of the current or its potential is regulated by automatic agencies.

In my construction the strength of the current or its potential is not affected by any automatic mechanism, but is controlled by means entirely outside of the electrical conditions within the motor, while the speed is regulated by the automatic operation of a governor acting through the movable brush. The movable brush thus performs a function in the motor different from that which it exercises in a dynamo-electrical machine, as it operates exclusively to maintain a uniform speed of the armature, and is not used to affect the current operating in the line-circuit with which the motor is connected. To regulate the speed in the desired manner, it is necessary that the movable brush *a* should be able, when required, to bear upon the same section of the commutator as the adjacent fixed brush *e'*, and the entire mechanism for shifting the brush *a* is therefore constructed to move past the holder *f* of the brush *e*. The commutator is therefore made wide enough to accommodate the two brushes side by side, as shown in Fig. 2, and the entire brush-holder *a'*, as well as the stud *d* and the frame which carries it, is constructed to move past the brush-holder *f*, as is shown in Figs. 1 and 2. Such operation is secured by mounting the stud *f'*, upon which the holder *f* is pivoted, upon the lug *g* at a greater distance from the center of the armature than the frame *d'*, and extending such stud over the nearer side of the commutator, so that the brush *e'* may bear upon its farther side. The frame and the pivot of the brush-holder *a'* are thus enabled to move backward to bring the brush *a* in line with the brush *e'* without interference from the stud *f'*. Springs *s*² are shown applied to the pivots of the brush-holders to press the brushes upon the commutator as required.

The brush-holder *f*, carrying the brush *e'*, is made considerably longer than the brush-holder *a'*, carrying the movable brush *a*. When the frame carrying the movable brush is swung backward by the action of the governor, it is thus enabled not only to be brought into line with the brush *e'*, but to move back of the same, so as to reverse the current through the armature in case the load upon the motor is suddenly thrown off. An extravagant speed is thus prevented, as well as

any derangement in the circuit with which it is connected.

It will be noticed by reference to Figs. 3 and 6 that the top of the bed upon which the standards *D'* and cores *C* are secured is perfectly flat, thus reducing the cost of constructing and fitting the joints. The top has an outline corresponding with the bases of the standards and the flanges of the cores, while the bottom of the bed, as shown in Fig. 6, is of rectangular form, with parallel sides to slide in the ways to which such motor-beds are commonly fitted, and the bed intermediate to the top and bottom surfaces is formed, as shown in Figs. 3 and 6, with sloping surfaces uniting the outlines of the top and bottom. Lugs *D*³ are formed upon the bed between the seats and provided with tapped holes *D*³ to receive bolts *D*⁴ for securing the standards to the bed.

The expansion of the cores at their lower ends into the flanges *C'* greatly increases the surface of contact at the joint between the bed and core, and thus reduces the magnetic resistance.

It will be noticed in Fig. 5 that the block of resistance material *R* is insulated from the sides of the case 11 by a layer of suitable insulating material 10. The case 11 is connected with the contact 3 by the connection *y*, and a plate 12, connected with the contact 2, forms one side of the resistance-box, having a metallic projection to press upon the resistance-block *R*. The insulating material 10 prevents the current entering by the contact 2 from passing to the connection *y* through the sides of the case and restricts its passage to the resistance material *R*.

The pins *C*⁴, inserted through the studs *C*³, may, if desired, be formed by bundling together several small rods, the ends of which may be readily separated, as shown in one of the transverse pins at the left side of Fig. 3, near the top of the stud. A closer connection between the stud and the casting is thus secured.

Having thus set forth my invention, what I claim herein is—

1. In a constant-current electric motor having the field magnetized by a current shunted from the face of the commutator, the combination, with the field-coils, armature-shaft, and its commutator, and a centrifugal governor actuated by the motor, of two main commutator-brushes and one or more auxiliary brushes, two of the brushes being attached to the terminals of the field-coils, and one or both of the said brushes being independent of the main brushes and movable by the governor, the difference of potential between the brushes connected with the field-coils being varied by the action of the centrifugal governor for the purpose of maintaining a constant speed under variations in the load by changing the strength of the magnetizing-current, substantially as shown and described.

2. In a constant-current electric motor, the means for maintaining the speed of the armature-shaft constant under variations of the load, consisting in the combination, with the
5 field-coils, the armature, the armature-shaft, its commutator, and one or more brushes auxiliary and independent of the main brushes, of electrical connections from two of the
10 brushes to the field-coils, a centrifugal governor operating in unison with the motor-armature, and suitable connections from the governor to the auxiliary brush or brushes to shift the same upon the surface of the commutator and thereby vary the difference of
15 potential between the field-coil brushes, as and for the purpose set forth.

3. In a constant-current electric motor, the means of maintaining the speed of the armature-shaft constant under variations of the
20 load, consisting in the combination, with the field-coils, the armature, the armature-shaft, its commutator, and one or more brushes auxiliary and independent of the main brushes, of electrical connections from two of the
25 brushes to the field-coils, a centrifugal governor located on the armature-shaft and operating in unison with the motor-armature, and suitable connections from the governor to the auxiliary brush or brushes to shift the
30 same upon the surface of the commutator and thereby vary the difference of potential between the field-coil brushes, as and for the purpose set forth.

4. In a constant-current electric motor, the
35 combination, with the armature-shaft and its commutator, of a movable brush and a pivoted frame having a projection thereon, the conical governor-head t in contact with such projection and movable longitudinally upon
40 the armature-shaft, an abutment, as m' , formed in the shaft and provided with radial groove l coincident with such hole, the weighted arms l' , pivoted in the outer ends of such groove with their inner ends fitted to
45 the hole in the shaft, and a spring operating upon the head in opposition to the centrifugal force of the weights, as and for the purpose set forth.

5. In a constant-current electric motor, the
50 combination, with the armature-shaft and its commutator, of a movable brush and a pivoted frame having a projection thereon, the conical governor-head t in contact with such projection and movable longitudinally upon
55 the armature-shaft, an abutment, as m' , formed in the shaft, the shoulder t' , formed upon the shaft adjacent to the abutment m' , the shell s , attached to the head t for inclosing the governor-weights, the bush o , fitted
60 loosely to the armature-shaft and screwed in the shell, and the spiral spring u , fitted to the shaft between the bush o and the shoulder t' and operating in opposition to the centrifugal force of the weights, as and for the purpose
65 set forth.

6. In a constant-current electric motor, the combination, with a movable brush and a piv-

oted frame having a projection thereon, of the conical governor-head t in contact with such projection and movable longitudinally upon
70 the armature-shaft over an abutment, as m' , formed in the shaft, and the head provided with radial groove l coincident with such hole, the arms l' , pivoted in the outer ends of such groove with their inner ends fitted to the hole
75 in the shaft, the shoulder t' , formed upon the shaft adjacent to the hole m , the shell s , attached to the head t and movable with the head upon the shaft, the spiral spring u , fitted to the shaft between the shell and the shoulder t' , and the weights n , attached to the arms
80 l' , the weights n being shaped externally to fit the interior of the shell and notched internally to fit around the spring u , as and for the purpose set forth.

7. In a constant-current electric motor, the means for maintaining the speed of the armature-shaft constant under variations of the
85 load, consisting in the combination, with the field-coils, of two commutator-brushes e and a , connected to the terminals of such coils, a pivoted frame carrying one of said brushes, a projection on said frame, a centrifugal governor-head mounted upon the end of the
90 armature-shaft and adapted to move longitudinally, a conical surface upon such governor-head in contact with the projection on said brush-frame, and a spring to press the projection toward such conical surface, as and
95 for the purpose set forth.

8. In a constant-current electric motor, the means for maintaining the speed of the armature-shaft constant under variations of the
100 load, consisting in the combination, with the field-coils, of two commutator-brushes a and e , attached to the terminals of such coils, the fixed brush e' , the movable brush a being carried upon a movable frame provided with
105 roller k , the governor-head t , movable longitudinally upon the armature-shaft adjacent to the roller and having a conical surface to bear upon such roller, the governor-weights pivoted to such head, and adapted, when rotated, to press the conical surface toward the
110 roller, and a spring acting in opposition to the centrifugal force of the weights, as and
115 for the purpose set forth.

9. In a constant-current electric motor, the combination, with a movable brush and a pivoted frame having a projection thereon, of
120 the conical governor-head t in contact with such projection and movable longitudinally upon the armature-shaft over a hole m formed in the shaft, and provided with radial groove
125 l coincident with such hole, the weighted arms l' , pivoted in the outer ends of such groove, with their inner ends fitted to the hole in the shaft, the shoulder t' , formed upon the shaft adjacent to the hole m , its pivoted frame carrying roller k , the head t , provided
130 with shell s and movable longitudinally upon the shaft, the shoulder t' , formed upon the shaft within the shell, the spiral spring u , inserted between the shoulder and the outer

end of the shell, the weights pivoted upon the head and operating to press the same toward the roller k , and the spring k' , operating to press the roller toward the conical surface of the head, as and for the purpose set forth.

10. In a constant-current electric motor, the combination, with a movable brush and a pivoted frame having a projection thereon, of the conical governor-head t in contact with such projection and movable longitudinally upon the armature-shaft over a hole m formed in the shaft, and provided with radial groove l coincident with such hole, the weighted arms l' , pivoted in the outer ends of such groove, with their inner ends fitted to the hole in the shaft, the shoulder l'' , formed upon the shaft adjacent to the hole m , its pivoted frame carrying roller k , the slotted head t , fitted upon the armature-shaft provided with the hole m , the weighted arms pivoted within the slot and having their inner ends fitted to the hole m , the shoulder l'' upon the armature-shaft adjacent to the hole m , the shell s , attached to the head t by screw-thread and provided with the adjustable bush o , the spiral spring u , fitted upon the shaft between the shoulder and the bush, and the adjustable spring k' , operating upon the frame to press the roller k toward the conical surface of the head t , as and for the purpose set forth.

11. In a constant-current electric motor, the combination, with the armature-shaft and its bearings D , of the fixed brushes e and e' and the movable brush a , the commutator A , of suitable width to receive the brushes a and e' side by side, the stud f'' , sustained upon the bearing D and projected across the nearer side of the commutator, the brush-holder f , pivoted upon the stud and holding the brush e upon the farther side of the commutator, the swinging frame having the seat d' , provided with the arms h , pivoted on ears j at the inner and outer sides of the bearing D , the stud d , projected from the frame over the nearer side of the commutator, the brush-holder a' , pivoted on such stud and holding the brush a upon the nearer side of the commutator, and the adjustable spring k' , operating to press the frame forward to separate the brushes a and e' , as and for the purpose set forth.

12. In a constant-current electric motor, the combination, with the armature-shaft and its bearing D , of the fixed brushes e and e' and the movable brush a , the commutator A , of suitable width to receive the brushes a and e' side by side, the stud f'' , sustained upon the bearing D and projected across the nearer side of the commutator, the brush-holder f , pivoted upon the stud and holding the brush e upon the farther side of the commutator, the swinging frame having the seat d' , provided with the arms h , pivoted on ears j at the inner and outer sides of the bearing D , the stud d , insulated upon the seat d' , the brush-holder a' , carried upon a movable frame provided with roller k , the governor-head t ,

movable longitudinally upon the armature-shaft adjacent to the roller and having a conical surface to bear upon such roller, the governor-weights pivoted to such head and adapted when rotated to press the conical surface toward the roller, and a spring acting in opposition to the centrifugal force of the weights, as and for the purpose set forth.

13. In a constant-current electric motor, the combination, with the armature, the armature-shaft, and its bearings, of the magnet-cores C , provided with the pole-pieces C^2 , the studs C^3 , projected from the bottoms of the cores through the bed and provided with the transverse pins C^4 , cast within the core C , recesses upon the under side of the bed around the studs, and nuts B^3 , fitted to the studs within the recesses to secure the cores upon the bed, as and for the purpose set forth.

14. In a constant-current electric motor, the combination, with the armature, the armature-shaft, and its bearings, of the magnet-cores C , provided with pole-pieces C^2 , flanges C' , and projecting studs C^3 , the bed B , with flat top and flat bottom, provided with the holes B^4 and recesses B^3 , and the nuts B^3 , fitted to screw-threads upon the studs within the recesses, as and for the purposes set forth.

15. In a constant-current electric motor having a portion of the armature-coils shunted by the field, the combination, with the fixed brushes $e e'$ and a movable brush a , operated as described, of a connection from the movable brush to one of the field-coils, a switch having a switch-lever connected with one of the line-conductors, the contact 1, connected with the other line-conductor and with the fixed brush e' , the contact 3, connected with the fixed brush e , and the contact 2, connected directly with the other terminal of the field and indirectly through a resistance with the brush e , as and for the purpose set forth.

16. In a constant-current electric motor having a portion of the armature-coils shunted by the field, the combination, with the fixed brushes $e e'$ and a movable brush a , operated as described, of a connection from the movable brush to one of the field-terminals, a switch having a switch-lever connected with one of the line-conductors, the contact 1, connected with the other line-conductor and with the fixed brush e' , the contact 3, connected with the fixed brush e , and the contact 2, having a plate 12 in contact with a block of resisting material, and the opposite side of such resistance material being connected with the contact 3 by a connection y , as and for the purpose set forth.

17. In a constant-current electric motor having a portion of the armature-coils shunted by the field, the combination, with the fixed brushes $e e'$ and a movable brush a , operated as described, of a connection from the movable brush to one of the field-terminals, a switch having a switch-lever connected with one of the line-conductors, the contact 1, connected with the other line-conductor and with

the fixed brush e' , the contact 3, connected with the fixed brush e , and the contact 2, having a plate 12 forming one side of the resistance-box and connected directly with the other terminal of the field, the case 11, with the block of resistance material R insulated from its sides, and the connection y from the bottom of the case to the contact 3, as and for the purpose set forth.

18. In a constant-current electric motor having a portion of the armature-coils shunted by the field, the combination, with the fixed brushes $e e'$ and a movable brush a , operated as described, of a connection from the movable brush to one of the field-coils, a switch having a switch-lever connected with one of the line-conductors, the contact 1, connected with the other line-conductor and with the fixed brush e' , the contact 3, connected with the fixed brush e , and the contact 2, connected directly with the other terminal of the field and indirectly through a resistance with the brush e , and a cross-head 13 upon the switch-lever, adapted to join the contacts 2 and 3, as and for the purpose set forth.

19. In a constant-current electric motor having a portion of the armature-coils shunted by the field, the combination, with the fixed brushes $e e'$ and a movable brush a , operated as described, of a connection from the movable brush to one of the field-coils, the bed-plate G , having the binding-posts 4 5 6 7 connected with the field-coils and the brushes, as described, the binding-posts 14 and 15 for the line-conductors, the contact 1, connected with binding-post 4, the contact 3, connected with binding-post 7, the contact 2, connected directly with binding-post 5 and through a resistance with the contact 3, and the switch-lever 9, provided with cross-head 13, adapted to connect the contacts 2 and 3, the whole arranged and operated substantially as herein set forth.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

WILLIAM BAXTER, JR.

Witnesses:

THOS. S. CRANE,
L. LEE.