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J. A. G. TRUDEAU.

ALTERNATING ELECTRIC MOTOR.

No. 543,223. Patented July 23, 1895.

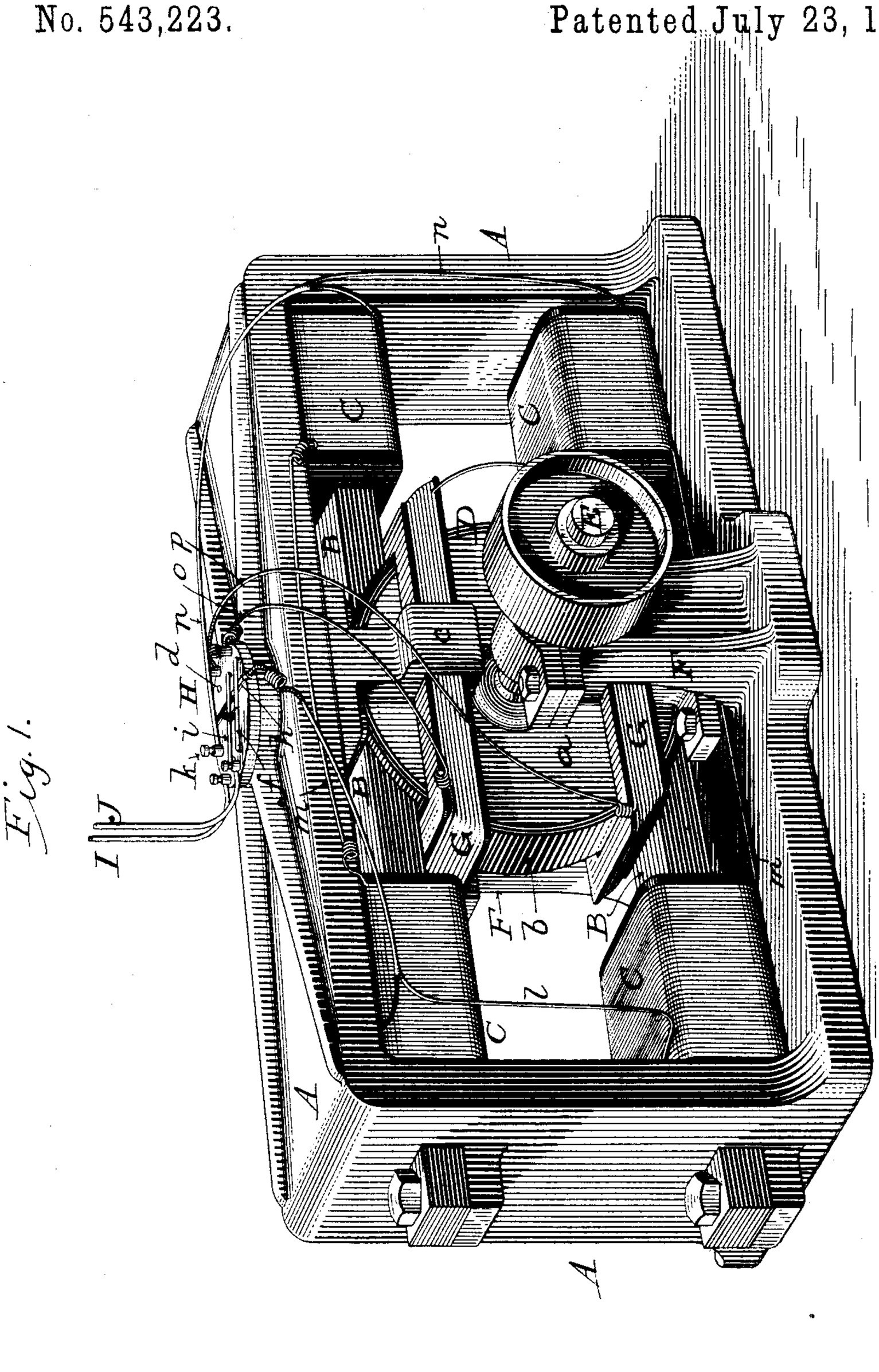

Fig. 1.

WITNESSES

C. C. Burdine.

Arthur Ashley

INVENTOR

Joseph A. G. Trudeau,

by Dodger & Lone

Attorneys.

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J. A. G. TRUDEAU.

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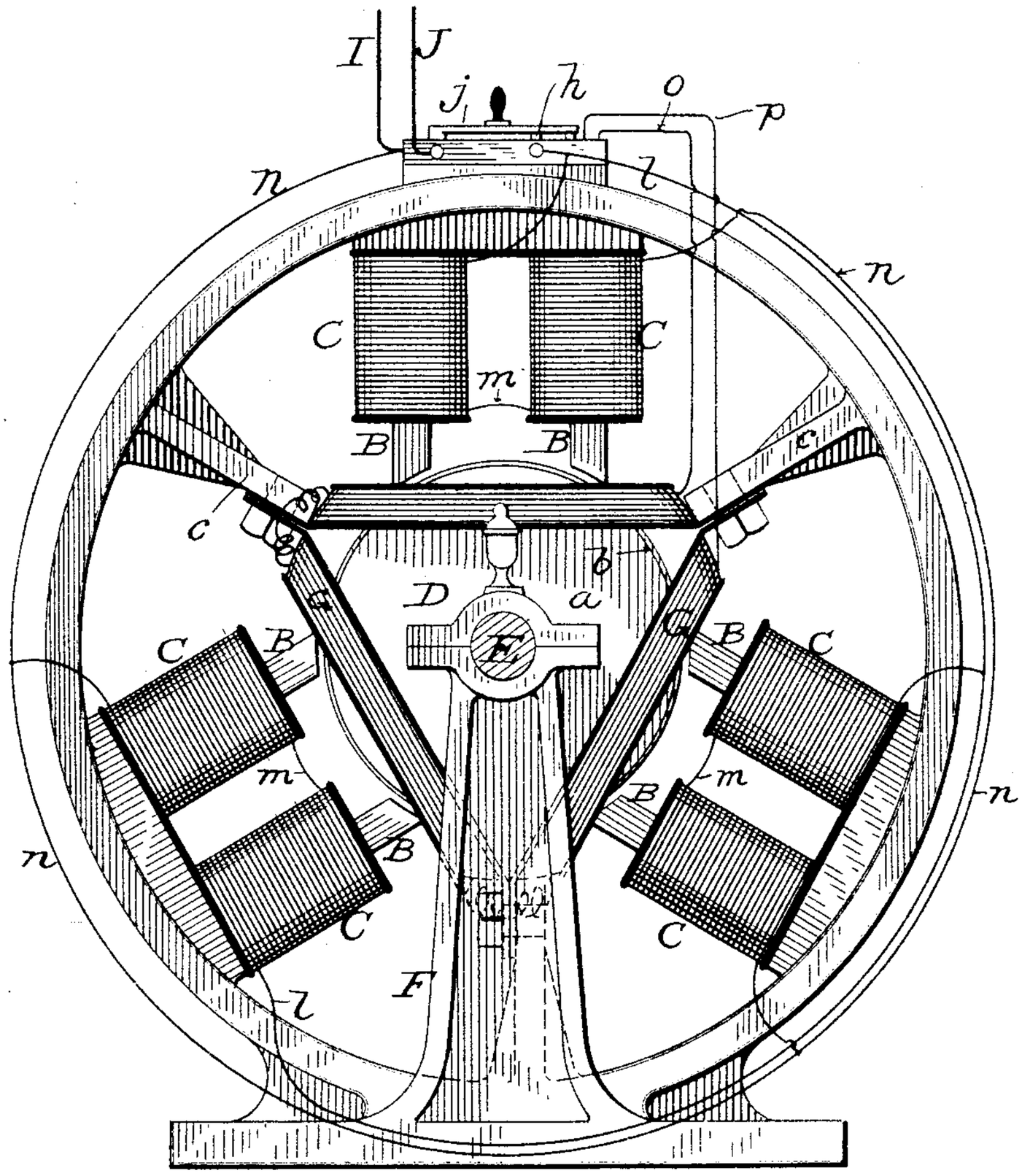
Fig. 2.



WITNESSES

Ellis. Burdine

Arthur Ashley

INVENTOR

Joseph A. G. Trudeau

by Dodger & Sons, *Attorneys.*

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J. A. G. TRUDEAU.

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Fig. 3.

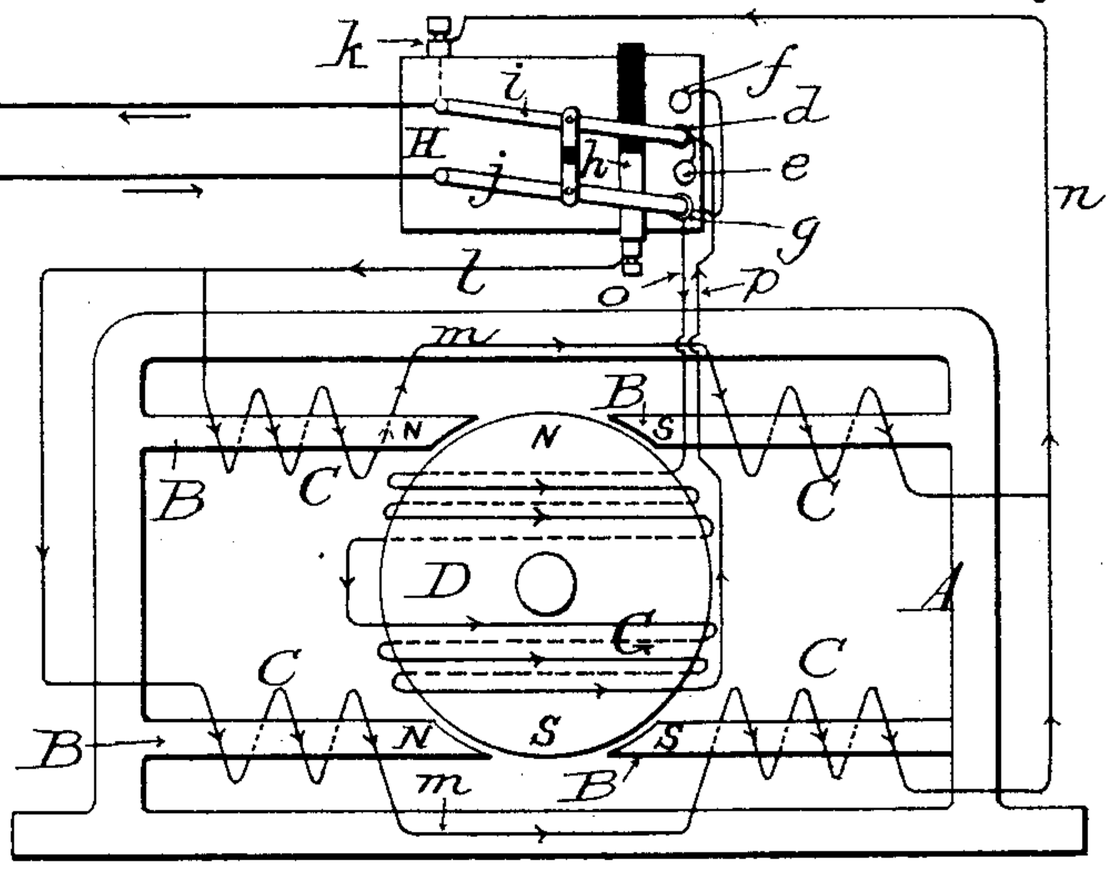
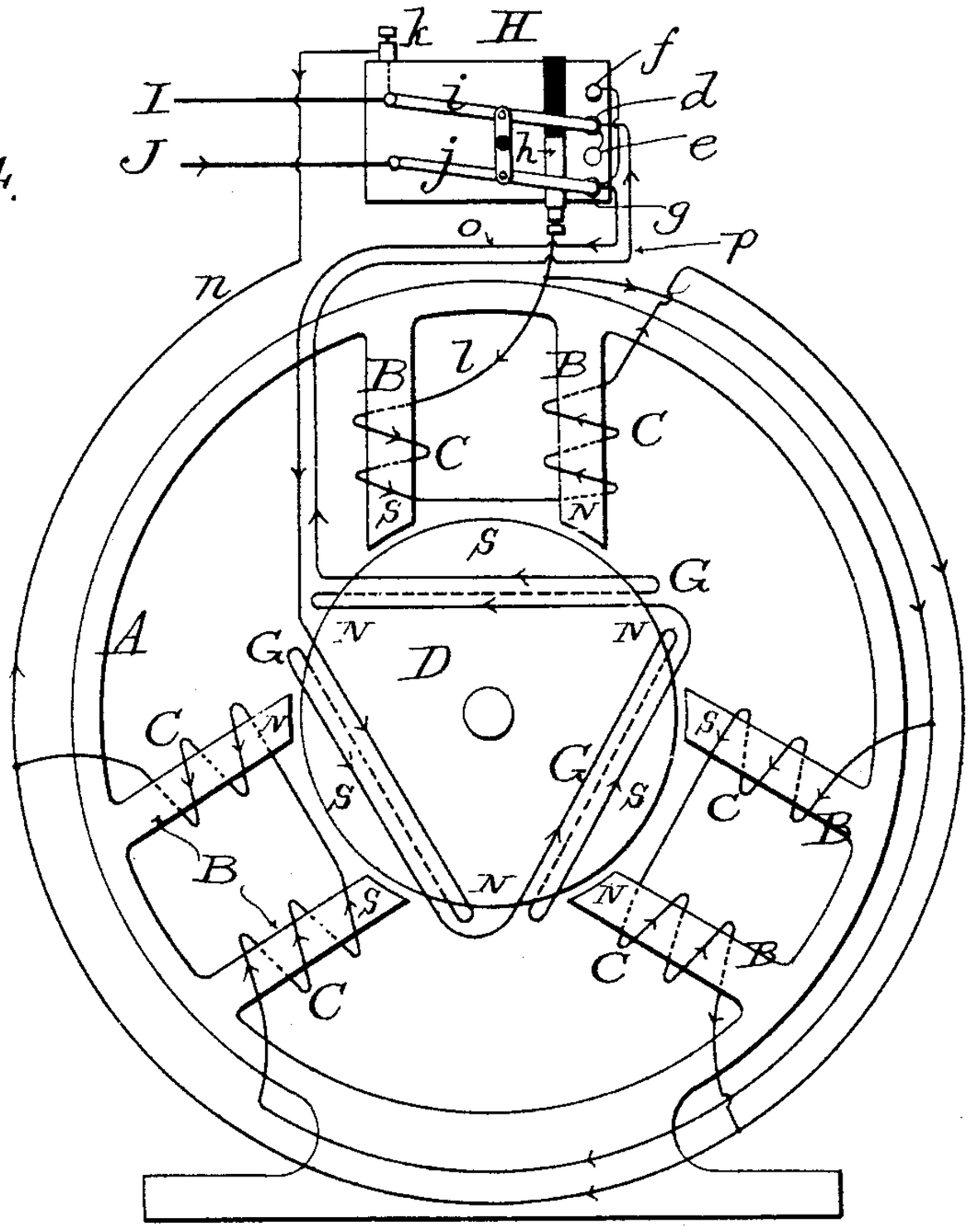


Fig. 4.



WITNESSES

C. C. Burdine.

Arthur Ashley

INVENTOR

Joseph A. G. Trudeau

by Dodger Sons, Attorneys.

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J. A. G. TRUDEAU.

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Fig. 5.

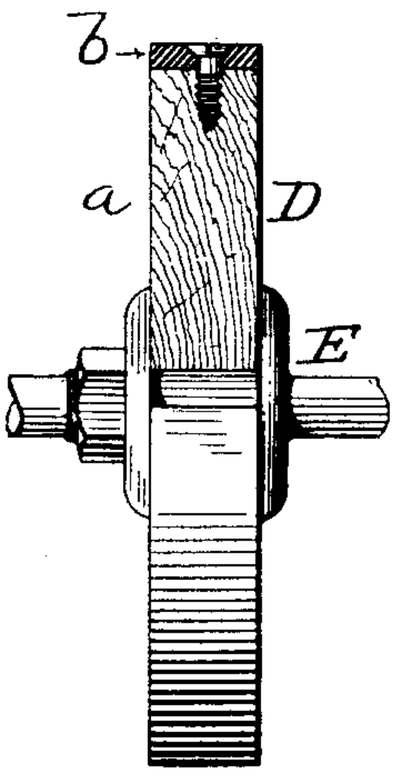


Fig. 6.

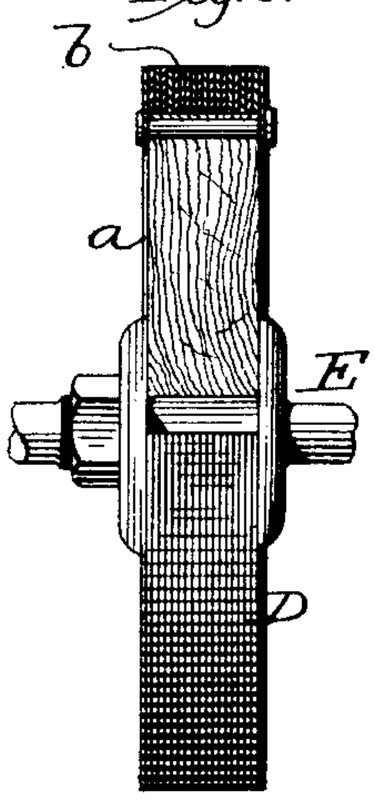


Fig. 7.

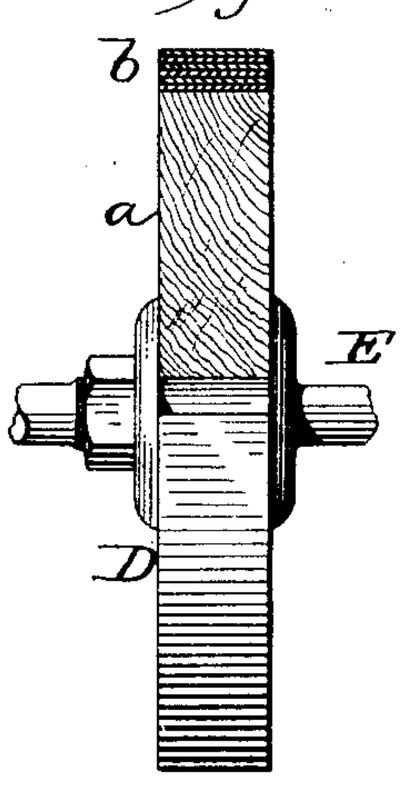


Fig. 8.

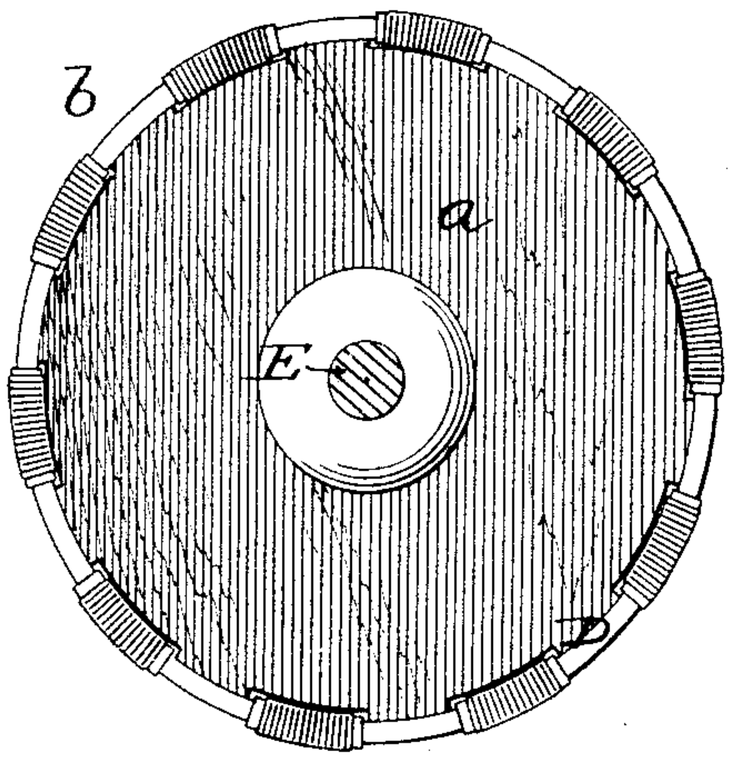
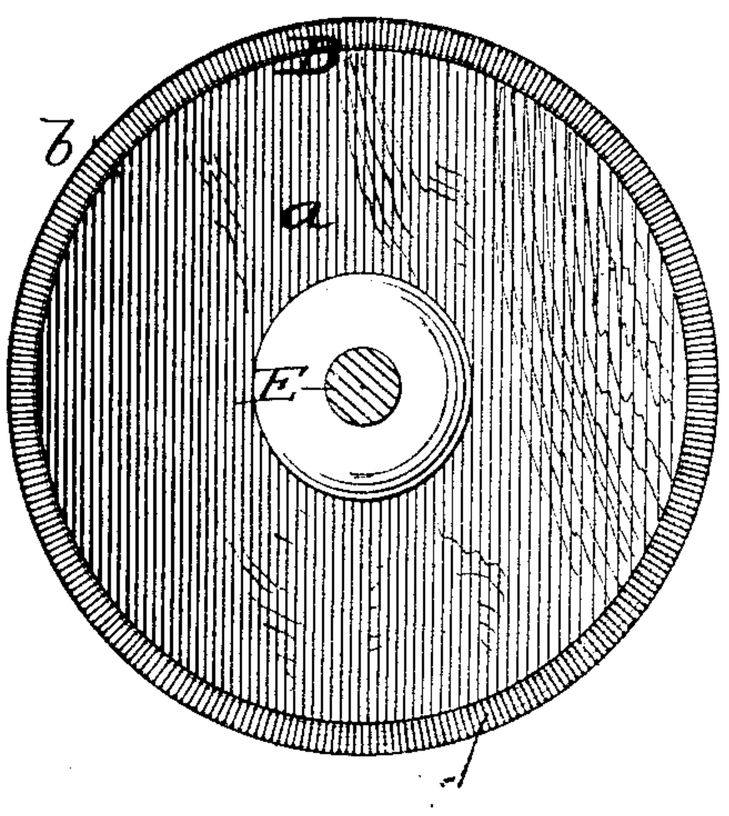


Fig. 9.



Witnesses
C. C. Burdine.
Arthur Ashley

Inventor
Joseph A. G. Trudeau
by Dodger & Sons
Attorneys.

UNITED STATES PATENT OFFICE

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

ALTERNATING ELECTRIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 543,223, dated July 23, 1895.

Application filed April 6, 1894. Serial No. 506,557. (No model.)

To all whom it may concern:

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

My invention consists in a novel construction of and mode of energizing alternating-current electromagnetic motors, as hereinafter explained with the aid of accompanying drawings.

Figure 1 is a perspective view of a simple form of motor embodying my invention; Fig. 2, a side elevation of a slightly-different form of motor involving the same principles of construction; Fig. 3, a view of a reversing-switch, also showing diagrammatically the winding of the motor shown in Fig. 1; Fig. 4, a diagram of the winding of the motor shown in Fig. 2; and Figs. 5, 6, 7, 8, and 9, views of different styles of armature.

In order that the novelty of my invention may be better understood and appreciated, it is advisable to refer briefly to the leading types of alternating-current motors hitherto constructed or proposed. These comprise, first, rotatory field-motors, or those in which two or more energizing circuits are employed to furnish alternating currents of relatively differing phase, whereby a continuous progression of the poles or points of maximum magnetization is produced, or a rotary magnetic field is created in one member or element which begets rotation of one member or element relatively to the other; second, magnetic lag-motors, or those which contain poles or parts having different magnetic susceptibility, and in which the magnetic periods produced by the same current or by different currents of like phase differ in the different poles or parts; third, angular displacement-motors, or those in which an energizing-coil common to the field and to the armature is placed at an angle of less than ninety degrees to the laminated field-magnet, and as a consequence produces polar axes in the two parts at an angle one to the other; or, in other words, produces like poles in the respective parts in closer proximity to each other than the unlike poles thereof, and thus sets up movement by repulsion. Under these several heads there are various modifications and details for effecting rotation or progression of the magnetic field; for starting the motors and bringing them into synchronism with the generators which supply them with current; for producing the magnetic lag, and the like.

My invention differs from these and from all others known to me, in that independent and distinct fixed energizing-coils are employed for polarizing both the field and the armature, and that both sets of coils receive current simultaneously and independently from the same generator, or from generators of like phase. Under my plan the armature rotates within its own field-energizing coils, so that while the points of maximum magnetic effect remain fixed in space the armature travels through the magnetic field. By this construction and arrangement I produce in the armature at points between two field-magnet poles or cores a pole of like sign with the proximate end of one of the field-magnet cores and of opposite sign to the other. Hence I secure the combined effects of repulsion and attraction upon the portion of the armature between said cores or poles.

Since the same current excites both field and armature, reversals of polarity will occur at the same instant in both, and therefore the same relation and effect will continue as long as the current passes. The direction of rotation will depend upon the direction of winding of the armature-exciting coils or the direction in which the current passes through them at any given instant relatively to that of the field-coils. This may at any time be changed by a suitable switch, and the rotation of the armature may consequently be reversed at will. The plan thus outlined obviates all use of commutators, brushes, sliding contacts, or special starting devices, and is independent of any considerations of synchronism between generator and motor.

I will now proceed to describe in detail two forms of motor which I have constructed and operated with highly satisfactory results; but I desire it to be understood that these are purely illustrative. In many respects the design, form, and proportion of parts may be varied, these depending upon many conditions well understood by electricians, such as

character of current, capacity of motor, mass of material, &c.

Referring first to Fig. 1, A indicates a suitable framework, which may best be made of cast-iron, and is furnished with a series of magnet-cores B. The cores may be cast as parts of the frame, or they may be separately formed and subsequently bolted or clamped in position, as shown. In practice it is found advisable to laminate these cores, and in such case they require to be separately produced, although their ends may be inserted into the mold and the iron of frame A cast upon them. The drawings represent the outer ends of the cores passing through the ends of the frame A and bolted fast to lugs thereon.

The cores are provided with bobbins or coils C so wound and connected that with a current or impulse of given sign the two cores at the left hand shall be of one polarity and the two at the right hand shall be of the opposite polarity at their inner ends.

D indicates a rotatable armature, which consists of a central hub or disk *a*, of wood or other non-magnetic material, and an annular band or hoop *b*, of soft iron, laminated or solid, as found expedient in any given case.

Generally speaking, it is deemed best, though by no means necessary, to laminate both the field-cores and the armature, or to make both solid; and it is also considered advantageous, yet not essential, that the cross area of the iron in the field-cores and in the armature be equal or approximately so.

The armature-hub *a* is carried by a shaft E, which is mounted in suitable bearings in standards F, as usual.

G indicates an open coil or bobbin divided into two sections, one surrounding or encompassing the armature at a point above the shaft E and the other inclosing that portion below the shaft. The coil-sections are carried by suitable brackets or arms *c* projecting from frame A, as shown.

To secure the best results, it is found expedient to have the outer faces of the coil or bobbin G fall within the inner circumference of the iron hoop or band *b* of the armature, so that at any one of the points of maximum polarization the hoop shall be of one polarity on both its inner and its outer face, or throughout its entire thickness.

While the coil or bobbin G is represented as divided into two parts, this is merely a matter of convenience to facilitate application and removal of the coil and of the armature; but the winding is continuous, and consequently the portion at the bottom of the armature will be of opposite polarity to that at the top of the armature whenever a current impulse traverses the coil.

The coil G receives current from the same generator as do the field-cores, and hence the armature is energized at precisely the same instant as is the field. Care should be taken to so proportion the metal of the field-cores and armature and the winding of their exciting-coils as to insure magnetization and demagnetization of each at the same instant as the other, and it is with this purpose that I preferably make the cores and the armature-hoop of like cross area and material.

Whatever be the direction of winding of the coil G relatively to the winding of the field-magnets, it follows necessarily from the winding of those field-cores on the same side of coil G that the polarity of the armature between said cores must be the same as the proximate end of one of said cores and opposed to that of the proximate end of the other. From this it also follows that one core will attract and the other will repel that portion of the armature lying between them. So, too, if the first current impulse cease and a reverse impulse succeed it in the field-coils the same action takes place in the armature-coil at the same instant and the effective relation remains unchanged. Hence the attraction and repulsion continue in the same directions as before, and the armature continues to rotate in one direction. Thus, assuming that the field-cores at the left receive a current impulse, which produces a north polarity in their inner or free ends, and those at the right receiving the same current acquire a south polarity, while the portion of the armature between the upper pair of cores is given a north polarity and that between the lower pair of cores is given a south polarity, in this case the upper core at the left being of like sign with the portion of the armature lying between it and the upper core at the right will repel said armature, while the upper right-hand core being of opposite polarity will attract it. At the lower side the left-hand core will attract and the right-hand one repel the portion of the armature lying between them. If, now, all the coils simultaneously receive a current impulse of opposite sign to that which previously passed, precisely the same action results, because the relation remains unaffected. If, however, the current be led to coil G or through the field-magnet coils, either alone in a reverse direction relatively to the other, the direction of rotation will be reversed, because those parts which previously had like sign now have opposite sign, and those which before were alike are now unlike. To effect such reversal I employ any convenient form of switch, preferring, however, to reverse the armature-current rather than that of the field. A convenient form of switch for this purpose is illustrated in Fig. 3. This comprises a suitable block or support H provided with a pair of contact blocks or studs *d* and *e*, electrically coupled, a second pair of contact studs or blocks *f* *g*, likewise electrically coupled, a flat conducting-strip *h* projecting slightly above the face of the block, a pair of swinging contact-bars *i* and *j*, and suitable binding-posts. The main wires I and J from the generator extend to and electrically connect with the pivots of bars *i* and *j*, and from

the former a branch extends to a binding-post *k*. When the contact-bar *j* is upon either stud *e* or *g*, it bears also upon the conducting-strip *h*, but when thrown farther to the left it passes entirely off said strip and consequently breaks connection with conductor *l*. Wire *l* is electrically connected with strip *h* and passes thence in two branches to the bobbins or coils of the field-cores at the left. Current entering by main or supply wire J will thus pass by bar *j*, strip *h*, and conductor *l* to the field-cores at the left, thence by conductors *m* to the corresponding cores at the right, thence by a conductor *n* to binding-post *k*, and thus back to main or supply wire I, with which said post is electrically connected, as above mentioned. With bar *j* resting upon stud *g* current also passes from main or supply wire J, bar *j*, contact *g*, and conductor *o* (which is electrically connected with posts *f* and *g*) to the armature-exciting coil or bobbin G, and thence by conductor *p*, stud *d*, and bar *i* to main or supply wire I. In this way the field-coils and armature-energizing coils are simultaneously supplied with current of like sign, and every change of sign must take place in both at the same instant. If now it be desired to reverse the motor, the connected bars *i* and *j* are thrown over, so that bar *i* bears upon stud or contact *f*, and *j* bears upon stud or contact *e*, which, as will be seen without further explanation, will cause the current to pass through the coil or bobbin G in a reverse direction from that occurring under the previous adjustment of bars *i j*, while its course through the field-coils remains the same.

In Fig. 2 I have represented another style of motor embodying my invention, this differing from that shown in Fig. 1 only in that the coil G for energizing the armature is divided into three sections, and the field magnets are three in number, each having two poles brought opposite the armature. This modification is but one of many that may be made, it being obvious that the extent to which the bobbins and consequent poles shall be increased is optional or dependent upon the conditions of each special case. Under this construction the magnet-poles exert a double effect—that is to say, the portions of the armature lying upon opposite sides of each pole are oppositely magnetized, and consequently each pole exercises repulsion upon that portion of the armature on one side of it and attraction on that portion on the opposite side. In this, as in the preceding form, the magnets may be straight-bar magnets or of horseshoe form, as preferred, the coils G being arranged accordingly.

Figs. 3 and 4 show diagrammatically the circuits under the construction shown in Figs. 1 and 2.

Figs. 5, 6, 7, 8, and 9 illustrate a few of many modifications that may be made in the construction of the armature.

In Fig. 5 the iron of the armature is in the form of a simple ring without lamination and without winding.

In Fig. 6 the iron is in the form of thin annular bands, the lamination being perpendicular to the axis of the armature.

In Fig. 7 the lamination is represented as concentric or parallel with the axis.

Fig. 8 represents the armature as furnished with a series of closed coils of insulated copper wire.

Fig. 9 shows a closed coil continuing all the way around the armature.

Obviously, the winding may be varied at will and as special working conditions require. These matters are well understood by electricians generally and need not be further specified.

Iron wire may obviously be used to form the magnetizable hoop or band of the armature.

It is manifest that the armature may be fixed, and the field the rotatable member; but as this involves rubbing contact at the points of introduction and escape of the field-current it is not deemed desirable. So, too, it is possible to have both the field and the armature rotate, the two parts running in opposite directions; but as this would involve the necessity of so connecting the two members through gearing or the like as to insure at all times the proper relation of the poles produced by the current, and as the slightest variation would impair or destroy this relation, such a construction is not deemed desirable. Nevertheless it is within the spirit and scope of my invention. Again, it is obvious that the direction of travel of the current may be reversed either in the field-coils or in the armature-coils, as found expedient, and that in either case the direction of rotation will be reversed. Finally, instead of employing only an annular iron band in the armature a solid iron disk may be employed; but I have found the hoop preferable in practice.

While I have represented but one armature disk or ring on the shaft, it is manifest that two or more may be used, suitable magnet-poles and energizing-coils being in such case provided.

It will be carefully noted that the field-coils and the armature-coils receive current independently. In other words, the circuit of the field-coils is distinct from that of the armature-coils, or they are in shunt relation, and as a consequence the current direction through either circuit may be changed at will to reverse the motor, which could not be readily done if the field and armature coils were in series. Again, it is particularly important that the points of maximum polarization of field and armature be brought into as close approximation as possible in order that the maximum effects of attraction and repulsion may be secured. This is attained by bringing field-cores of opposite sign at their effective ends as near together as possible without neutralization of one by the other.

I am aware that it has been proposed to construct an alternating-current meter with stationary field and armature coils, either in continuous series or in parallel series, a portion of the field-coils and a portion of the armature-coils being arranged in each of the parallel series. This I do not claim.

I am also aware that it has been proposed to employ such apparatus as a motor, as set forth in British Letters Patent No. 1,383 of 1888, to Borel and Paccaud.

My invention differs from the foregoing in that the field and the armature coils are not in series in any sense, but in independent branches of the supply-circuit. It further differs therefrom in that the direction of travel in one branch is made reversible by suitable switch, so that the direction of rotation may be changed, and, finally, in that the polar points of field and armature are brought into close proximity, thereby insuring the greatest obtainable effects of attraction and repulsion.

Having thus described my invention, what I claim is—

1. In an electro-motor, the combination with suitable field magnets, of a rotatable armature having a circumferential iron hoop and a non-magnetic central portion, and an energizing coil encompassing the armature, and having its outer folds within the inner circumference of said hoop, substantially as set forth, whereby that portion of the hoop outside the coil will be of one polarity through its entire thickness.

2. In combination with an electro-motor, a switch comprising connected contacts *d*, *e* and *f*, *g*; conducting bar *h*, contact bars *i*, *j*, and binding post *k*, all constructed and arranged to operate substantially as set forth.

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

JOSEPH A. G. TRUDEAU.

Witnesses:

WALTER S. DODGE,

HORACE A. DODGE.