No. 721,678. PATENTED MAR. 3, 1903.

E. R. DOUGLAS.

MAGNETIC CLUTCH.

APPLICATION FILED JULY 14, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.

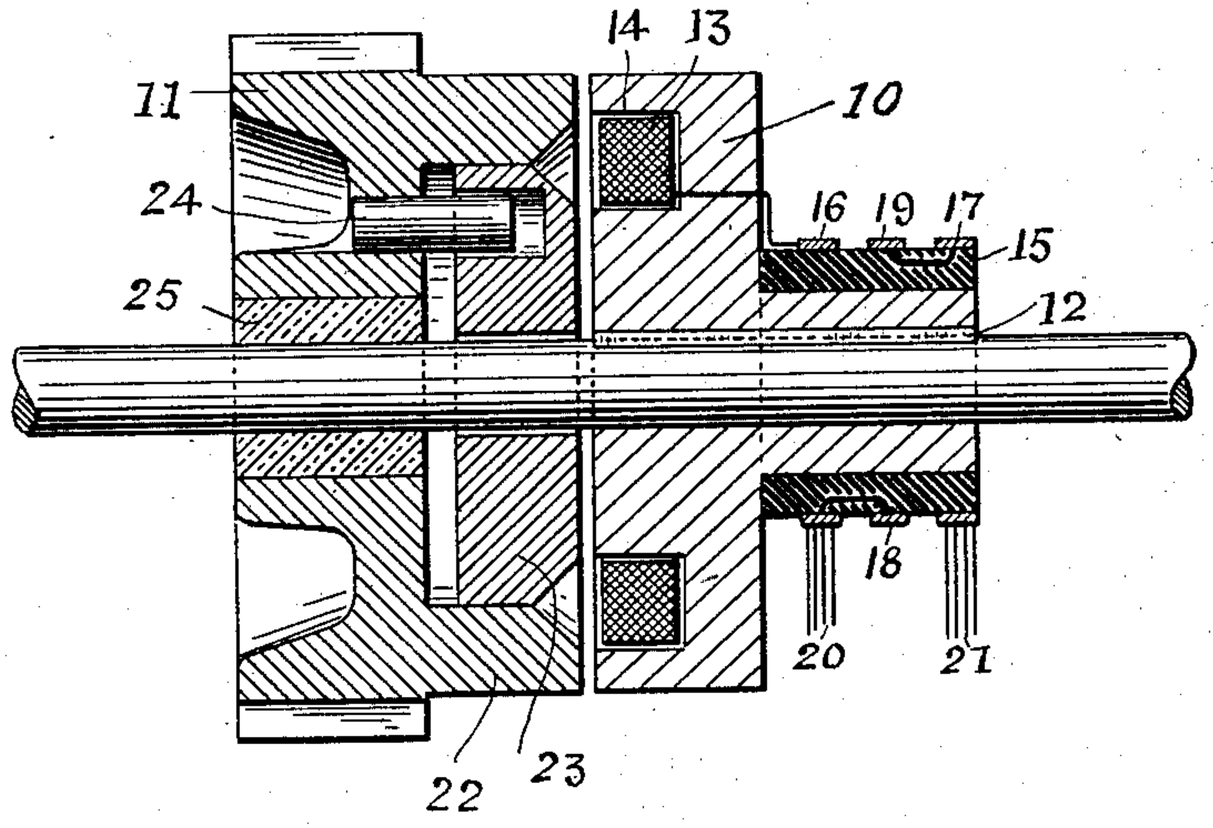
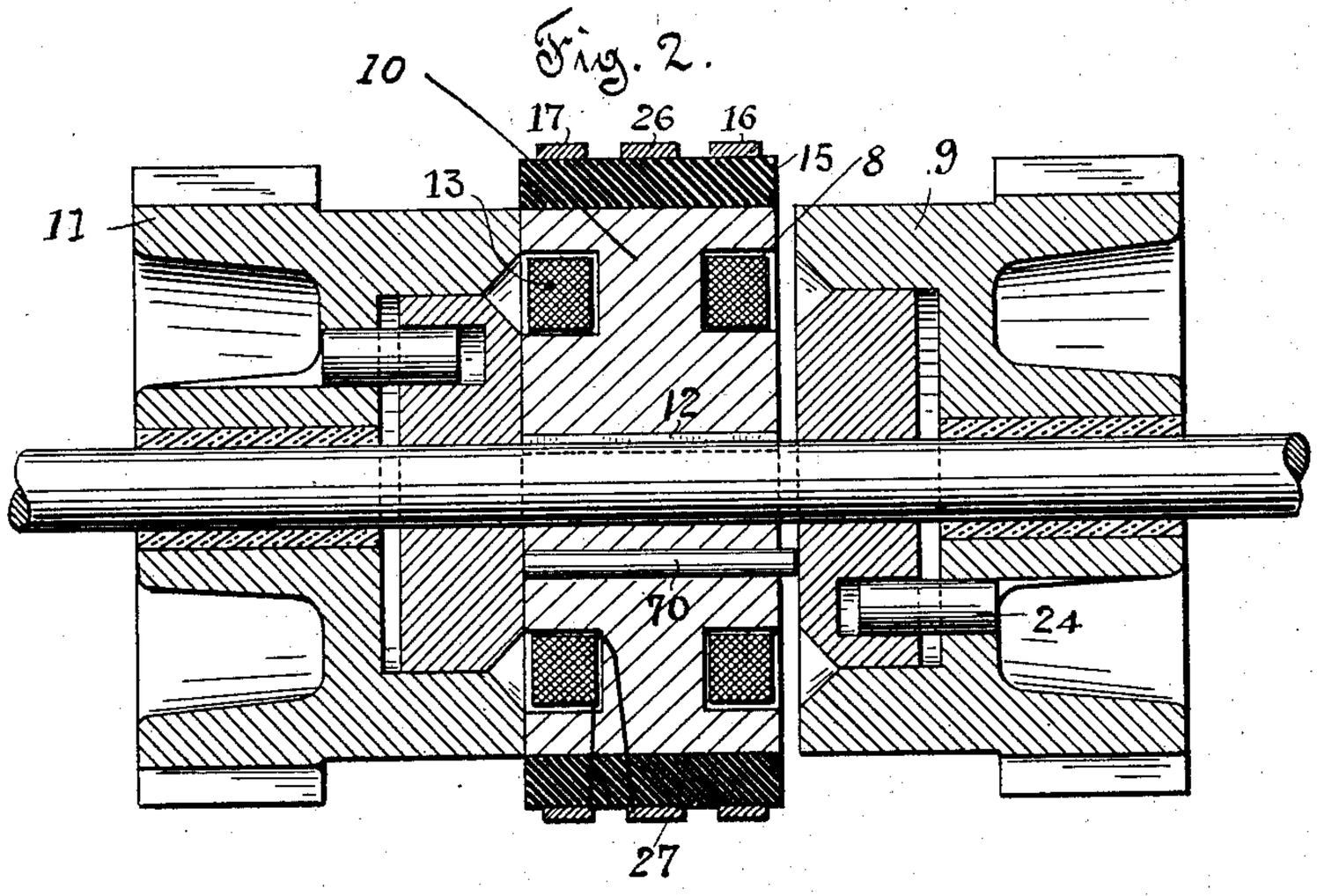


Fig. 2.



Witnesses
Charles Hanimann
Ella Finch

Inventor
Edwin Rust Douglas
By His Attorney
Chas. J. Earll

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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 3.

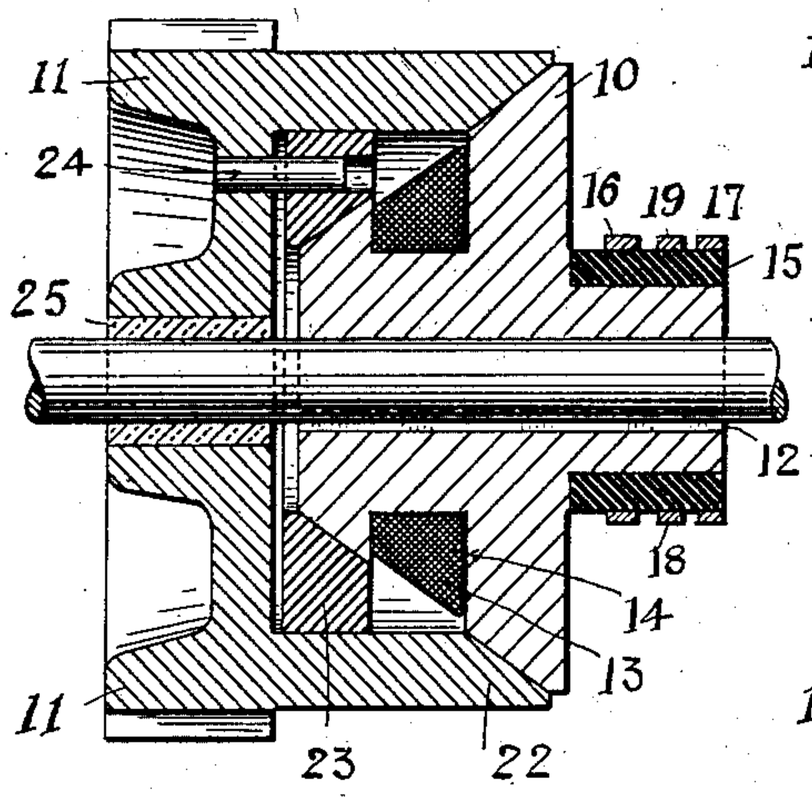

Fig. 4.

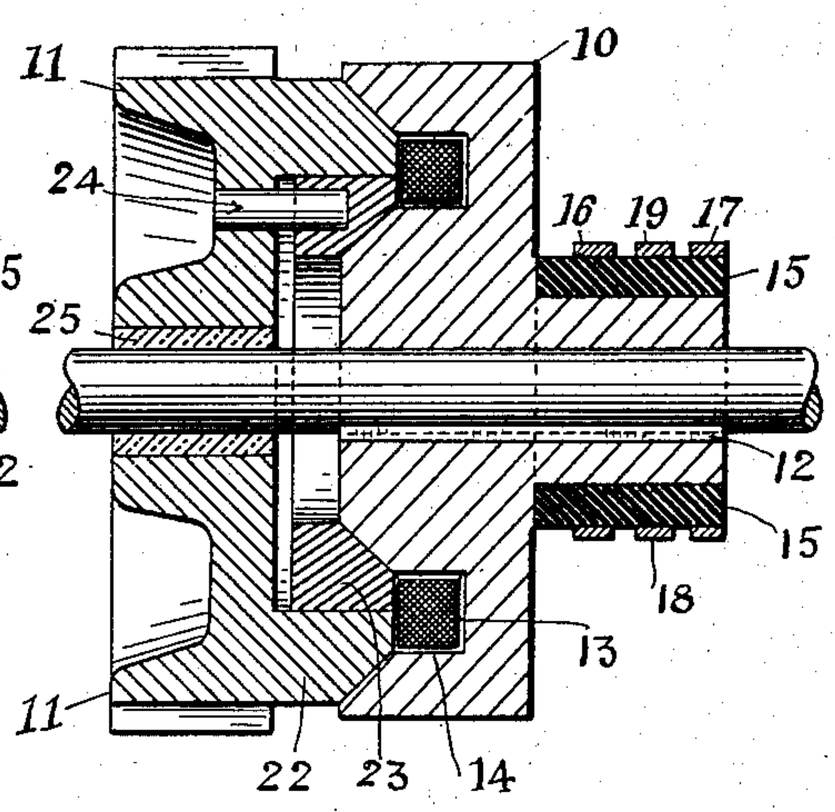

Fig. 5.

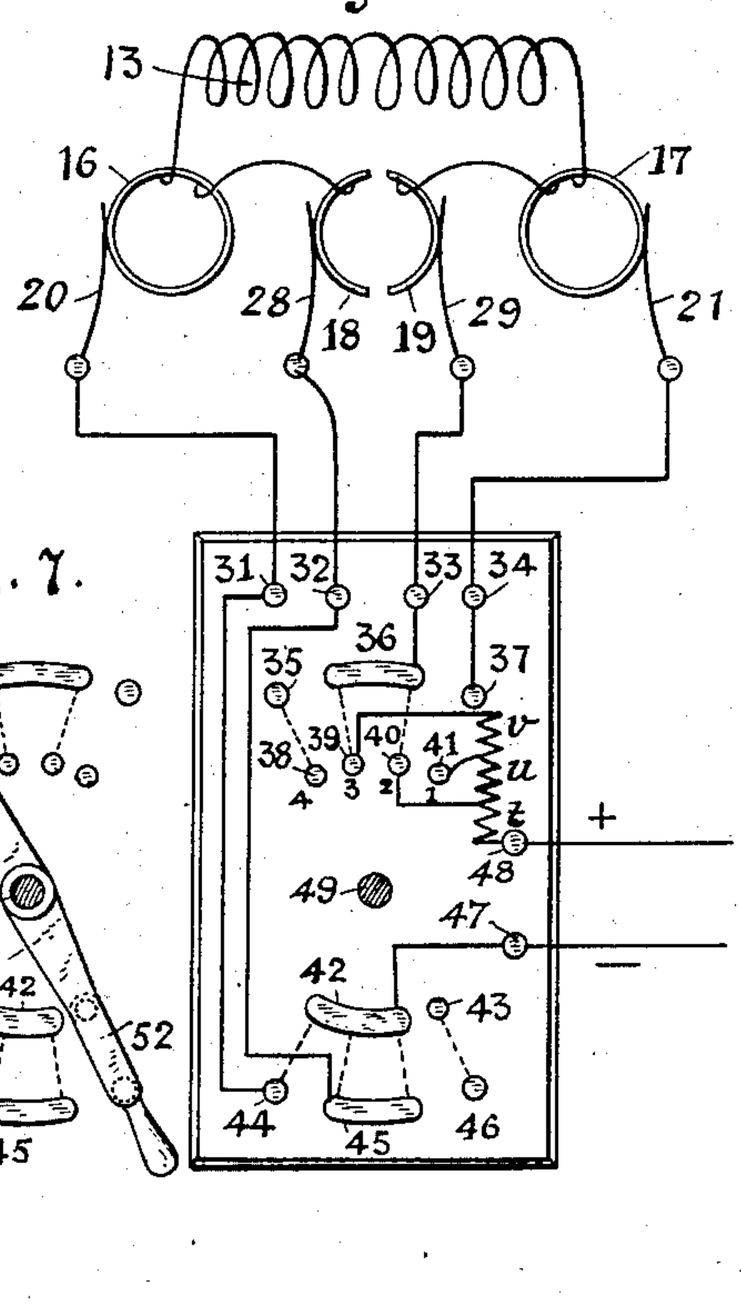

Fig. 6.

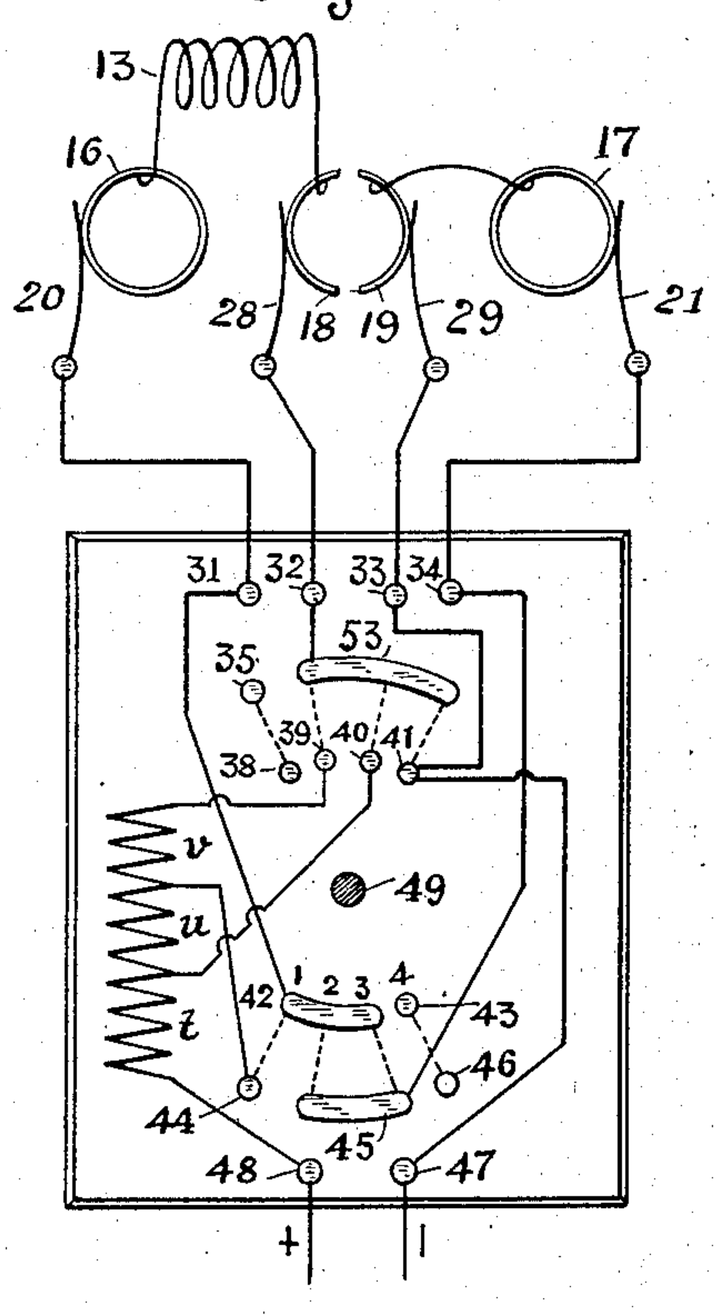

Fig. 7.

Witnesses
Charles Kanimann.
Ella Buck

Inventor
Edwin Rust Douglas.
By his Attorney
Chas. S. Hall

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E. R. DOUGLAS.

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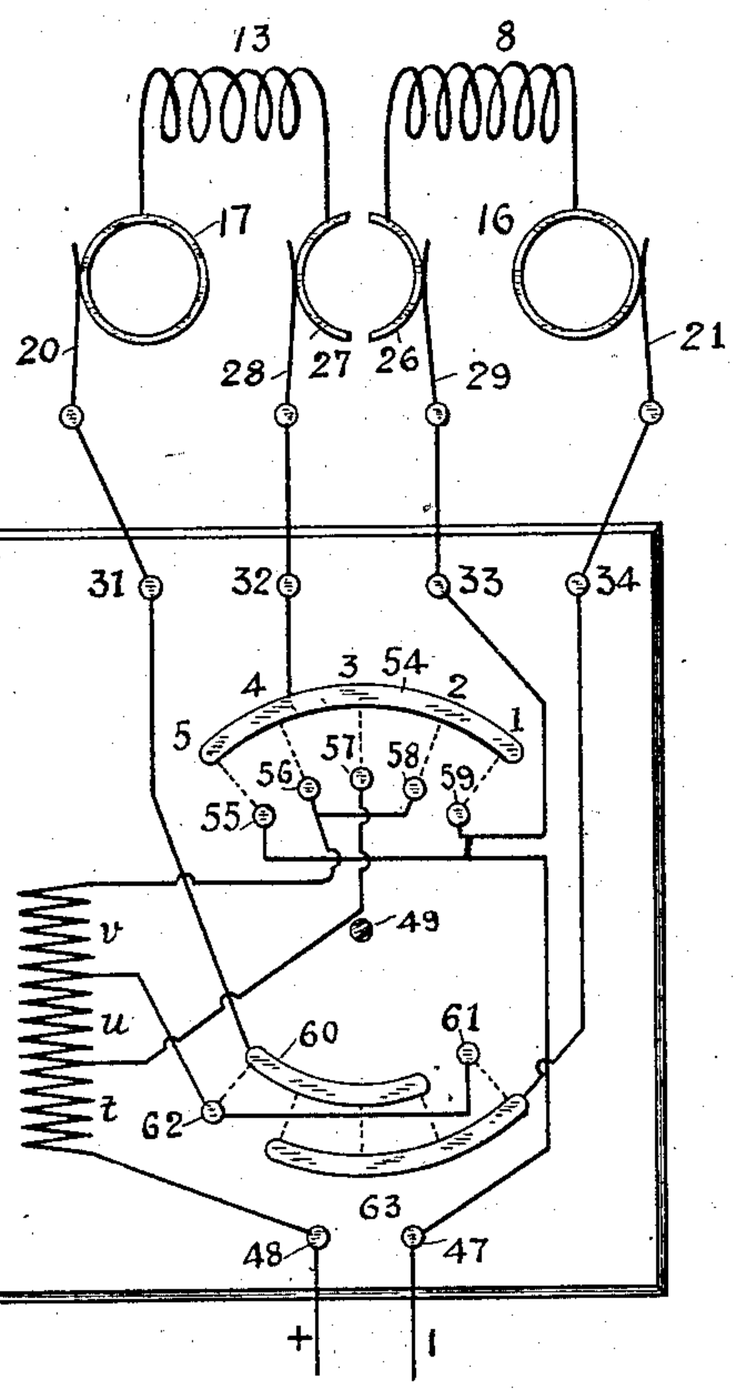
NO MODEL. 3 SHEETS—SHEET 3.

Fig. 8.



Witnesses
Charles Hanimann.
Ella Finch

Inventor
Edwin Rust Douglas
By his Attorney
C. A. Earle

UNITED STATES PATENT OFFICE.

EDWIN RUST DOUGLAS, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO CROCKER-WHEELER COMPANY, OF AMPERE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

MAGNETIC CLUTCH.

SPECIFICATION forming part of Letters Patent No. 721,678, dated March 3, 1903.

Application filed July 14, 1902. Serial No. 115,404. (No model.)

To all whom it may concern:

Be it known that I, EDWIN RUST DOUGLAS, a citizen of the United States of America, and a resident of East Orange, county of Essex, and State of New Jersey, have invented certain new and useful Improvements in Magnetic Clutches, of which the following is a specification.

My invention relates to electromagnetic clutches in which the engagement and disengagement of the members are controlled by the magnetic action induced by an electric current.

The object of my invention is to produce a clutch of this class which shall be simple and efficient in its construction and operation, which shall automatically adjust its friction-surfaces to meet the varying conditions produced by wear, and one which shall be more certain in its engagement and disengagement than those heretofore in use.

My invention consists in providing means for causing an electric current to magnetize a clutch body to throw the clutch into action and means for rapidly demagnetizing the same to throw the clutch out of action, in providing means whereby the two poles of the armature engage the corresponding poles in the main body portion without interfering with each other and without interfering with the magnetic circuit, and in other novel features of construction to be hereinafter fully pointed out and described.

Clutches of this kind usually consist of two or more rotatable members, either mounted on the same shaft or on different shafts having a common axis of rotation. One of these members is usually fixed to the shaft and the others are free to turn relative thereto except when the members are in engagement with each other. One of the members is provided with a coil of insulated wire adapted to receive an electric current to magnetize it, and this member I will refer to as the "main body." The other member, which coacts with the main body and when in engagement completes the magentic circuit, I will refer to as the "armature." Both the main body and the armature are made of iron. It is well known that if the iron armature be allowed to make actual contact without the intervention of a non-magnetic material, such as fiber or brass, the driving force will be a maximum, because the reluctance of the magnetic circuit will be thereby reduced to a minimum; but it is also well known that if this be done the clutch will not readily disengage when the current is interrupted, as the residual magnetism is sufficient to hold the armature against the main body with considerable force. To cause immediate disengagement when the current is interrupted, various means have been employed, as by increasing the reluctance of the magnetic circuit by a small amount of non-magnetic material interposed somewhere in the magnetic circuit, either between the poles of the armature or of the main body or at some other point. These devices, while assisting disengagement, have the disadvantage that they greatly weaken the driving power of the clutch, or, what amounts to the same thing, require a great deal more energy to be expended in the magnetizing-coil to give the same driving force, requiring a much larger coil and making the clutch more bulky. A clutch constructed in this manner with a magnetic circuit interrupted as above indicated may require ten times as much current as would otherwise be needed to produce the same driving force.

The invention herein set forth provides a magnetic clutch which will immediately disengage when the current is interrupted and at the same time requires no non-magnetic material to be inserted in its magnetic circuit.

The contact-surfaces of clutches of this character are usually annular in form, one pole or ring lying within the other and being of smaller diameter. The result is that the effective turning moment of the outer ring or pole is much greater than that of the inner, provided the pressure is equally great; but as the wear of the outer ring or pole is also greater the result is that after the clutch has been in use for a considerable period the greater pressure is taken up by the inner pole, and thus the efficiency of the clutch is materially reduced. In my improved clutch the poles are so constructed that neither pole in-

terferes with the action of the other, each pole regardless of wear exerting its full pressure when the current is on.

In the drawings accompanying and forming part of this specification, Figure 1 represents a longitudinal section through a single clutch embodying my invention. Fig. 2 represents a longitudinal section corresponding to Fig. 1, but of a double clutch. Fig. 3 shows a section of the clutch in which the surfaces are conical in shape. Fig. 4 represents a clutch in which the contact-surfaces are likewise conical, but differently disposed from those of Fig. 3. Fig. 5 is a diagram of the wiring and switch for the form of clutch shown in Figs. 1, 3, and 4. Fig. 6 shows another method of making the connections by which the same result is obtained. Fig. 7 shows the switch-lever. Fig. 8 is a diagram of the wiring and connections adapted to control the double clutch shown in Fig. 2.

The reference characters are used in the same sense in all of the figures and the specification.

Numeral 10 represents the main body of the clutch, which, as here shown, is connected to a shaft.

11 represents the armature, which is engaged with the main body 10 when power is to be transmitted by the clutch.

12 represents a key, by means of which the main body is secured to a shaft.

13 represents a coil of insulated wire in the recess 14 of the main body.

15 represents a sleeve, of insulating material, secured to the main body 10. Mounted on the sleeve 15 are the contact-rings 16 and 17 and the commutator, consisting of two segments 18 and 19. One end of the coil 13 is electrically connected with the ring 16 and the other end with the ring 17.

20 and 21 are brushes which bear upon the rings 16 and 17, respectively.

22 is the outer pole of the armature, and 23 is the inner pole. The inner pole is made to occupy the recess of the outer pole in such a way that it is permitted to move in and out longitudinally, but is prevented from turning relative to the outer pole by means of the pin 24 or in any other convenient manner. The hub of the armature is provided with the sleeve 25, which is preferably made of bronze or some other good bearing material which at the same time is non-magnetic.

In the forms shown in Figs. 3 and 4 both poles of the main body and of the armature are conical in shape, the purpose of which is to give greater resistance between the surfaces of the poles of the main body and those of the armature. In all other respects the clutches shown in Figs. 3 and 4 are similar to that shown in Fig. 1.

Fig. 2 represents a double clutch, where the main body is provided with two separate magnetizing-coils 8 and 13 and with two armatures 9 and 11. These armatures are alike and are the same as the armature of Fig. 1. The main body is provided with the sleeve of insulating material 15, on which are mounted the contact-rings 16 and 17 and the commutator-segments 26 and 27. In this case, however, one end of the coil 8 is connected with the ring 16, the other end with one of the commutator-segments 26, while one end of the coil 13 is connected with the opposite commutator-segment 27, and its other end is connected with the ring 17, as will be more fully explained hereinafter in describing the switchboard and diagram of the windings for the double clutch.

In Fig. 5 is shown a diagram of the electrical connections and switch for the clutches shown in Figs. 1, 3, and 4. The contact-rings 16 and 17 and the commutator, consisting of the segments 18 and 19, are here shown side by side for convenience instead of in their actual position, as shown in Fig. 1, for instance. 28 and 29 represent brushes, which are so placed as to make contact with the commutator-segments 18 and 19 at diametrically opposite points. 31, 32, 33, and 34 represent binding-posts, which are connected, respectively, with the brushes 20, 28, 29, and 21. 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, and 46 represent contact-points on the switchboard, arranged concentrically about a central stud or pivot 49. On this pivot swings a lever 50, carrying insulated from it and from each other two contact-springs 51 and 52, one for connecting the contact-points above the center 49 and the other for connecting those below. This lever may be swung into four position, (indicated by the numerals 1, 2, 3, and 4 on the switchboard.) 47 and 48 represent the terminals to which the current-mains are connected. u, v, and t represent electrical resistances.

I will now trace the course of the current for the four positions of the switch-lever. Assume, first, that the switch-lever occupies position 1, in which position the contact-points 37 and 41 will be electrically connected by one arm of the lever and contact-points 42 and 44 by the other arm. With the switch-lever in this position the current will flow as follows: from the positive main through the terminal 48, resistances t and u, points 41 37 34, brush 21, ring 17, coil 13, ring 16, brush 20, points 31 44 42, terminal 47 to the negative main, thus energizing the coil 13 and causing the clutch to engage. As the rings 16 and 17 are solid, the current in the coil 13 will be continuous. Now suppose the handle set in position 2. The current will then flow from the positive main through resistance t, points 40 36 33, and to the brush 29, and in the position shown in the diagram it will then flow through the segment 19 of the commutator, ring 17, coil 13, ring 16, commutator-segment 18, brush 28, points 32 45 42, terminal 47 to the negative main. As the clutch rotates the piston of the commutator-segments 18 and 19 is reversed, segment 18 making contact with brush 29 and segment 19

making contact with brush 28. The current will then flow, beginning with the positive main, as before, to the brush 29, from 29 to segment 18, ring 16, through coil 13, in the opposite direction to ring 17, segment 19, brush 28, and, as before, points 32 45 42, and terminal 47. It is thus seen that for this position of the switch-lever the current in coil 13 is reversed in direction twice during each rotation. Now suppose the switch-lever to occupy position 3. The current will then flow from the positive main through resistances *t u v*, points 39 36 33, brush 29, segment 19, ring 17, coil 13, ring 16, segment 18, brush 28, points 32 45 42, and to the negative main. As the clutch rotates the direction of the current in coil 13 in position 3 will be reversed in the same manner as it was for position 2, the only difference being that in position 3 the current passes through the additional resistances *u* and *v*, and its strength will therefore be correspondingly less. When the switch-lever is moved to position 4 the circuit is broken and no current flows. It is obvious that more positions between positions 3 and 4 could be added in which the resistance would be successively increased, and consequently the amount of current passing through the coil 13 be successively diminished and at the same time the direction of the current in coil 13 reversed twice during each revolution of the clutch, as in positions 2 and 3. Two positions only are here shown for the sake of simplicity and because in many cases two will be sufficient.

The actual construction of the switch need not be as indicated in Fig. 5. It may be made in a cylindrical form or the contacts may be disposed in other ways, or the motion of the handle may be one of sliding instead of turning about the center, so long as connections are made which cause a continuous current in one direction to flow through the energizing-coil 13 to engage the clutch and cause the current to be reversed by means of the commutator-ring, thus producing an alternating current in the coil to demagnetize and disengage the clutch. Another method of making the connections by which the same result is achieved is shown in Fig. 6. Here the energizing-coil 13 has one of its ends connected with the contact-ring 16 and its other end connected with one of the commutator-segments 18 instead of with the other contact-ring, and the opposite commutator-segment 19 is connected with the contact-ring 17. Suppose now the switch occupies position 1. The current will then flow from the positive main through 48, resistances *t* and *u*, points 44 42 31, brush 20, ring 16, coil 13, segment 18, brush 28, points 32 53 41 to the terminal 47 and negative main, or if the segment 18 is in contact with the brush 29 the current will then pass from 18 through brush 29, points 33 41 to the terminal 47 and negative main. It is thus seen that although one end of the energizing-coil in this arrangement is connected with one of the commutator-segments when the switch-lever is in position 1 a continuous current will flow through said coil and cause the clutch to engage. Suppose now that the handle is moved to position 2. The current will then flow from the positive main through resistance *t*, points 40 53 32, brush 28, segment 18, coil 13, ring 16, brush 20, points 31 42 45 34, brush 21, ring 17, segment 19, brush 29, points 33 41, terminal 47, and negative main, and when the clutch has turned half-way around its course from brush 28 will be through the segment 19, ring 17, brush 21, points 34 45 42 31, brush 20, ring 16, and in the opposite direction through coil 13, segment 18, brush 29, points 33 41, and thus to the terminal 47 and negative main. It is thus seen that in position 2 of the switch-lever an alternating current is sent through the energizing-coil which passes through the resistance *t*. In the same way in position 3 an alternating current is caused to flow through the energizing-coil, but with the resistances *t*, *u*, and *v* included in the circuit, thereby reducing the strength of the current and securing a demagnetizing action. By having a sufficient number of such points and properly proportioning the resistances the demagnetizing action may be secured to any extent desired. Position 4 breaks the circuit entirely and leaves the clutch disengaged.

Fig. 8 represents a diagram of the switch-board and connections for the double clutch shown in Fig. 2. Here 8 and 13 represent, respectively, the two coils in the main clutch-body. 16 and 17 represent the two contact-rings, and 26 and 27 represent the segments of the commutator. In this form of switch-board I prefer to use five positions for the switch-lever, as indicated by the numerals 1, 2, 3, 4, and 5. When the switch-lever is in position 1, the current flows from the binding-post 48 through *t* and *u*, 62, 60, 31, brush 20, ring 17, coil 13, segment 27, and thence either through brush 28, points 32 54 59, or through brush 29, points 33 59, and thence to the post 47 and negative main, thus energizing the coil 13 by a direct current. When the handle is in position 2 the current flows as follows: from the positive main through 48, *t*, *u*, and *v*, 56, 58, 54, 32, brush 28, and thence either through segment 27, coil 13, ring 17, brush 20, points 31 60 63 34, brush 21, ring 16, coil 8, segment 26, brush 29, points 33 59 47 into the negative main or when the half-revolution has been made, as before, up to the brush 28, and thence through the segment 26, coil 8, ring 16, brush 21, points 34 63 60 31, brush 20, ring 17, coil 13, segment 27, brush 29, points 33 59 47 into the negative main, in the latter case traversing both coils 13 and 8 in the opposite direction. Thus in this position of the switch-lever an alternating current flows through both the coils 8 and 13 in series. When the handle is in position 3, the current flows from 48 through *t*, 57, 54, 32, brush 28, and thence either through seg-

ment 27, coil 13, ring 17, brush 20, points 31 60 63 34, brush 21, ring 16, coil 8, segment 26, brush 29, points 33, 59, and 47, or up to brush 28, as before, and thence through segment 26, coil 8, ring 16, brush 21, points 34 63 60 31, brush 20, ring 17, coil 13, segment 27, brush 29, points 33, 59, and 47 to the negative main. Thus position 3 of the switch-lever controls the current in the same manner as position 2, except that it passes through one resistance *t*, thereby giving a stronger current than when in position 2, where the resistances *t*, *u*, and *v* are in the circuit. In position 4 the current flows through 48, *t*, *u*, *v*, 56, 54, and thence the same as in positions 2 and 3. The strength of this current will be the same as in position 2, but weaker than in position 3. In position 5 the current flows through 48, *t*, *u*, 62, 61, 63, 34, brush 21, ring 16, coil 8, segment 26, and thence either through brush 29, points 33 59 to 47, or through brush 28, points 32 54 55 to 47. The coil 8 is thus energized by a direct current. Thus in position 1 the armature on the side of the main body in which the coil 13 is located is thrown into engagement, and in position 5 the other armature is thrown into engagement, and in passing either way between these engaging positions there is sent through both coils in series first a weaker then a stronger and then a weaker alternating current, thus demagnetizing the clutch. If more complete demagnetization is required, it may be obtained by inserting additional points between 1 and 2 and between 4 and 5, with connections similar to those for positions 2, 3, and 4, so as to reduce the strength of alternating current in the windings more gradually by a greater number of steps. No position is shown in this diagram where the current is cut off entirely. If desired, however, such a point may easily be provided between positions 1 and 2 or between 4 and 5, or in both, similar to position 4 in the diagram in Figs. 5 and 6. It is thus seen that in both the double and single clutches herein described by means of the two contact-rings and the single commutator I am enabled to engage and disengage and demagnetize the clutch mechanism.

Where the double clutch is used, as illustrated in Fig. 2, in order to render more certain the disengagement of one armature when the other is in engagement I provide a sliding pin 70, which extends through the main clutch-body and is of such length as to force one armature away from said body when the other is drawn into engagement.

It is obvious that the number of segments of the commutator need not be limited to two, but may be increased to any even number desired to give the required frequency of alternations in the demagnetizing-current, such segments being alternately connected. It is also obvious that instead of having the armature composed of two poles, one of which is movable relative to the other, the poles of the armature may be fixed and those of the main body made separate and movable relative to each other in substantially the same manner as is shown for the armature-poles in the drawings, giving practically the same result.

In the operation of my invention where the switch mechanism is arranged as shown in Figs. 5 and 6 the switch-lever will normally stand at position 4 when the clutch is out of engagement and will be brought to position 1 to put the clutch in engagement. The fact that the switch-lever passes through positions 3 and 2 in passing from position 4 to position 1, and thereby momentarily causes an alternating current to flow through the energizing-coil, does not have any effect upon the clutch. To throw the clutch out of engagement again, the switch-lever is moved in the opposite direction and passes successively from position 1 to positions 2, 3, and 4, respectively, the lever being permitted to remain long enough in positions 2 and 3 to permit the alternating current to effect the demagnetization of the clutch. In the double clutch, as illustrated in Figs. 2 and 8, position 1 energizes coil 13 and engages armature 11 with the main body, while position 5 energizes coil 8 and engages armature 9 with the main body. When it is desired to cause one or the other of these armatures to engage the main body, it is only necessary to move the switch-lever either to position 1 or 5, according to which armature it is desired to engage. To cause the disengagement of the armature, the switch is moved from position 1 successively to positions 2, 3, and 4 or from position 5 successively to positions 4, 3, and 2. The lever may be allowed to remain in positions 2 or 4, or it may be brought midway between the positions 1 and 2 or between positions 4 and 5, when no current will flow through either of the energizing-coils.

Having thus described my invention, what I claim is—

1. In a magnetic clutch, the combination with the main clutch-body and means for energizing same, of an armature adapted to engage the main clutch-body consisting of poles one of which slides upon the other without breaking the magnetic circuit.

2. In a magnetic clutch, the combination with the main body provided with two annular poles and an energizing-coil between said annular poles, of an armature having poles adapted to engage the poles of said main body, one of the said armature-poles being movable relative to the other.

3. In a magnetic clutch, the combination with a multipolar body capable of being magnetically energized, rotatably mounted, of a rotatable armature having poles adapted to engage the poles of said magnetically-energized multipolar body, and means for automatically adjusting the contact-surfaces of said poles and maintaining the magnetic circuit.

4. In a magnetic clutch, the combination

with a multipolar body rotatably mounted and capable of being magnetically energized, of a rotatable armature consisting of two cylindrical poles, one adapted to be received in the other, and means for preventing one from turning relatively to the other, and permitting a longitudinal movement of one relatively to the other.

5. In a magnetic clutch, the combination with the main body comprised of two annular poles and an energizing-coil, of the armature adapted to engage said main body, said armature having poles longitudinally slidable relative to each other.

6. In a magnetic clutch, the combination with the main body, of a shaft on which said main body is mounted, an armature mounted loose upon said shaft, said armature consisting of two cylindrical poles one of which is fitted into the other and adapted to have longitudinal movement relative thereto, and a sleeve made of non-magnetic material separating said armature from said shaft.

7. In a magnetic clutch, the combination with the magnetically-energizable member and its armature, of an electric winding on said magnetically-energizable member, and means for causing an alternating current to flow through said coil to demagnetize said clutch.

8. In a magnetic clutch, the combination with a magnetically-energizable member and its armature, of an electric winding upon said magnetically-energizable member, insulated contact-rings connected to the ends of said winding, an insulated commutator-ring having its segments alternately connected to said contact-rings, and an electric switch having connections to said contact-rings and to said commutator-ring.

9. In a magnetic clutch, the combination of two members, one a main body provided with an insulated energizing-coil and two magnetic poles, the other an armature also provided with two poles, the poles of one of said members sliding freely relative to each other in a direction parallel to the axis of rotation.

10. In a magnetic clutch, the combination with a main body provided with an energizing-coil, of two insulated contact-rings connected respectively with the two ends of the energizing-coil, and a segmental commutator-ring having its segments alternately connected with said contact-rings.

11. In a magnetic clutch, the combination with a main body provided with an energizing-coil, of two insulated contact-rings connected respectively with the two ends of the energizing-coil, and means whereby connections may be made with said contact-rings and a segmental commutator to cause a continuous current or alternating currents of different strengths to flow through said energizing-coil.

12. In a magnetic clutch, the combination with a main body provided with an energizing-coil, of two insulated contact-rings connected respectively with the two ends of the energizing-coil, brushes engaging said contact-rings, and a switchboard provided with a series of contact-points connected with each of said brushes and a series of contact-points connected with the terminals of an external circuit having varying amounts of resistances between said terminals and the contact-points, and a switch-lever for connecting said contact-points whereby, as said switch-lever occupies its successive positions, a direct current and alternating currents of different degrees of strength are made to successively traverse the energizing-coil of said main body.

13. In a magnetic clutch, the combination with a main body and the energizing-coil therefor, of a segmental commutator-ring and two contact-rings mounted on said main body, the brushes 20 and 21 contacting said contact-rings and the brushes 28 and 29 contacting said commutator, and a switchboard provided with the switch-lever 50, and the contact-points 44, 37, 45, and 36 connected respectively with the brushes 20, 21, 28 and 29, the contact-points 39, 40 and 41 connected to the terminal 48 through resistances u, v and t, and the contact 42 connected with the terminal 47.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EDWIN RUST DOUGLAS.

Witnesses:
GEO. W. BOWER,
S. N. THOMAS.