(No Model.) 4 Sheets—Sheet 1.

J. A. G. TRUDEAU.

ALTERNATING ELECTRIC MOTOR.

No. 561,144. Patented June 2, 1896.

Fig. 1.

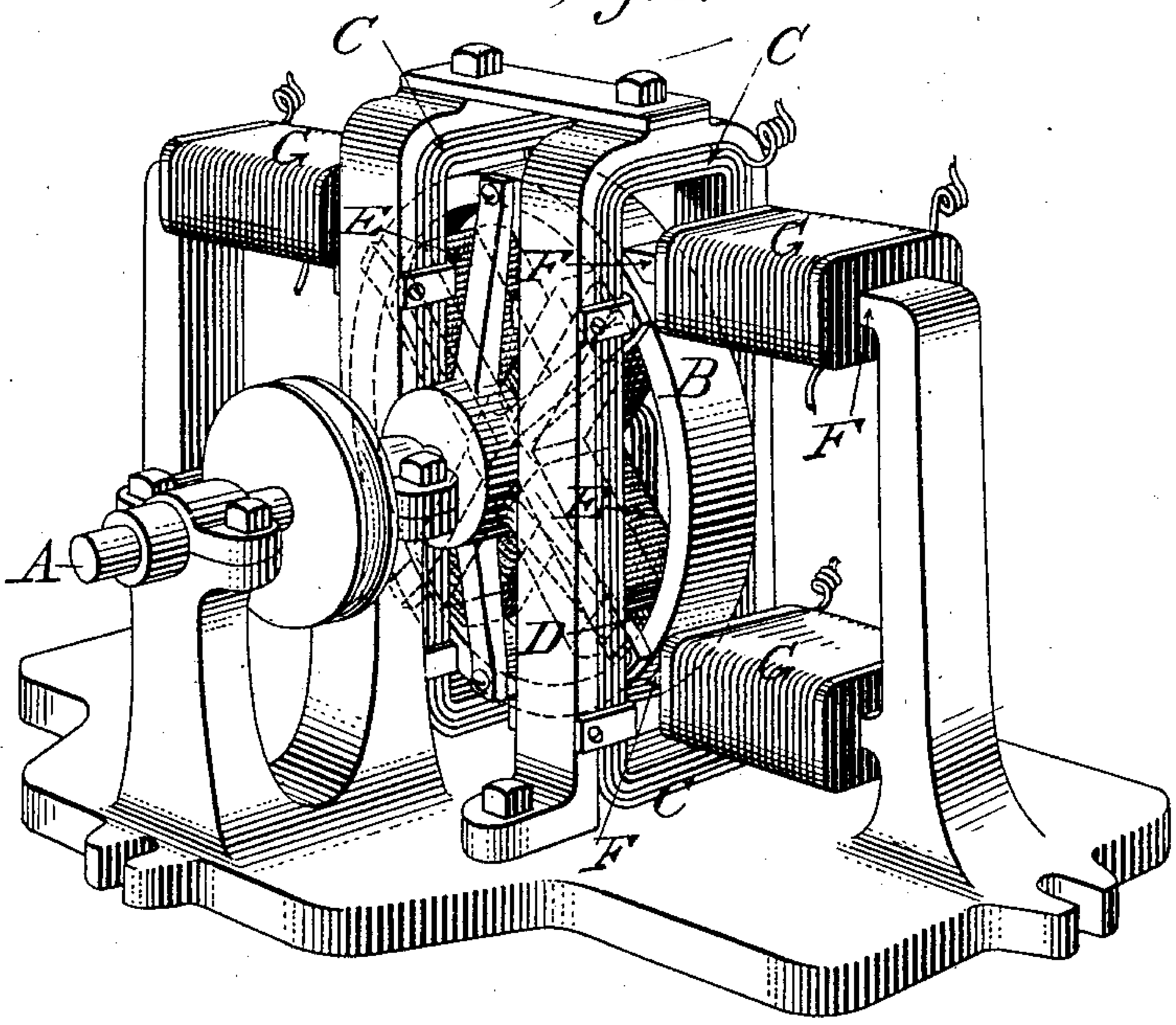
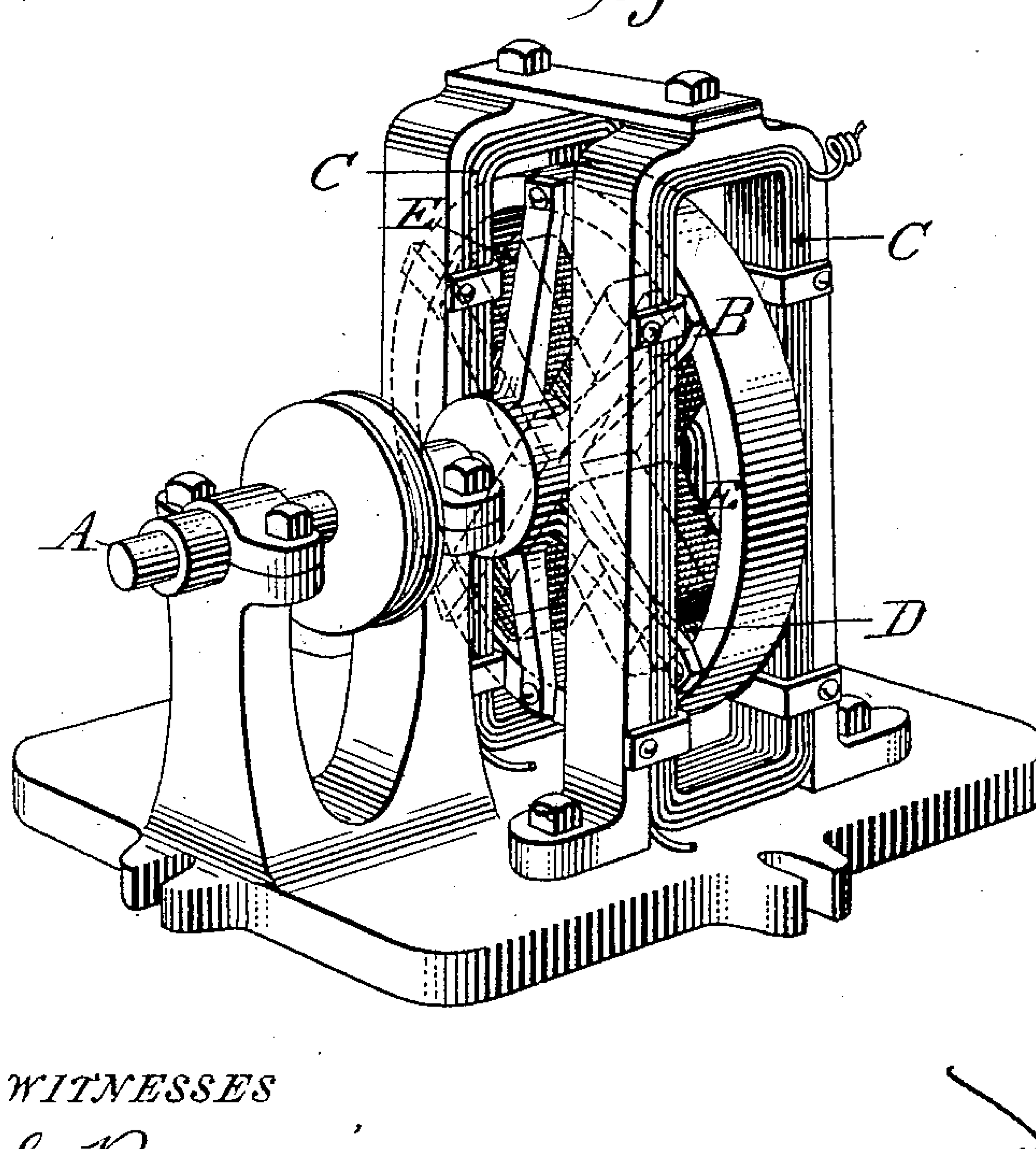


Fig. 2.



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J. A. G. TRUDEAU.
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Fig. 3.

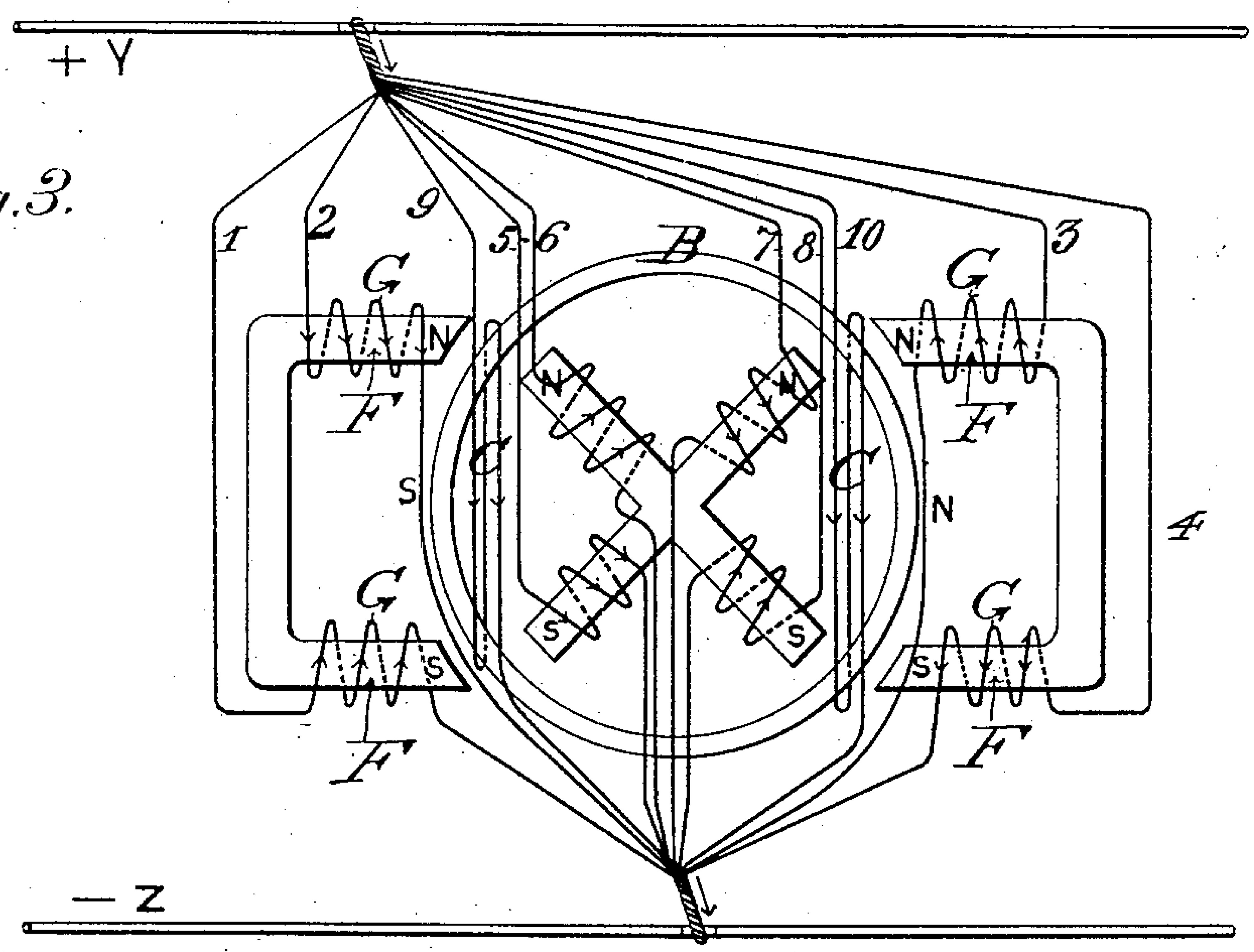
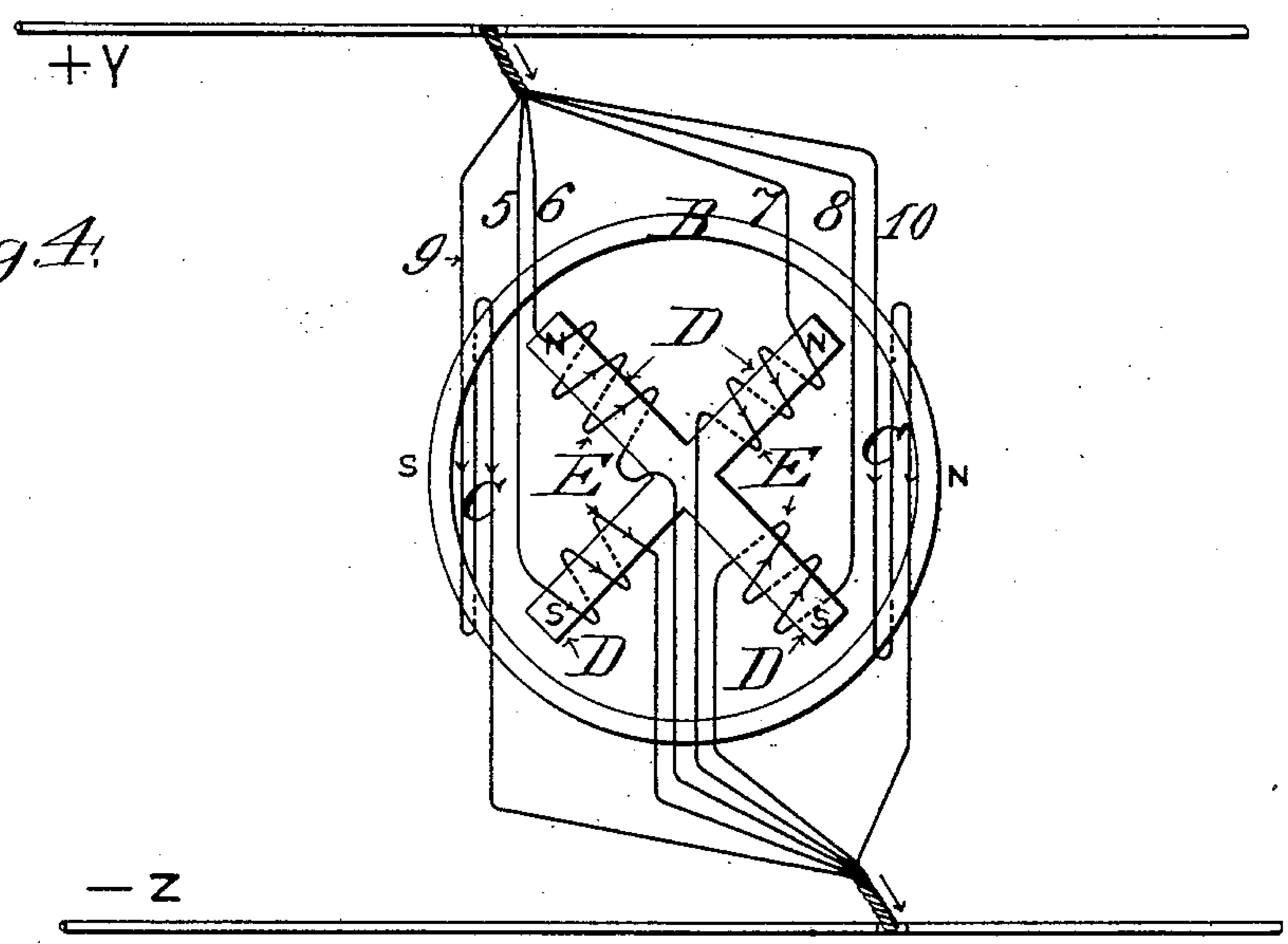


Fig. 4.



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J. A. G. TRUDEAU.

ALTERNATING ELECTRIC MOTOR.

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Fig. 5.

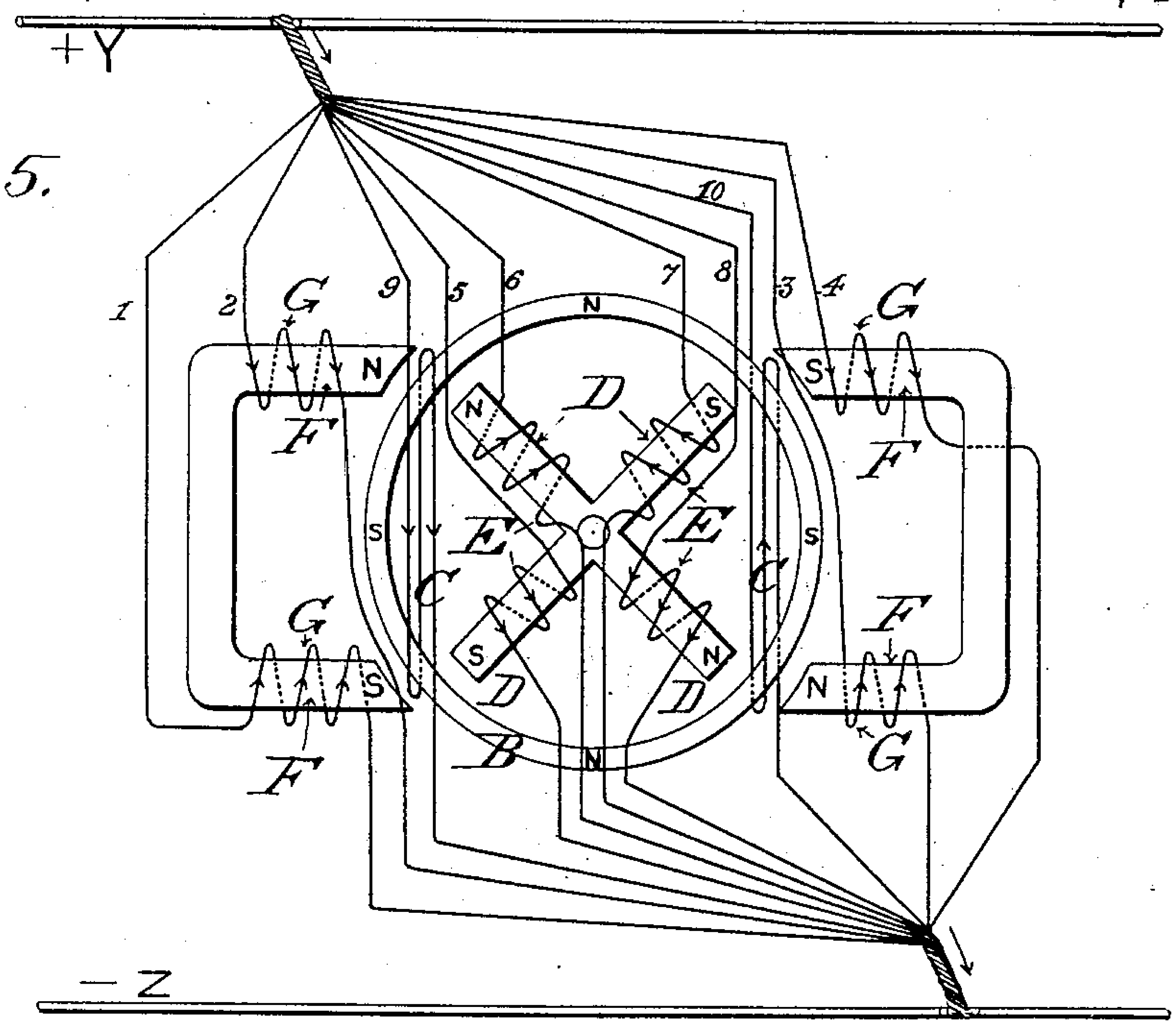
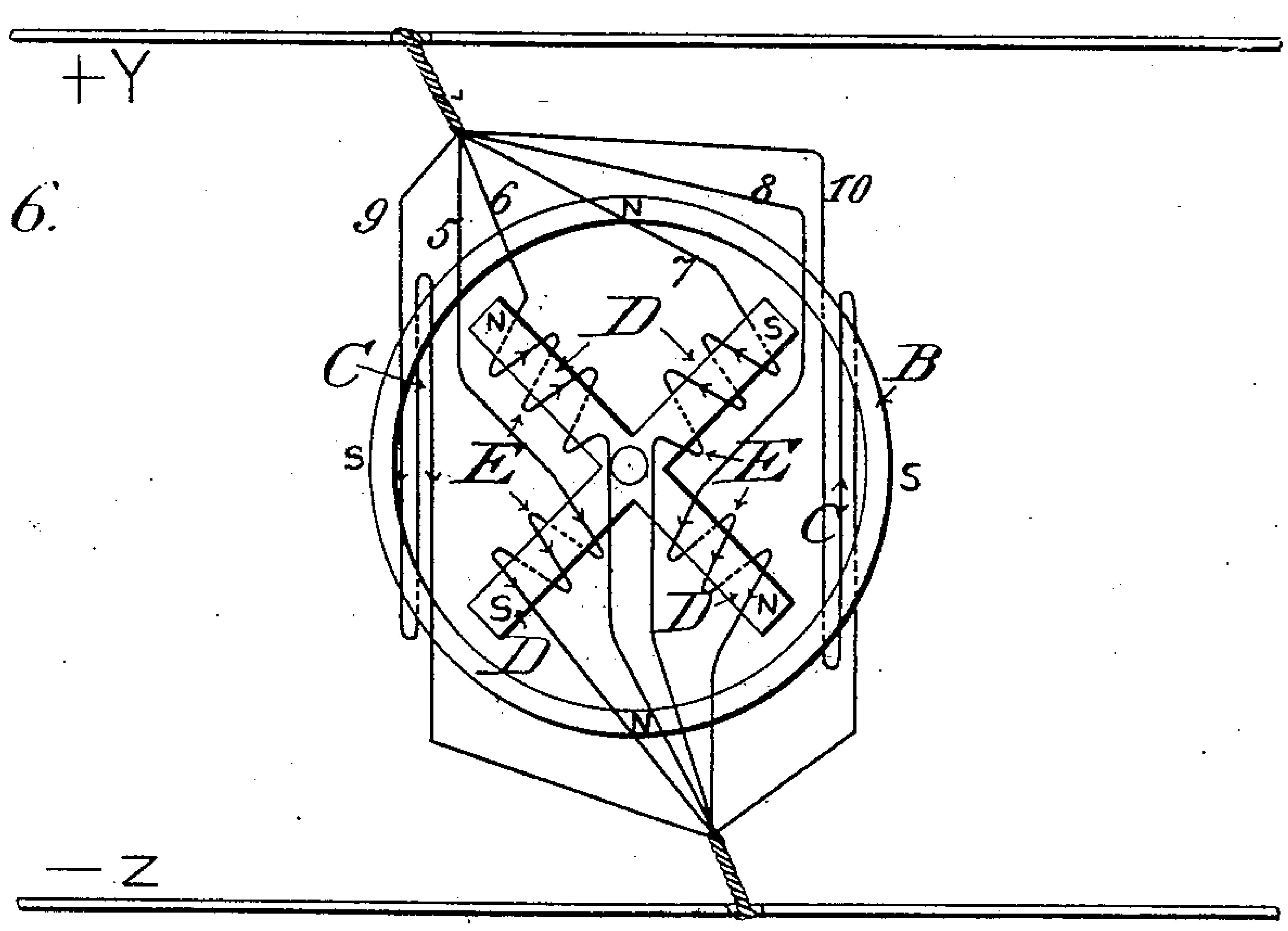


Fig. 6.



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4 Sheets—Sheet 4.

J. A. G. TRUDEAU.

ALTERNATING ELECTRIC MOTOR.

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Fig. 7.

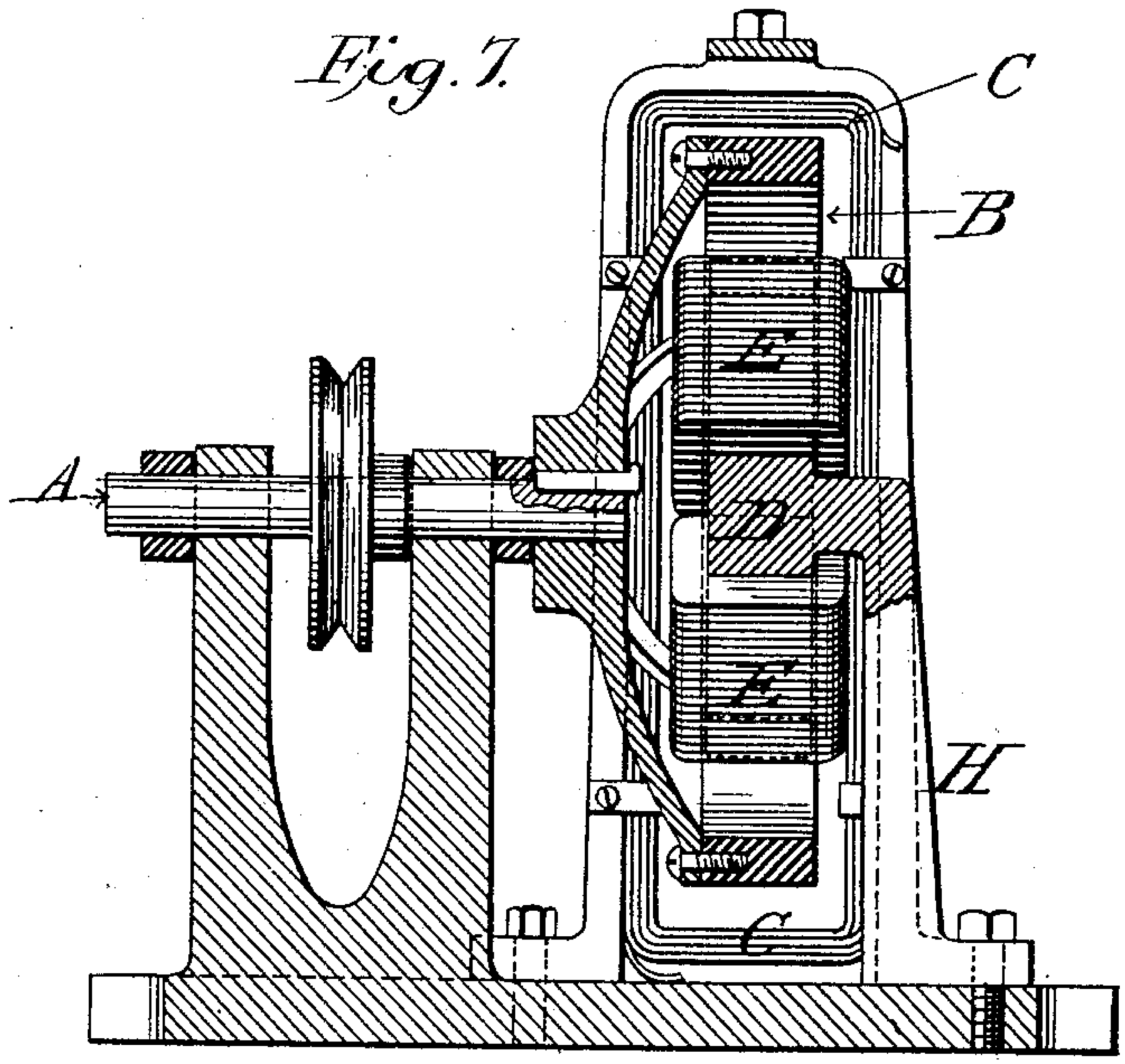
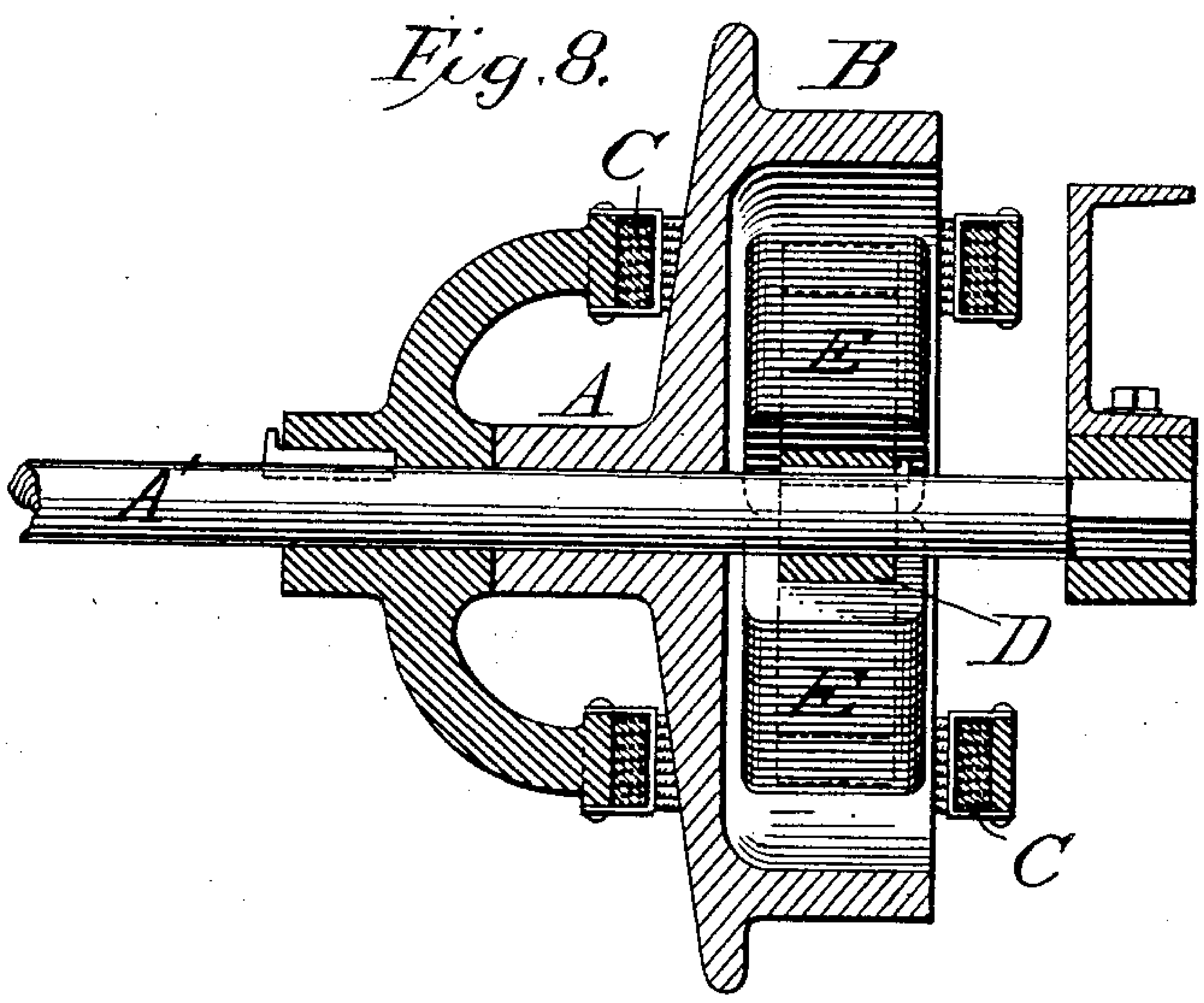


Fig. 8.



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UNITED STATES PATENT OFFICE.

JOSEPH A. G. TRUDEAU, OF OTTAWA, CANADA.

ALTERNATING ELECTRIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 561,144, dated June 2, 1896.

Application filed July 18, 1894. Serial No. 517,907. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH A. G. TRUDEAU, a subject of the Queen of Great Britain, residing at Ottawa, in the Province of Ontario and Dominion of Canada, have invented certain new and useful Improvements in Electromotors, of which the following is a specification.

My invention relates to alternating-current electromotors; and it consists, primarily, in the combination, with an annular or hollow armature, of internal field-magnets.

The invention further consists in the combination with the annular armature and internal field-magnets, of external field-magnets, and in other combinations, features, and details hereinafter set forth.

In its general construction the motor hereinafter set forth resembles and is based upon the same principle as the motor set forth in my application, Serial No. 506,557, filed on the 6th day of April, 1894; but the present improvements are designed to render the motor more compact or to secure a greater amount of power for a given size of motor. The form and arrangement of parts may vary considerably without departing from the spirit or scope of my invention, provided the idea of placing field-magnets within the armature be retained.

In the accompanying drawings, Figure 1 is a perspective view of my improved motor, having the external and internal magnets; Fig. 2, a similar view showing the internal magnets only; Fig. 3, a diagrammatic representation of one arrangement of the coils or windings for the motor shown in Fig. 1; Fig. 4, a similar view showing one winding of the motor represented in Fig. 2; Figs. 5 and 6, similar views illustrating a modified winding of the motors shown in Figs. 1 and 2, and Figs. 7 and 8 details illustrating certain modifications or variations in the form of the motor.

The preferred construction of the motor will first be described in connection with the accompanying drawings, and its mode of operation will then be pointed out.

Referring first to Fig. 1, A indicates a shaft carried in suitable bearings or supports and carrying at its outer end an annular armature B, which will advisably be made of soft castiron or of laminated iron, wire wound into compact form, or other body capable of being rapidly magnetized and demagnetized.

C C indicate stationary armature-energizing coils, which are wound about the annular armature and brought as close thereto as is consistent with free movement of the armature without danger of contact with the coils. A current or current-impulse of given sign being passed through the coils C C will effect polarization of the annular armature B, the location of the points of polarization being dependent upon the location and direction of winding of the coils C, as is well understood.

D D indicate field-magnet cores, which are wound with coils E of insulated wire, the direction of winding being varied to suit the winding of the armature-coils C. These cores and coils D, as will be seen by reference to the various figures, are located within the annular armature B or within the space which, under ordinary circumstances, is unused and unavailable.

F F indicate external field-magnets, the polar projections of which are brought into close proximity to the armature B and in radial alinement with the polar ends or projections of the internal magnet-cores D, or nearly so.

Where but little power is required and it is desired to make the motor as small and compact as possible, the outside magnets F, with their coils or windings G, may be omitted and the motor made in the form represented in Fig 2.

Referring to Figs. 3 and 4, the manner of winding the motor will be explained.

First referring to Fig. 3, Y and Z represent the two main conductors or leads, which receive alternately positive and negative pulsations of current. Assuming, for purposes of explanation, that the positive impulse is for the instant passing over conductor Y, it will then pass by a series of independent branches 1 2 3 4 to the coils G of the external field-magnets F, the windings of which are in such direction as to produce at such instant north polarity in the two upper poles and south polarity in the two lower poles. It at the same instant passes by separate and independent branches 5 6 7 8 to the internal field-magnet coils E, which are wound in a manner similar to the external field-magnet coils, so that there will be like poles in alinement or in approximate alinement in the inner and outer fields. Still further distinct and independent branches 9 and 10 pass from the lead Y to the armature-coils C, which are so wound as to produce a south pole at the left and a north pole at the right, as indicated in Fig. 3. The several coils are connected, each by its separate conductor, with the lead Z in precisely the same manner as the first is connected with the lead Y. This will cause the armature to be strongly polarized at a point between the upper and lower coils at the left and at a similar point at the right, the polarity at the left being alike with the lower field-poles and unlike with the upper field-poles, while at the right the reverse is true. As a consequence, the unlike poles attracting and the like poles repelling, the armature B will be caused to rotate to the right or with the hands of a clock. If now an impulse be sent in the reverse direction it will pass through the various conductors and coils from the lead Z and will reverse the polarity of the armature and of the field-magnets; but as the relation remains unchanged, so the direction of rotation will continue the same.

In Fig. 4 the arrangement is precisely the same as in Fig. 3, except that the conductors 1, 2, 3, and 4 are omitted, there being no external field-magnets.

Referring now to Figs. 5 and 6, a slightly different arrangement of the circuits will be explained, the arrangement in the two figures being precisely the same, except that in Fig. 5 the external field-magnets are represented and in Fig. 6 they are omitted. One explanation will therefore answer for both. Assuming that a positive-current impulse pass by line or lead Y, it will divide between the various branches 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 and will produce field-poles alternately north and south, beginning at the upper left hand with north and following around in order to the right back to the starting-point, and producing north polarity in the armature at the upper and lower sides and south polarity at the right and left hand sides. As a consequence of this arrangement, which is produced by the well-known rule for winding, there will be four external and four internal field-poles and four armature-poles, each field-pole attracting that portion of the armature at one side and repelling that portion at the other side of its exposed end. Upon the passage of a negative impulse, the direction of travel being reversed at the same instant in all the coils, their relation remains unchanged, and the armature will consequently rotate continuously in the one direction.

Fig. 7 represents in vertical section the construction of the motor and shows the manner of supporting the internal field-magnets, a standard or post H being employed for this purpose and the shaft A being carried in boxes or pillow-blocks, as indicated. Connection between the annular armature B and the shaft is made by suitable spokes, by a spider, or by a solid disk, as found expedient in any given case; but it is advisable to employ non-magnetic metal or material for this connection, so that the magnetism of the armature may be confined to the annular body or ring B. The shaft A will be provided with a pulley from which to transmit motion to other machinery, or the armature B may itself constitute the band-pulley.

Fig. 8 represents a modification of the construction, and one designed for use in connection with cars and other vehicles. In this A indicates the shaft, which in this instance is made tubular in form and mounted on an internal shaft A′, which latter may be the axle of a car, truck, locomotive, or other vehicle, and will be fixed or held against rotation. D indicates the internal field-magnets, which are keyed or otherwise made fast upon the inner shaft A′, and C indicates the armature-coils encompassing the armature, but fixed in position. The coils will in practice be suitably incased or covered to prevent injury, and the armature B may be closed in, if desired. When used for street-cars, locomotives, &c., the armature B will or may be made in the form of a track-wheel, as indicated in Fig. 8; but this is optional, since power may be conveyed from the armature or its shaft in any convenient or usual manner.

The proportions of the parts, number of poles, and other matters of detail may be varied widely, the invention consisting, broadly, in placing field-magnets within the annular armature. In practice it is deemed preferable to employ a considerable number of coils both in the field and for the armature in order that there may be no lag of the current when the reversals occur, the coils being comparatively short.

The iron of the field and armature should be so proportioned as to give approximately the same cross-section and mass, so that the time of polarization of the different parts shall be absolutely simultaneous and that the reversals shall take place at precisely the same instant in every part.

By placing the field-magnets within the armature I am enabled greatly to reduce the size of the motor for given capacity, and by employing both the internal and the external magnets I am enabled to get a field of approximately double the strength practicable with the use of external magnets only.

While far better results are obtainable by placing each coil in an independent branch or shunt, measurably good results may be secured by placing two or more of the coils in the same branch, provided the coils be not unduly long and the inclosed iron be of small mass. Hence, while I prefer independent branches, I do not mean to restrict myself absolutely thereto.

The various branches, 1 to 10, inclusive, will be wound into a cable extending from the main to the motor and again from the motor to the main.

It is obvious that a series of annular armatures may be combined in one motor, or that the armature may be made in the form of a long hollow cylinder; but it is preferred to adopt the hoop or narrow-band form in order that there may be a comparatively small mass of iron and that the armature may consequently be readily magnetized and demagnetized without lag or retardation.

The internal and external field-magnets may be placed slightly out of radial alinement or one set given more or less lead relatively to the other, so that a longer action or a continuing force may be exerted upon the armature to effect its movement.

The direction of rotation will of course depend upon the relative directions of the current in the field and armature coils. Hence by introducing a suitable reversing-switch into one or the other branch or circuit the machine may be made reversible at will. This, however, is fully set forth in my former application and is not herein claimed, and hence is not shown in the drawings.

I do not broadly claim the combination of an annular armature and a field-magnet within the same.

Having thus described my invention, what I claim is—

1. In an electromotor, the combination of a rotatable armature; stationary energizing-coils therefor; stationary field-magnets located within the armature; and energizing-coils encircling said field-magnets, the armature-coils and field-coils being both connected with a source of electric supply, but in shunt relation to each other.

2. In an electromotor, the combination of a rotatable annular armature; stationary polarizing-coils therefor; stationary field-magnets located outside the armature and provided with their own energizing-coils; stationary field-magnets located within the armature and provided with their own energizing-coils; a source of electric energy; and conductors connecting the three sets of energizing-coils independently or in shunt relation to each other, with the source of energy.

In witness whereof I hereunto set my hand in the presence of two witnesses.

JOSEPH A. G. TRUDEAU.

Witnesses:

WILLIAM W. DODGE,

HORACE A. DODGE.