No. 837,425. PATENTED DEC. 4, 1906.

S. S. SEYFERT.

COMMUTATOR.

APPLICATION FILED FEB. 20, 1905.

3 SHEETS—SHEET 1.

Fig. 1.

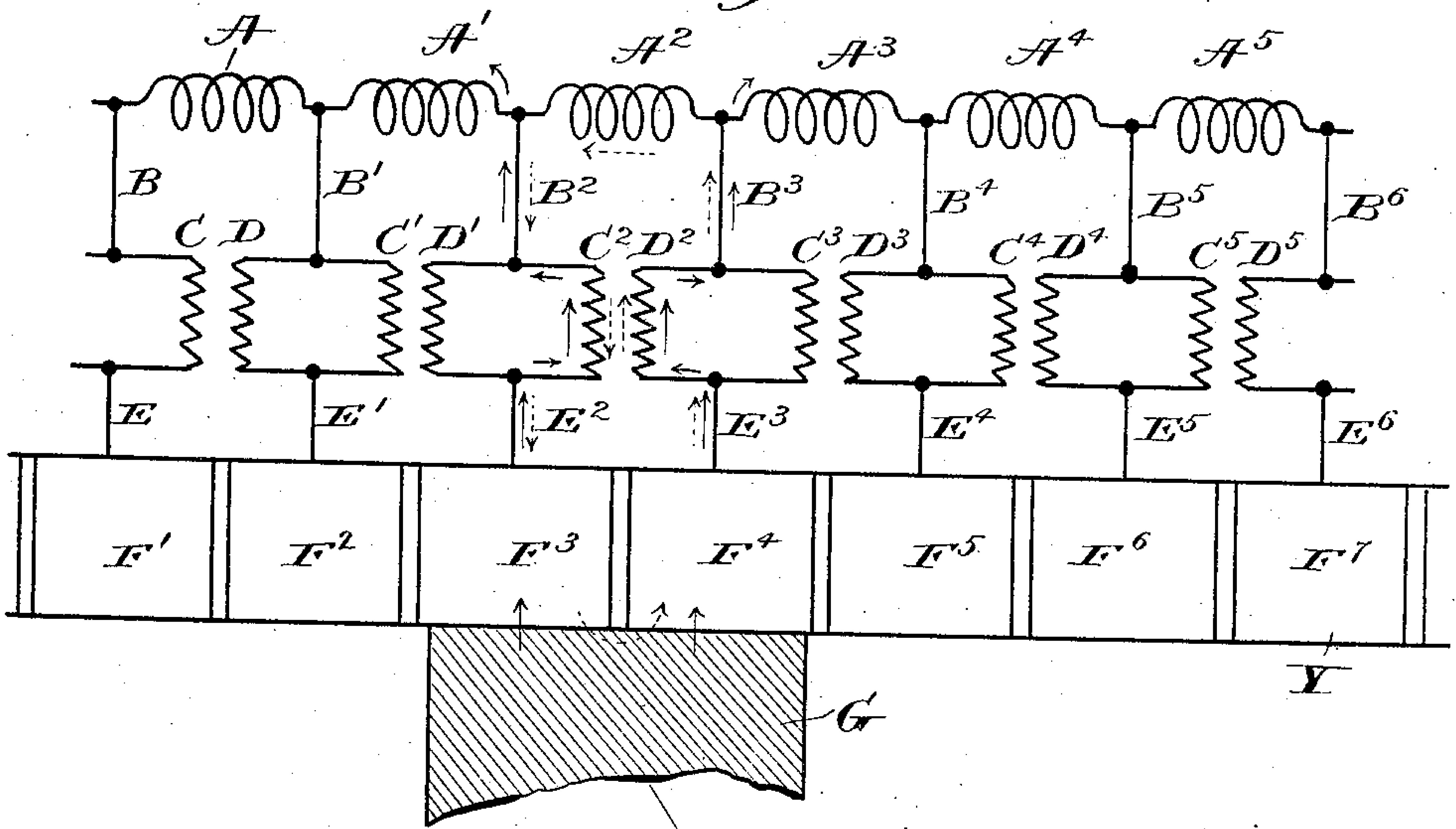
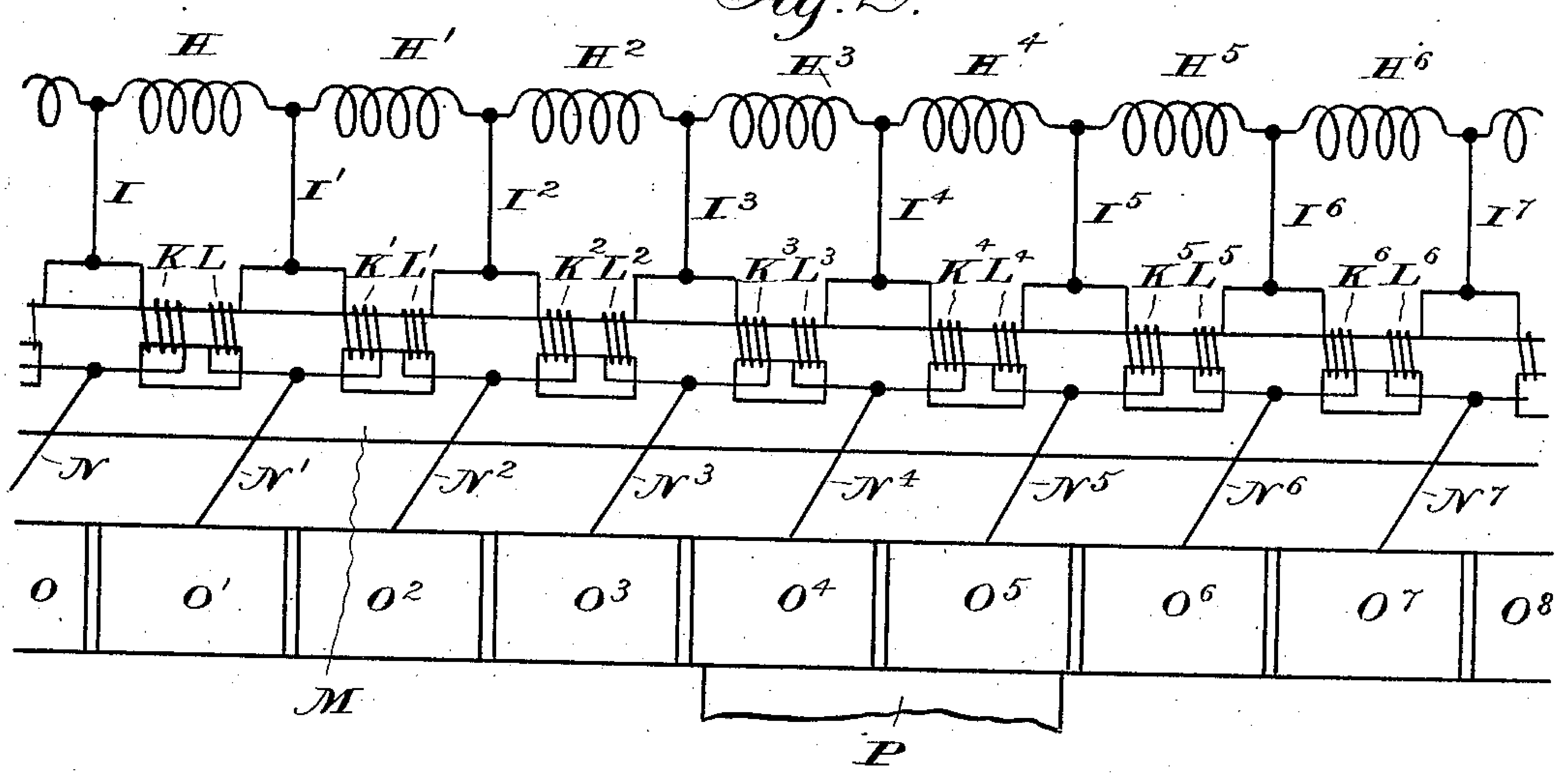


Fig. 2.



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3 SHEETS—SHEET 2.

Fig. 4.

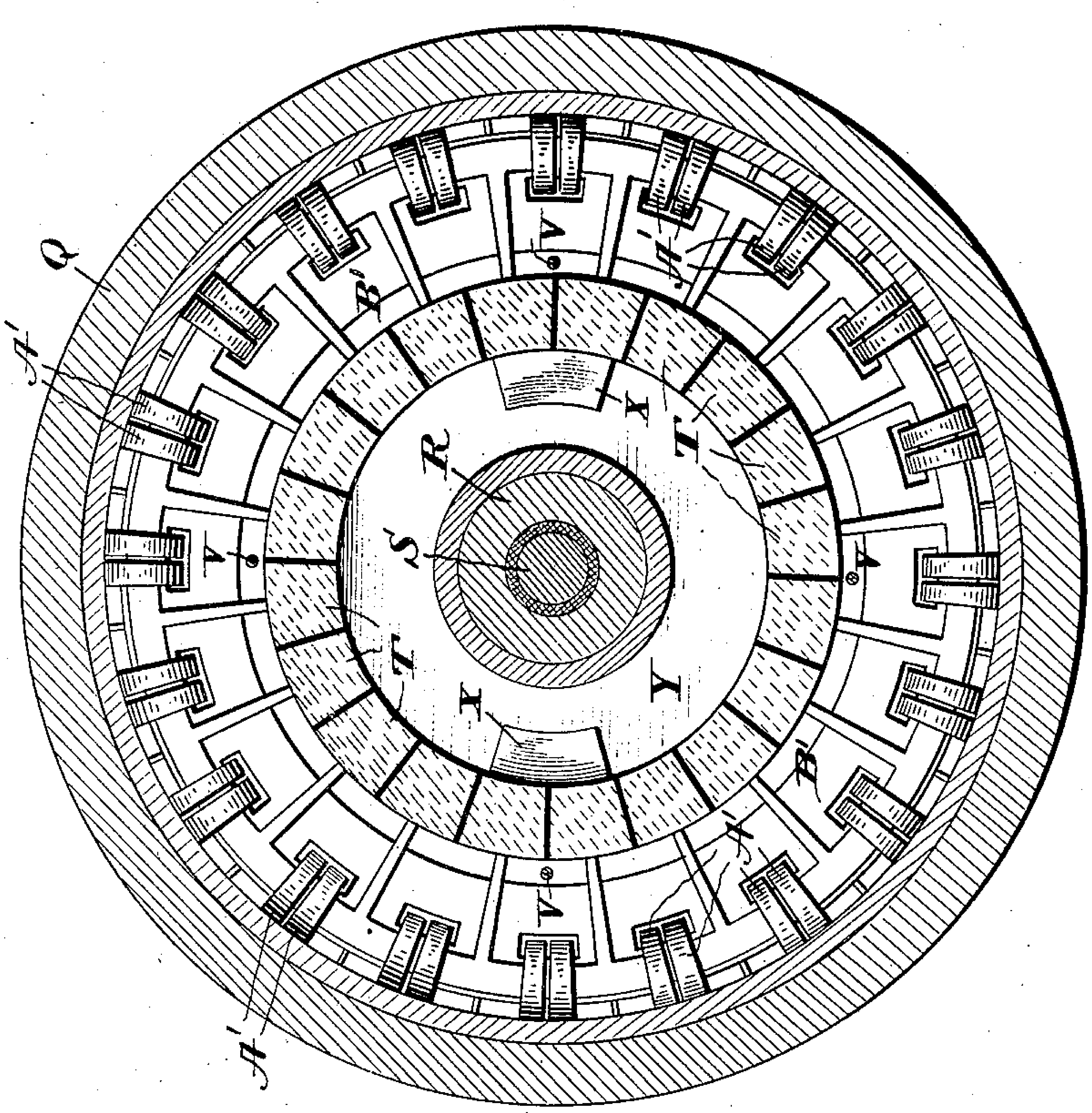
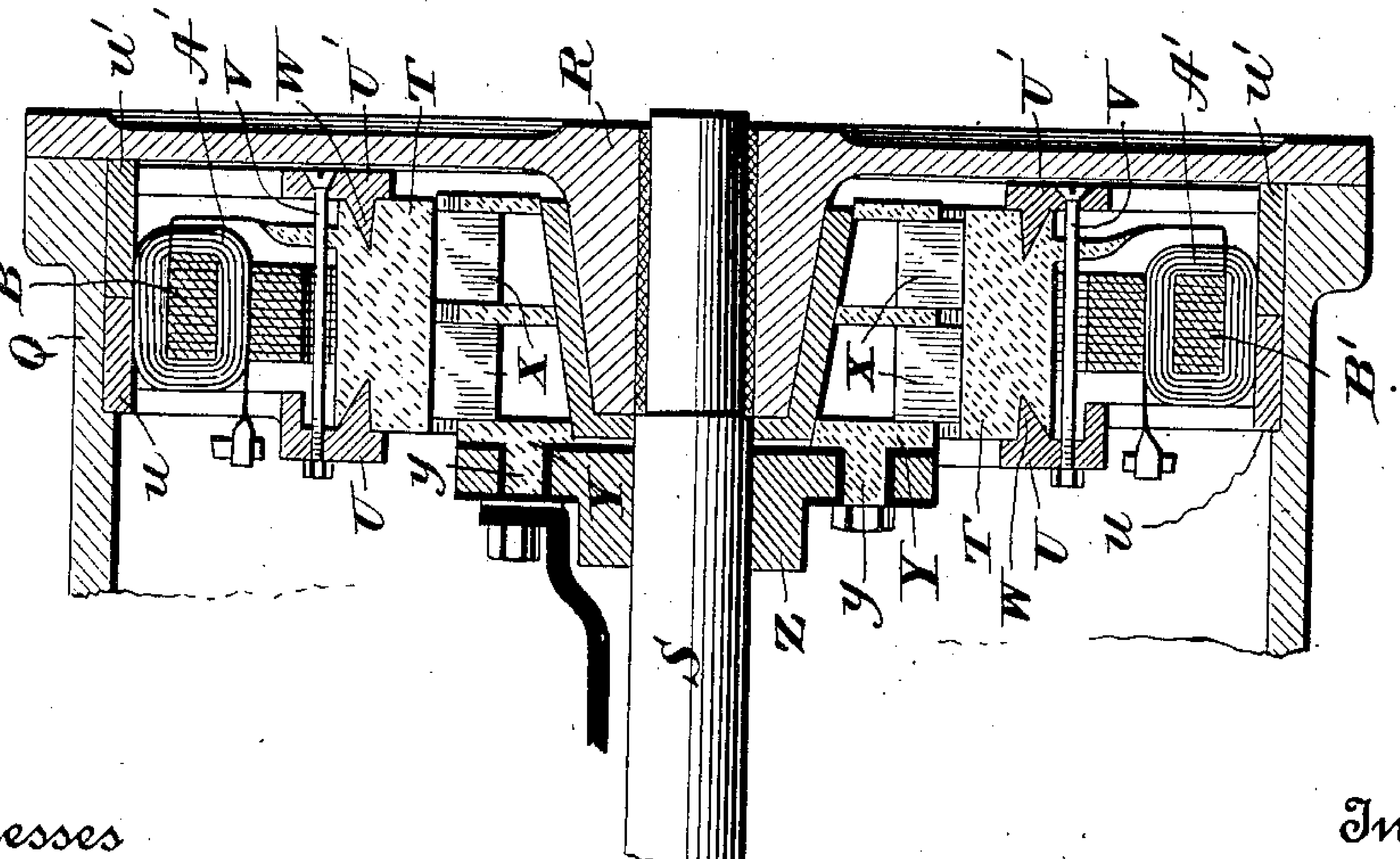


Fig. 3.



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3 SHEETS—SHEET 3.

Fig. 6.

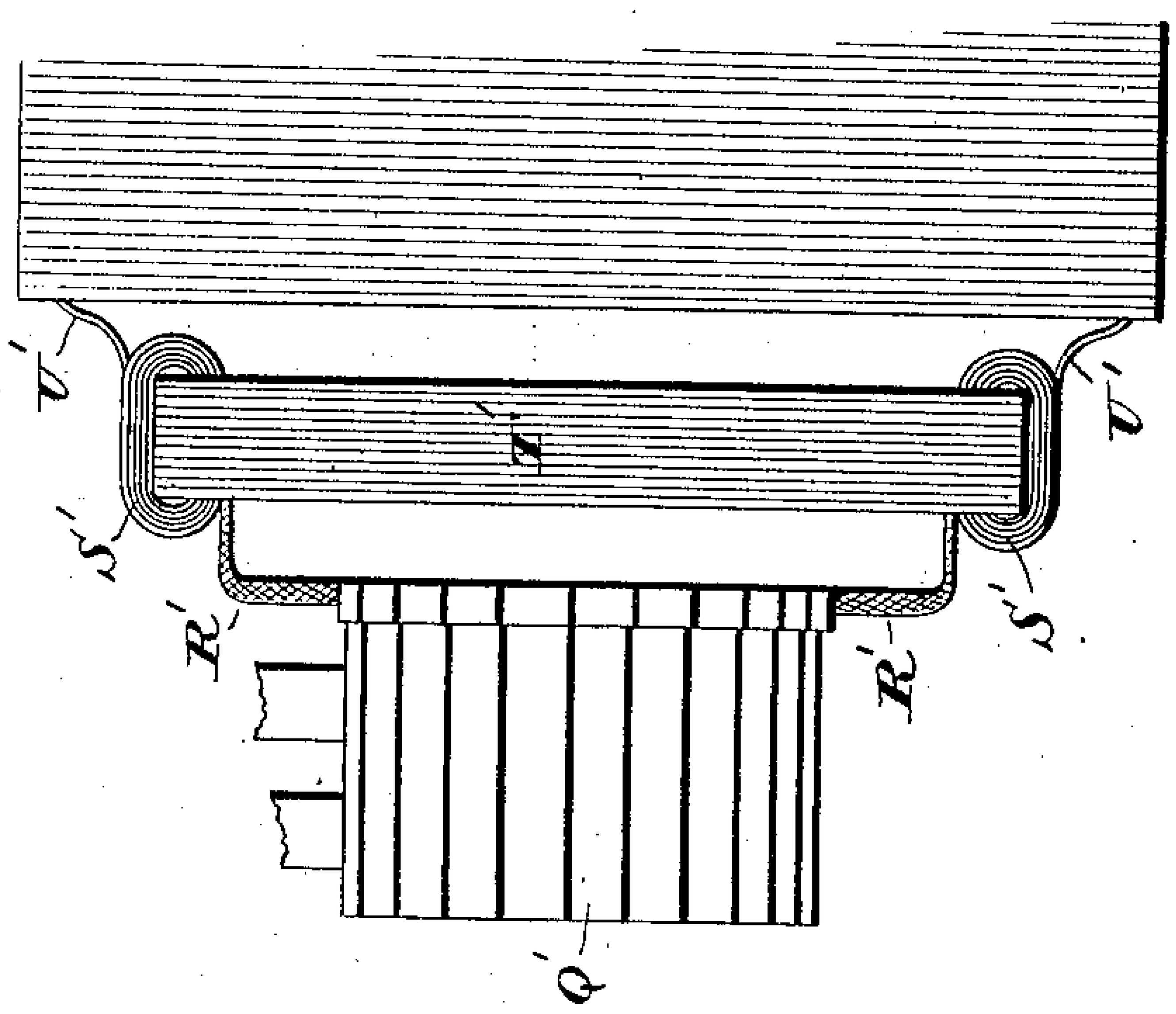
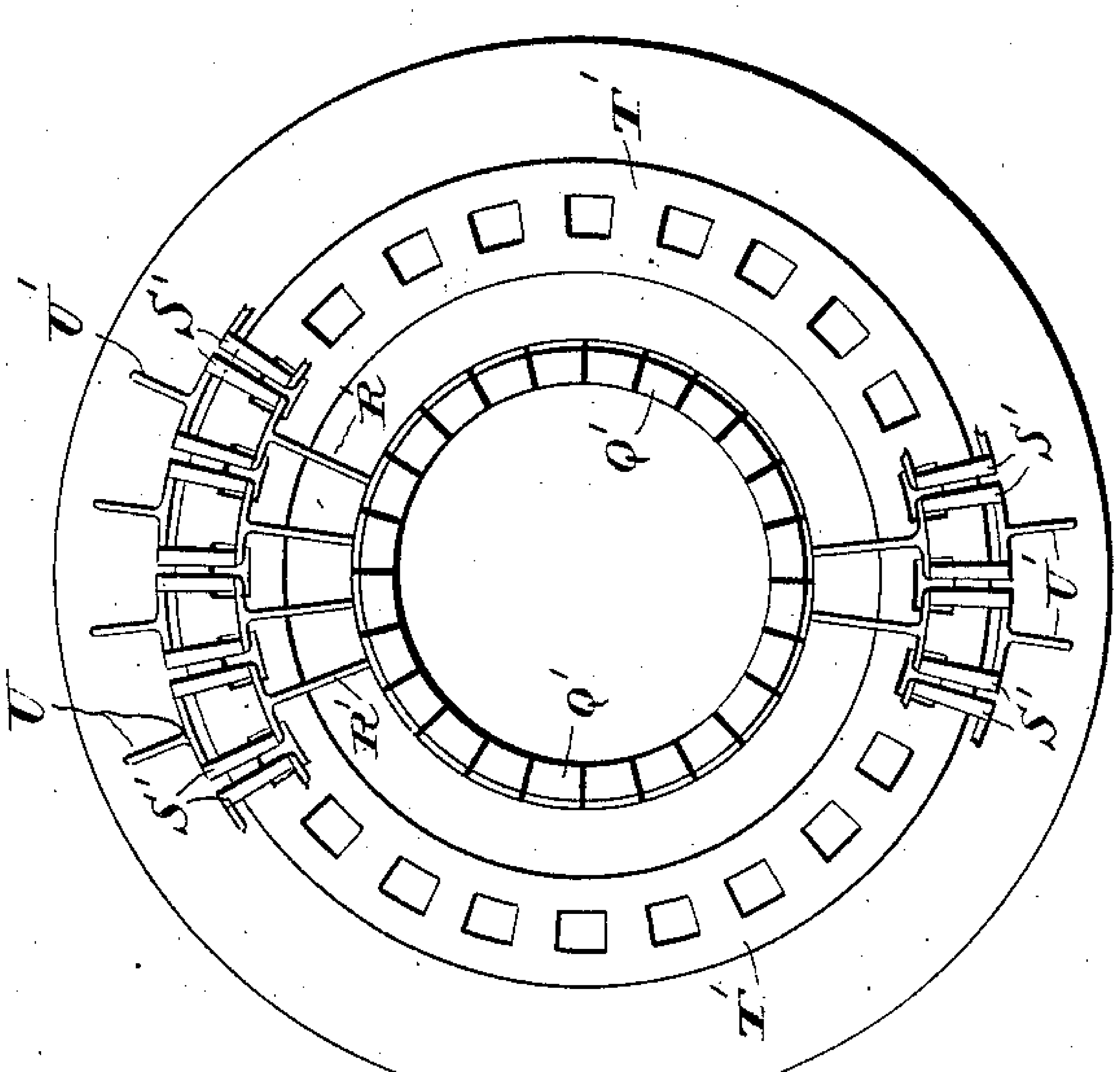


Fig. 5.



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UNITED STATES PATENT OFFICE.

STANLEY S. SEYFERT, OF SOUTH BETHLEHEM, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO WILLIAM S. FRANKLIN, OF SOUTH BETHLEHEM, PENNSYLVANIA.

COMMUTATOR.

No. 837,425. Specification of Letters Patent. Patented Dec. 4, 1906.

Application filed February 20, 1905. Serial No. 246,587.

To all whom it may concern:

Be it known that I, Stanley S. Seyfert, of South Bethlehem, in the county of Northampton, and in the State of Pennsylvania, have invented a certain new and useful Improvement in Commutators; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, in which—

Figures 1 and 2 are diagrammatic views of a commutator embodying my invention, and Figs. 3 and 4 are respectively a side elevation and a longitudinal sectional view of a commutator embodying my invention, and Figs. 5 and 6 are views similar to Figs. 4 and 5 of another embodiment of my invention.

The object of my invention has been to provide a commutator by which currents of high voltages can be commutated without sparking, such commutator, while especially valuable in alternating-current motors, being adapted for use in commutating other currents than those in a motor; and to such ends my invention consists in the commutator hereinafter specified.

The commutators of all single-phase motors at present devised other than that hereinafter described are, so far as I am aware, so constructed as to be subject to such serious sparking at the brushes as to prevent the use of currents at economical voltages. The main cause of sparking is the fact that the coil of the armature which is short-circuited by the brushes is the seat of a comparatively high electromotive force induced in it by "transformer" action, because of the alternating character of the exciting-field. Such coil is perpendicular to the lines of force and is therefore in position to embrace the largest possible number of lines of force, so that the inductive action therein is the strongest possible in any coil of the armature. Such coil being short-circuited by the brushes, large currents will flow in it, because of the comparatively low resistance of the short-circuit path. These currents cause heating of the brush-contacts, a loss of power, and sparks when the short-circuit is broken. The object of the commutator about to be described is to reduce such short-circuit currents, and thus to save power and minimize the destructive heating and sparking at the commutator.

The commutator is diagrammatically illustrated in Fig. 1, in which the coils on sections A A′, &c., of the armature-winding are connected by leads B B′, &c., which would ordinarily pass directly to the commutator-segments, but which in accordance with my invention are connected with choke-coils C C′, &c., and D D′, &c., in pairs, the choke-coils being connected by leads E E′, &c., with the commutator-segments F F′, &c. The choke or inductance coils C′, &c., and D′, &c., are so arranged that when alternating current flows upward or downward in both coils of a pair their magnetizing action will be equal and opposite, and no impedance will be offered to the passage of the current. If, however, current tries to flow up one coil and down the adjacent coil of a given pair, such as up one coil C^2 and down the adjacent coil D^2, the magnetizing action of the two coils will be in the same direction, and a heavy impedance will be opposed to such current. For this purpose two choke-coils may be wound on the same iron core or magnetic circuit, and the terminals are connected so as to obtain the effect above mentioned. Thus coils C and D are linked with one magnetic circuit, while coils C^2 and D^2 are linked with another magnetic circuit, and so on. In the operation of my commutator, as illustrated in Fig. 1, at the instant when the brush G bridges over the segments F^3 and F^4, if "transformer" electromotive forces are introduced in coil A^2 they will tend to produce corresponding currents in the short-circuit, which may be assumed to be in the direction of the dotted arrow below such coil at a given instant. Then current will tend to flow down the lead B^2, down coil C^2, down lead E^2, through commutator-segment F^3, through the brush G to the segment F^4, and thence through lead E^3 and coil D^2 and back to the armature-coil by lead B^3. It will thus be seen that this short-circuit current must flow down coil C^2 and up coil D^2; but, as before stated, when this takes place the coils interpose a large choking effect, and hence the short-circuit current will be kept down on account of the inductance of the coils C^2 and D^2. While the coils C^2 and D^2 will largely prevent the flow of current formed by transformer action in the short-circuited coil, they do not offer any objectionable resistance to the flow of the main armature-current, because such current will pass through both of such coils in the same direction—that is, upward or downward, so that their magnetizing action will be counterbalanced. No substantial portion of the short-circuit current above described can flow in the isolated coils D′ and C^3 because their magnetizing action is not counterbalanced by any opposite magnetizing action, and such coils therefore offer their full impedance to the passage of current.

Continuing now the theory of my commutator, if a number of commutator-segments between a set of positive and negative brushes be, say, fifty, then each of the choke-coils, as above described, will be actually carrying half of the armature-current for only about one twenty-fifth of the time. If $\frac{1}{2}$ be half the armature-current (assuming bipolar, simplex, lap-winding) and R be the resistance of a choke-coil, then while current is actually flowing the rate of heat-generation in the coil under consideration is $R(\frac{1}{2})^2$; but since this occurs only one twenty-fifth of the time the actual rate of heat generation may be twenty-five times as great while it occurs and still not heat the choke-coils faster than the armature is being heated—that is, the resistance of the choke-coil may be twenty-five times as great as would be permissible if the current were flowing all the time, or the cross-section of the conductors of the choke-coils may be made one twenty-fifth of the cross-section of the armature-conductors, keeping their length the same. The same effect can be obtained by multiplying the length of the choke-coils by five and decreasing their cross-section to one-fifth, thus giving approximately five times as many turns and twenty-five times as much an inductance in a given space. Thus it happens that the resistance of two of these choke-coils in series will be considerable, and this still further tends to reduce the short-circuit current. On the other hand, with respect to the main-armature current, the two coils C^2 and D^2, Fig. 1, are in parallel and their combined resistance will still be small as compared to the total armature-resistance. I thus obtain the effect of the introduction of ohmic resistance in the short-circuit formed by the bridging of two commutator-segments by a brush; but I do so without requiring the use of high-resistance material, inasmuch as my choke-coils may be of good copper wire, but of greatly diminished cross-section and greater length as compared with the conductor of the armature. I thus obtain the double object of introducing high resistance in the short-circuit, together with the choking effect of the coils thus formed, without introducing an objectionable bulk of material. If the inductance-coils were formed of material of high ohmic resistance and a sufficient length were used to produce the desired inductive effect, a bulk would result that would be a serious objection.

The choke-coils may be of copper strap insulated with asbestos, so as to be thoroughly heat-proof.

It will be seen that with my commutator the simplest form of armature-winding may be used and no special form of brushes is required. A higher voltage per segment can also be used, giving either a higher line voltage or a lower ratio of transformation.

The commutator may be varied in form. In Fig. 2 is illustrated diagrammatically an arrangement of commutator on the principle of that illustrated in Fig. 1, in which compactness and economy of iron is effected. The armature-coils H H′, &c., are, as before, connected by leads I I′, &c., with choke-coils K K′, &c., and L L′, &c., the latter being wound on the multiple iron core M. This core may consist of a ring or band of iron laminations with openings punched in the same for receiving the coils. The coils are connected by leads N N′, &c., with commutator-segments O O′, &c., that coact with the brush P.

In Figs. 3 and 4 is illustrated a commutator constructed according to the arrangement illustrated in Fig. 2 and applied to a railway-motor. The case Q is provided with a cover R, in which is formed a bearing for the shaft S. The commutator-segments T are held between two annular plates U and U′, respectively, the plates having flanges *u* and *u′*, respectively, which bear against the inner surface of the motor-casing. The plates are clamped against opposite sides of the commutator-segments by bolts V, the plates having **V**-shape ribs W, which engage complemental recesses formed in the commutator-segments. The ring of commutator-segments is thus made stationary. The inner surface of the segment-ring is used for contact with the brushes X, and the latter are mounted in brush-holders Y, having stems *y*, that are secured by nuts to a carrier Z, that is mounted on and rotates with the shaft. The brush-holders are insulated from the carrier and the connections with the brushes are made to the brush-holders. Between the plates U and U′ the choke-coils A′ and their core B′ are mounted. The core is annular in form, as illustrated in Fig. 4, and it is preferably laminated. The core is provided with slots parallel to but removed from its outer periphery, and the choke-coils are wound through such slots. The coils are, as indicated in Fig. 2, connected with the commutator-segments and with the armature-coils. The coils are most conveniently formed of strap conductor, although wire can be used.

In Figs. 5 and 6 is illustrated a commutator constructed according to the arrangement illustrated in Fig. 2, in which commutator the external brushes are used as in the ordinary commutator. The commutator-segments Q′ are, as usual, mounted on the shaft, and they are connected by leads R′ with choke-coils S′, corresponding to the choke-coils A′, said coils being mounted upon a core T′, which corresponds with the core B′ of the commutator illustrated in Figs. 3 and 4. The choke-coils are connected by leads U′ with the armature-coils. The electrical action of the commutator illustrated in Figs. 5 and 6 is the same as that illustrated in Figs. 3 and 4.

My commutator has, among others, the following advantages:

The commutator, being stationary, may be constructed very rigidly and is better suited to radiate heat than the ordinary commutator. This is an important factor, as the commutator of an alternating-current motor has an especial tendency to heat on account of the short-circuited current under the brushes. The stationary commutator allows of a great subdivision of poles, and hence less trouble with short-circuit voltages under the brushes (because the flux per pole need not be as great, and hence less voltage produced per coil).

It being practicable to use a material of good conductivity, such as copper, in the choke-coils and still to obtain the desired resistance, the cost is less than if it were necessary, as heretofore, to use a material of poor conductivity, such as German silver.

The commutator-segment ring being external permits the core of the choke-coils and the coils themselves to be as large as desired.

The use of an external segment-ring affords room within the ring for the shaft-bearing, thus saving the space on the shaft which would be taken up if the bearing were beyond the side face of the segment-ring as heretofore constructed. This is an important consideration where the space is limited, as in railway-motors.

It is obvious that various changes can be made in the above-illustrated construction which will be within the scope of my invention.

Having thus described my invention, what I claim is—

1. In an electrical device, the combination of an armature comprising coils, a commutator comprising segments, leads connecting said coils and segments, and oppositely-acting inductances in each lead, the inductances of opposite signs in different leads being situated in the same magnetic circuit.

2. In an electrical device, the combination of an armature comprising coils, a commutator comprising segments, leads connecting said coils and segments, and oppositely-acting inductances in each lead, the inductances of opposite signs in different leads being situated in the same magnetic circuit, said inductances being composed of material of high conductivity.

3. In an electrical device, the combination of an armature comprising coils, and a commutator comprising segments, of inductive resistance connected in the leads passing from said coils to said segments, said resistance being active as against current tending to form by short-circuiting a coil and being passive as against the main armature-current.

4. In an electrical device, the combination of an armature comprising coils, a commutator comprising segments, and ohmic and inductive resistance connected in the leads passing from said coils to said segments, said resistance being of high conductivity, being active as against current tending to form by short-circuiting a coil, and being passive as against the main armature-current.

5. In an electrical device, the combination of an armature comprising coils, a commutator comprising segments, and oppositely-wound inductance-coils connected in each lead from said armature-coils to said segments, oppositely-wound coils of adjacent leads having a common magnetic circuit.

6. In an electrical device, the combination of an armature comprising coils, a commutator comprising segments, and oppositely-wound inductance-coils connected in each lead between said armature-coils and said segments, oppositely-wound coils of adjacent leads having a common core and a common magnetic circuit, all of said cores forming parts of a single mass of iron.

7. In an electrical device, the combination of an armature comprising coils, a commutator comprising segments, and oppositely-wound inductance-coils connected in pairs in the leads passing from said coils to said segments, each of said pairs of coils being wound upon a core common to said pair, all of said cores forming parts of a single mass of iron or steel, said mass comprising a ring or rings of steel having slots formed parallel to, but removed from, its periphery, said coils being wound through said slots.

8. In an electrical device, the combination of an armature comprising coils, a commutator comprising segments, and oppositely-wound inductance-coils connected in pairs in the leads passing from said coils to said segments, each of said pairs of coils being wound upon a core common to said pair, all of said cores forming parts of a single mass of iron or steel, said mass comprising a ring or rings of steel having slots formed parallel to, but removed from, its periphery, said coils being wound through said slots, and over said periphery.

9. In an electrical device, the combination of an armature comprising coils, a commutator comprising segments, and oppositely-wound inductance-coils connected in pairs in

the leads passing from said coils to said segments, each of said pairs of coils being wound upon a core common to said pair, all of said cores forming parts of a single mass of iron or steel, said mass comprising a ring or rings of steel having slots formed parallel to, but removed from, its periphery, said coils being wound through said slots and over said periphery, said coils being formed of bands of metal of high conductivity.

10. In an electrical device, the combination of an armature comprising coils, a commutator comprising segments, and oppositely-wound inductance-coils connected in pairs in the leads passing from said coils to said segments, each of said pairs of coils being wound upon a core common to said pair, all of said cores forming parts of a single mass of iron or steel, said mass comprising a ring or rings of steel having slots formed parallel to, but removed from, its periphery, said coils being wound through said slots and over said periphery, said coils being formed of bands of metal of high conductivity, said bands being insulated with non-combustible material.

In testimony that I claim the foregoing I have hereunto set my hand.

STANLEY S. SEYFERT.

Witnesses:

WILLIAM S. FRANKLIN,

A. L. COPE.