(No Model.) 2 Sheets—Sheet 1.

W. MATHER & J. & E. HOPKINSON.

DYNAMO ELECTRIC MACHINE.

No. 390,180. Patented Sept. 25, 1888.

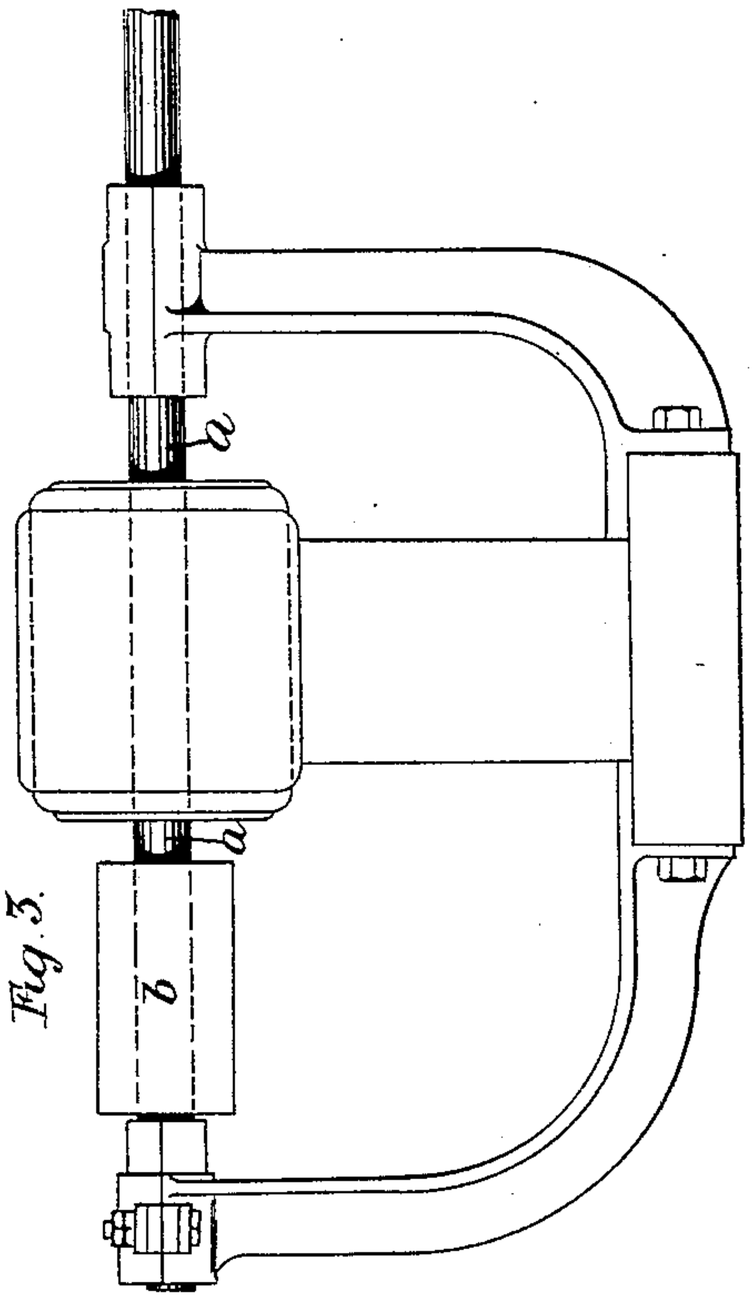

Fig. 3.

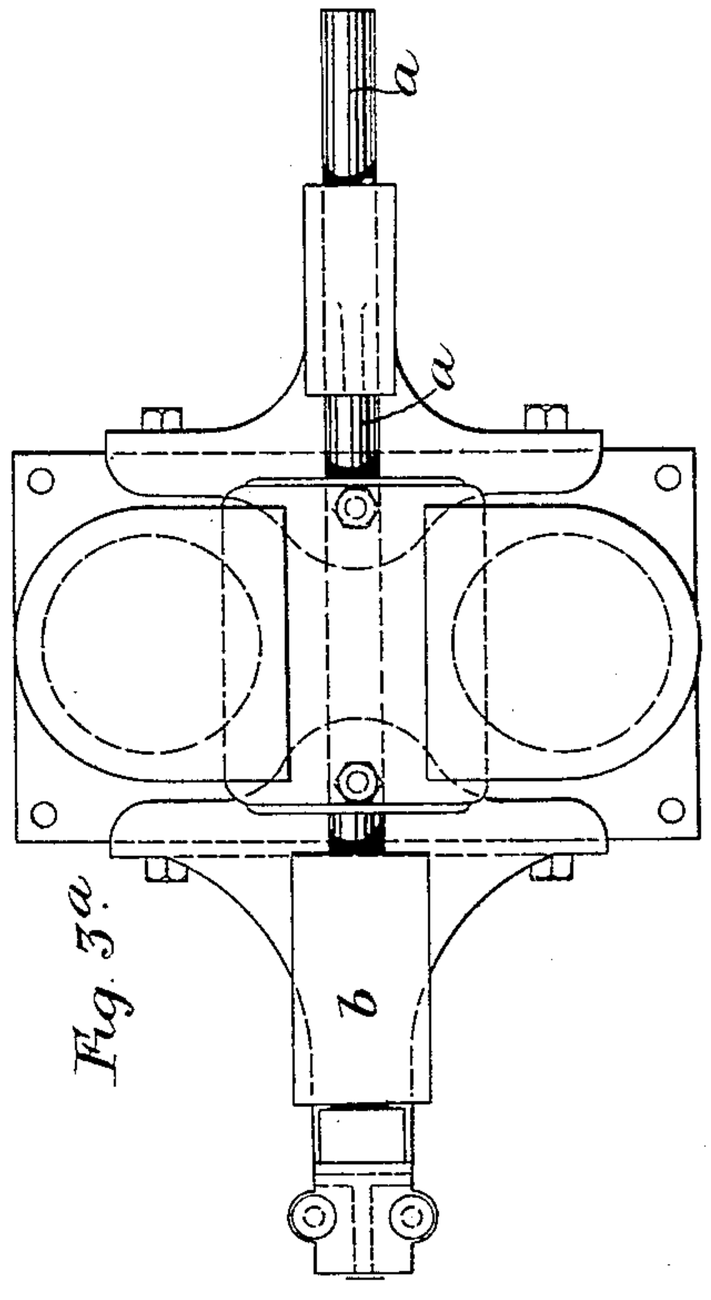

Fig. 3a.

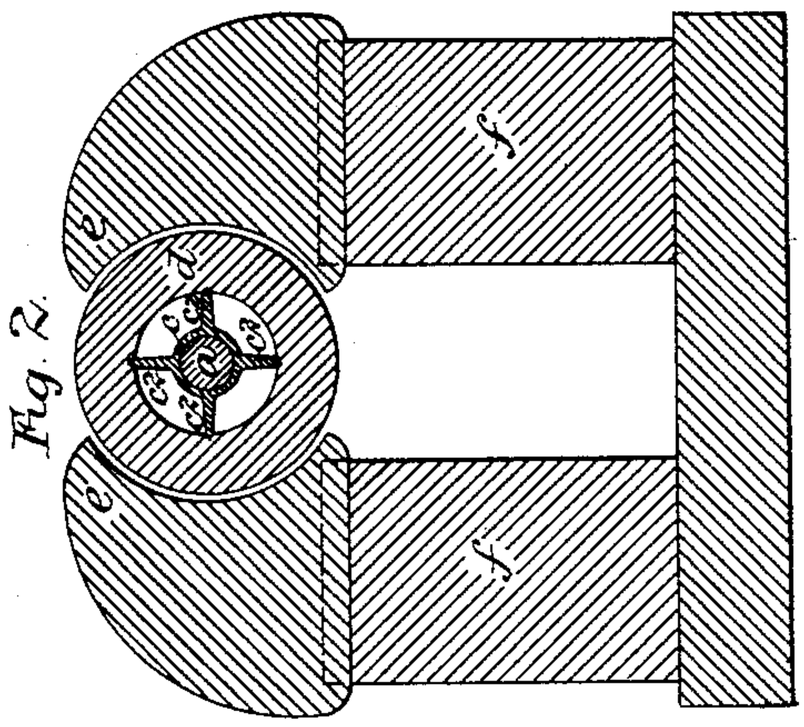

Fig. 2.

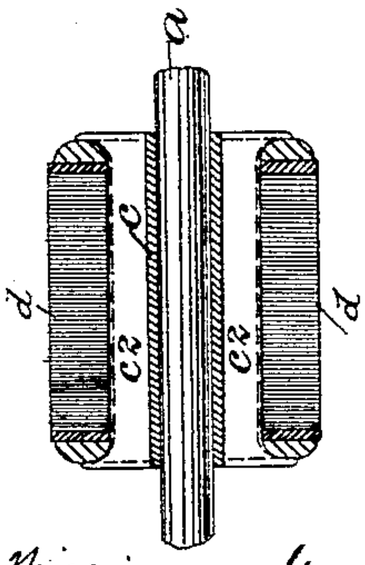

Fig. 1.

Witnesses
C. W. Beckham
F. C. Tasker.

William Mather
John Hopkinson and
Edward Hopkinson
by A. Pollock
their attorney

(No Model.) 2 Sheets—Sheet 2.

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DYNAMO ELECTRIC MACHINE.

No. 390,180. Patented Sept. 25, 1888.

Fig. 1.

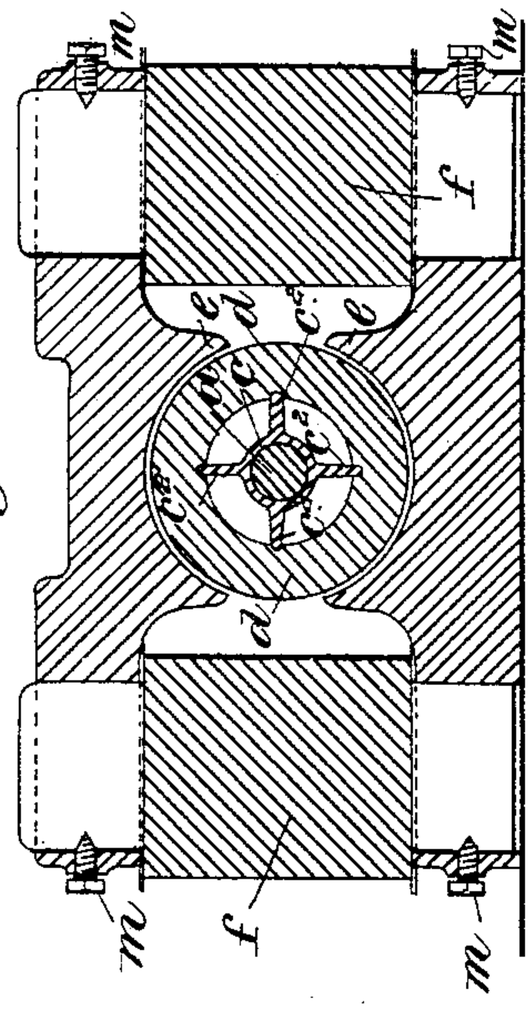


Fig. 7.

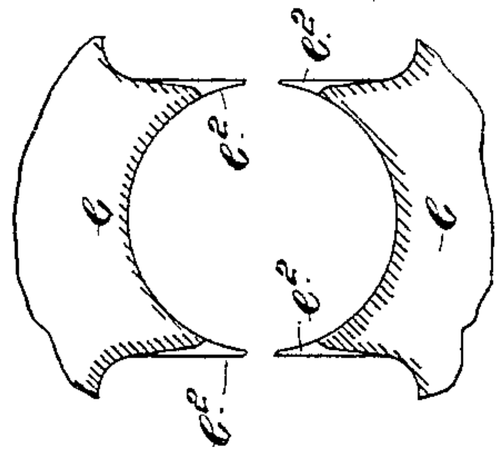


Fig. 5.

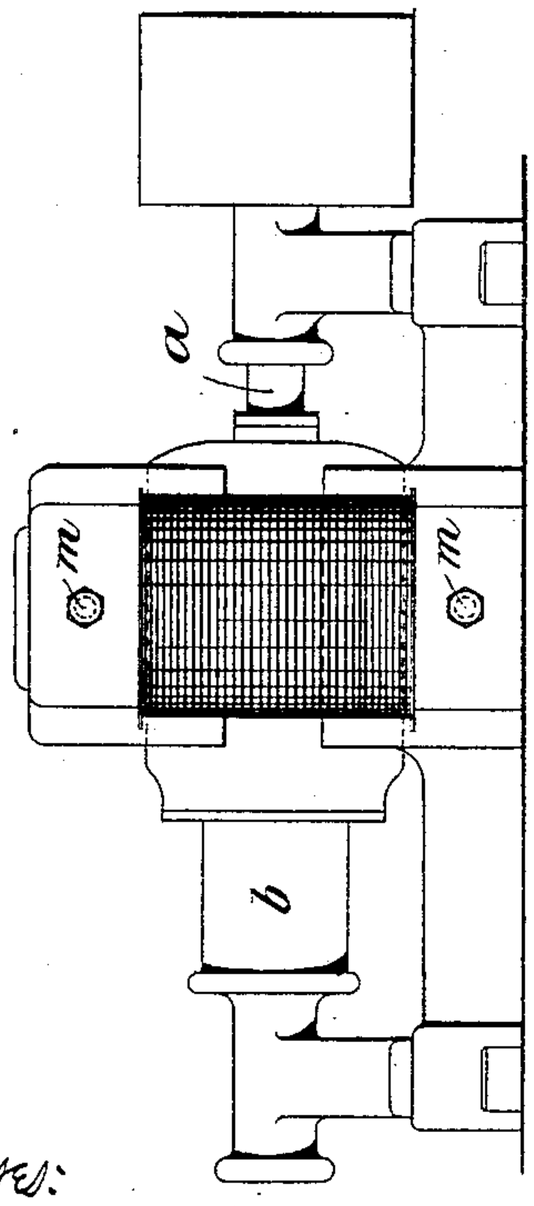
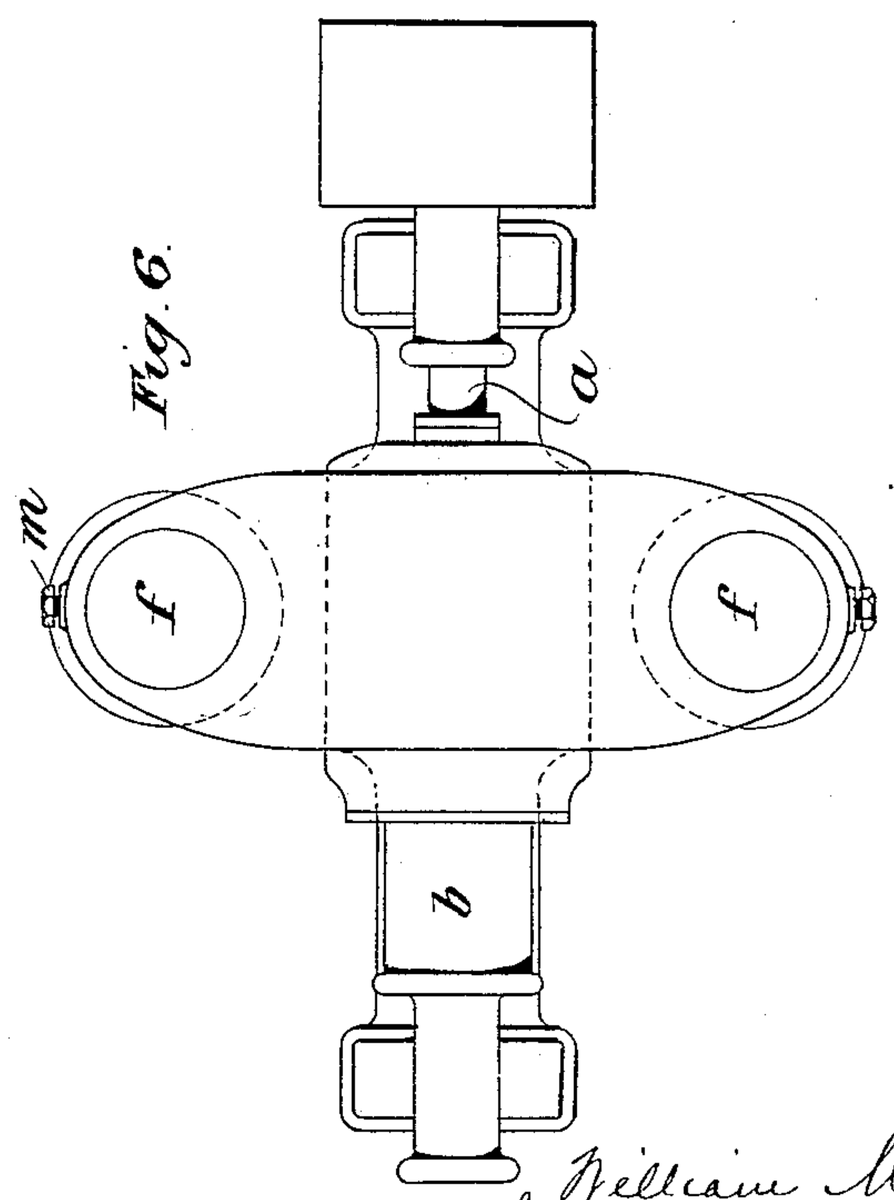


Fig. 6.



Witnesses:
C. W. Beckham.
P. C. Tasker.

William Mather
John Hopkinson 2d
Edward Hopkinson
by A. Pollok
their attorney

UNITED STATES PATENT OFFICE.

WILLIAM MATHER AND EDWARD HOPKINSON, OF MANCHESTER, COUNTY OF LANCASTER, AND JOHN HOPKINSON, OF WESTMINSTER, ENGLAND.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 390,180, dated September 25, 1888.

Application filed September 19, 1887. Serial No. 250,110. (No model.) Patented in England November 27, 1884, No. 15,648.

To all whom it may concern:

Be it known that we, WILLIAM MATHER, engineer, JOHN HOPKINSON, F. R. S., and EDWARD HOPKINSON, engineer, subjects of the Queen of Great Britain and Ireland, and residing, respectively, WILLIAM MATHER at The Salford Iron Works, Manchester, in the county of Lancaster, England, JOHN HOPKINSON at 4 Westminster Chambers, in the city of Westminster, England, and EDWARD HOPKINSON at The Salford Iron Works aforesaid, have jointly invented certain new and useful Improvements in Dynamo-Electric Machines, (for which we have obtained a patent in Great Britain, No. 15,648, dated November 27, 1884,) of which the following is a specification.

Our invention relates to improvements in dynamo-electric machines, and more particularly to that class of such machines wherein the armature is of the type commonly known as a "gramme ring," or of the earlier form known as the "Pacinotti ring." We greatly augment the intensity of the magnetic field and thereby the output of the machine by increasing the section of iron in the magnets and pole-pieces beyond the section that has hitherto been used in machines of this class. To the same end we construct the armature so that the section of iron is not much less than the section in the magnets, thereby insuring that the magnetic induction is not restricted by reason of the iron becoming too rapidly saturated. We are thus able to obtain at low cost a field of not much inferior intensity to that obtained in the improved form of Edison machine, for which British Letters Patent No. 973, dated February 22, 1883, were granted to one of us, namely, John Hopkinson. In order to reduce the weight of the pole-pieces, we may construct them so that their bounding-lines are approximately coincident with the lines of magnetic induction, and by special polar extensions (explained hereinafter in reference to the drawings) we produce a weak field near the neutral point capable of controlling any tendency to sparking at the commutator.

In that form of our machine wherein the magnetic circuit is formed partly of cast-iron and partly of wrought-iron we so apportion the section of the two metals and their surface of contact that the resistance to magnetization may be not greater in one part of the circuit than in another. The interior of the ring is entirely open, allowing free admission of air onto the surface of the conducting-wire, and in connection therewith we may with special advantage make use of the improved means for the ventilation of dynamo-electric machines for which British Letters Patent No. 768, dated January 5, 1884, were granted to two of us—namely, William Mather and John Hopkinson.

Our improvements are equally applicable, whether the dynamo-electric machine be used for the generation of the electric current or for the conversion of electrical into mechanical power.

In order that our invention may be better understood, we refer to the accompanying drawings, wherein—

Figure 1 shows the armature in longitudinal section, while Fig. 2 shows a cross-section, together with one arrangement of magnets having a single magnetic circuit. Figs. 3 and 3ª show an elevation and a plan of the same machine. Figs. 4, 5, and 6 show the several views of a dynamo constructed with a double magnetic circuit, Fig. 4 being a cross-section, Fig. 5 a side elevation, and Fig. 6 a plan. Fig. 7 shows the extension of the pole-pieces, whereby the field at the neutral point is controlled.

It will be understood that all the figures are to a certain extent diagrammatic, as details of construction which are not necessary to the explanation of this invention are omitted.

In all the figures, *a a* represent the shaft; *b*, the commutator; *c*, a boss with arms c^2 to carry the core *d*, which consists of soft-iron plates or wire continuous in the direction of the lines of force but divided into sections in the direction of the length of the armature by paper or other insulator. The curved form of the pole-pieces, to avoid useless weight, is shown in Fig. 2, the boundary-line being approximately coincident with the line of magnetic induction. The pole-pieces *e e* may be of cast-iron, and the magnet-limbs *f f* of wrought-iron. We let the latter into the pole-pieces, as shown in the section, to secure

that at no part of the cast-iron shall the sectional area be less than at least half as much again as the sectional area of the wrought-iron cores.

In the double magnetic-circuit form of machine shown in Figs. 4, 5, and 6 we, for convenience, extend the under yoke or pole-pieces to form the base of the machine, to which the pedestals carrying the bearings of the armature-shaft are bolted. To restrict the leakage of magnetic field, we make the pedestals of non-magnetic material or separate them from the base by a plate of non-magnetic material.

The extension of the pole-piece shown at e^2 in Fig. 7 is of small sectional area compared with the other parts of the pole-piece. The said extensions e^2 are integral parts of the pole-pieces. The area of the extensions may be further reduced by making the polar extension extend only through a portion of the depth of the pole-piece—that is to say, the extension e^2 does not extend entirely across the pole the full length of the armature, but embraces a portion only of the length of the armature. By this construction we produce a weak field near the neutral point, and thus control any tendency to sparking at the commutator.

Heretofore the pole-pieces of field-magnets have been made to embrace more or less of the periphery of the armature, and have in some instances been tapering in form toward the neutral point. The polar extensions of the present invention differ from such previous devices both in purpose and construction. The pole does not taper gradually and uniformly toward the neutral point—that is, the polar extensions do not merge imperceptibly into the poles proper, but are throughout of small sectional area compared therewith. This construction is essential to effect the purpose above stated.

In order to avoid the cost of making the turned core of the magnet and the bore of the hole in the yoke a precise fit, we may sometimes make use of a tightening set-screw, *m m*, by means of which we bring the opposed surfaces of core and yoke through which the lines of magnetic force pass into contact, leaving the shaft a loose fit in other parts.

Having now described and particularly ascertained the nature of our invention and the manner in which the same is or may be used or carried into effect, we declare that what we claim is—

1. In a dynamo-electric machine, the combination, with the armature, of the field-magnets, comprising solid wrought-iron cores, and cast-iron poles of much greater sectional area than said cores, the latter being let into the former and being at their ends entirely surrounded by the metal forming the poles, substantially as described.

2. The combination, with the armature, of the pole-pieces having curved bounding-lines approximately coincident with the lines of magnetic induction and provided with special polar extensions of small sectional area compared with the poles proper, substantially as and for the purpose set forth.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

WILLIAM MATHER.
JOHN HOPKINSON.
EDWARD HOPKINSON.

Witnesses to the signature of William Mather:

E. BUTLER ROWLEY,
Solicitor, Manchester.

GEO. W. BROWN,
Clerk with E. Butler Rowley, 2 Booth Street, Manchester.

Witnesses to the signature of John Hopkinson:

E. BUTLER ROWLEY,
Solicitor, Manchester.

W. WARDLE,
His Clerk.

Witnesses to the signature of Edward Hopkinson:

SYDENHAM PAYNE,
Solicitor, Dover.

JOHN WATTS,
37 *High Street, Dover.*