No. 815,365. PATENTED MAR. 20, 1906.

E. H. MILLER.

ELECTROMAGNET.

APPLICATION FILED NOV. 26, 1904.

2 SHEETS—SHEET 1.

Fig. 1.

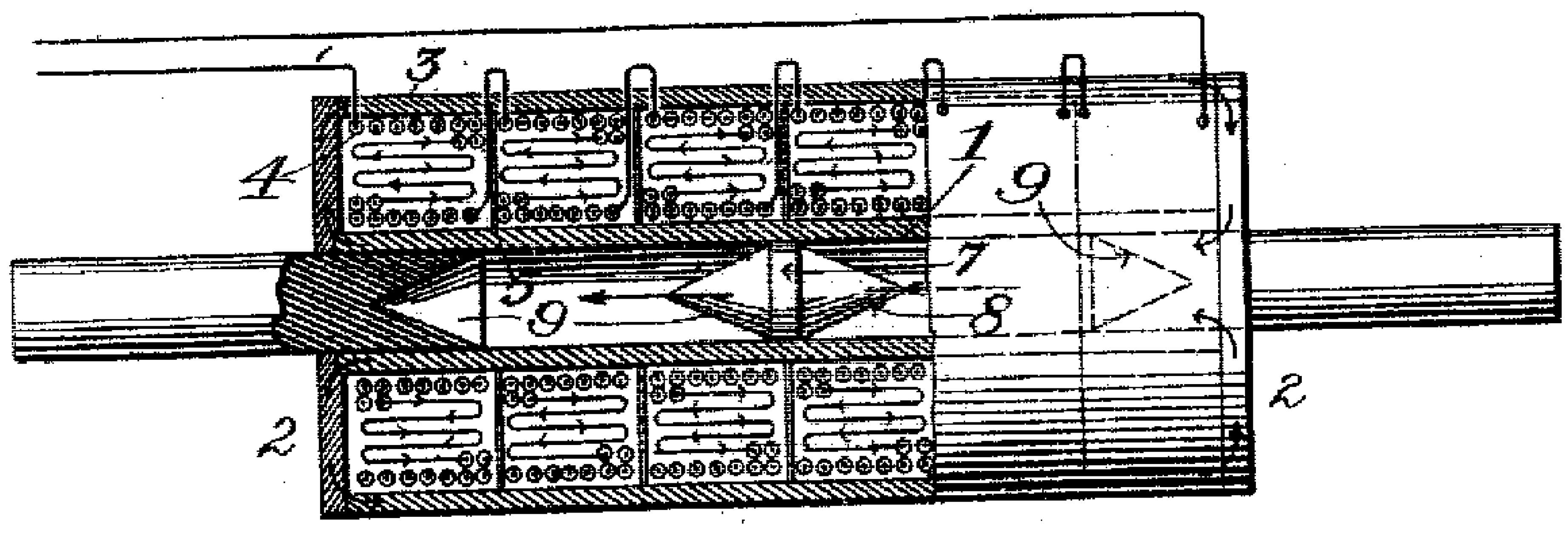
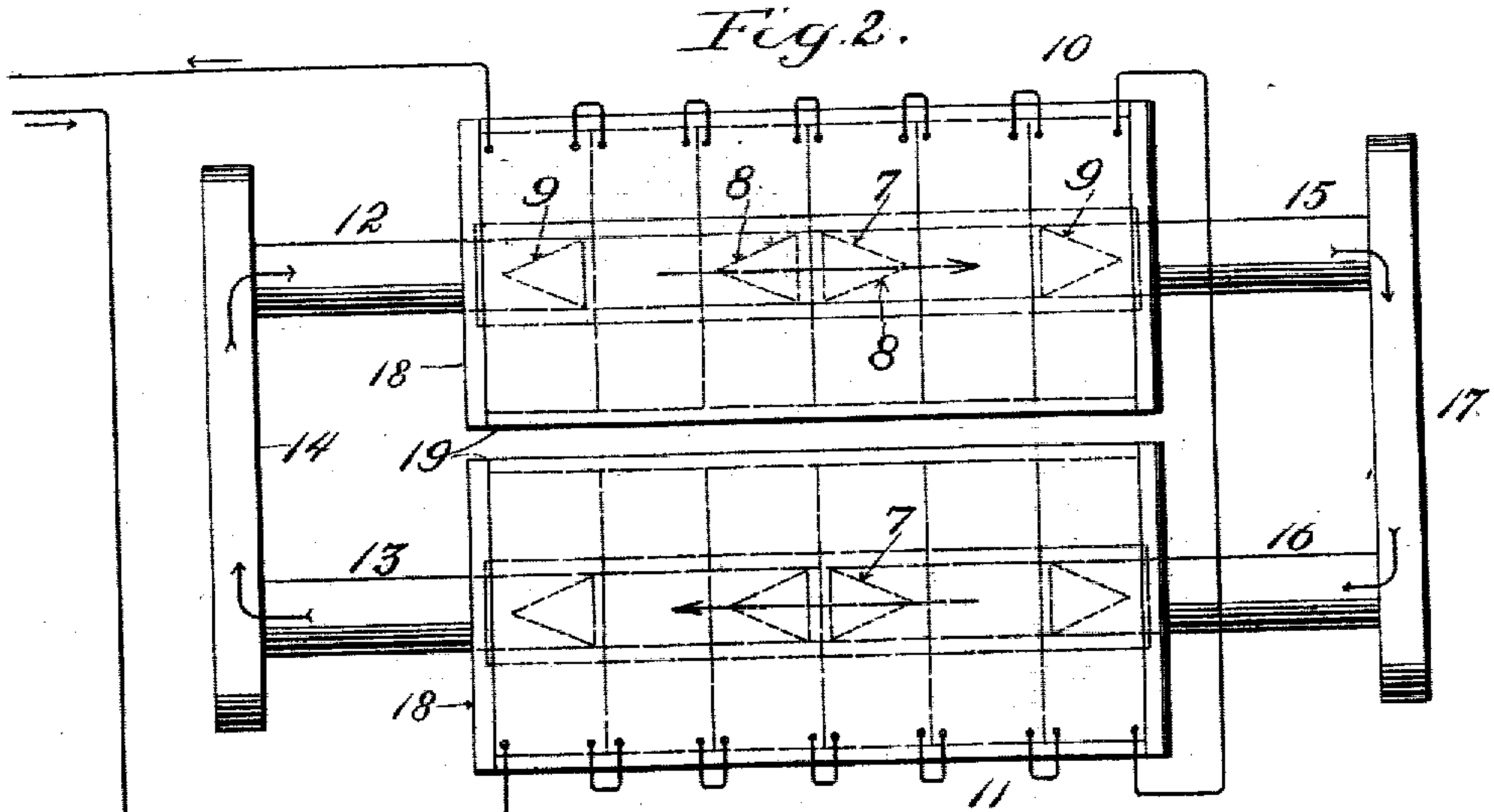


Fig. 2.



Witnesses;

Paul A Blair

Inventor

Ernest H. Miller

by Julian C. Dowell

Attys

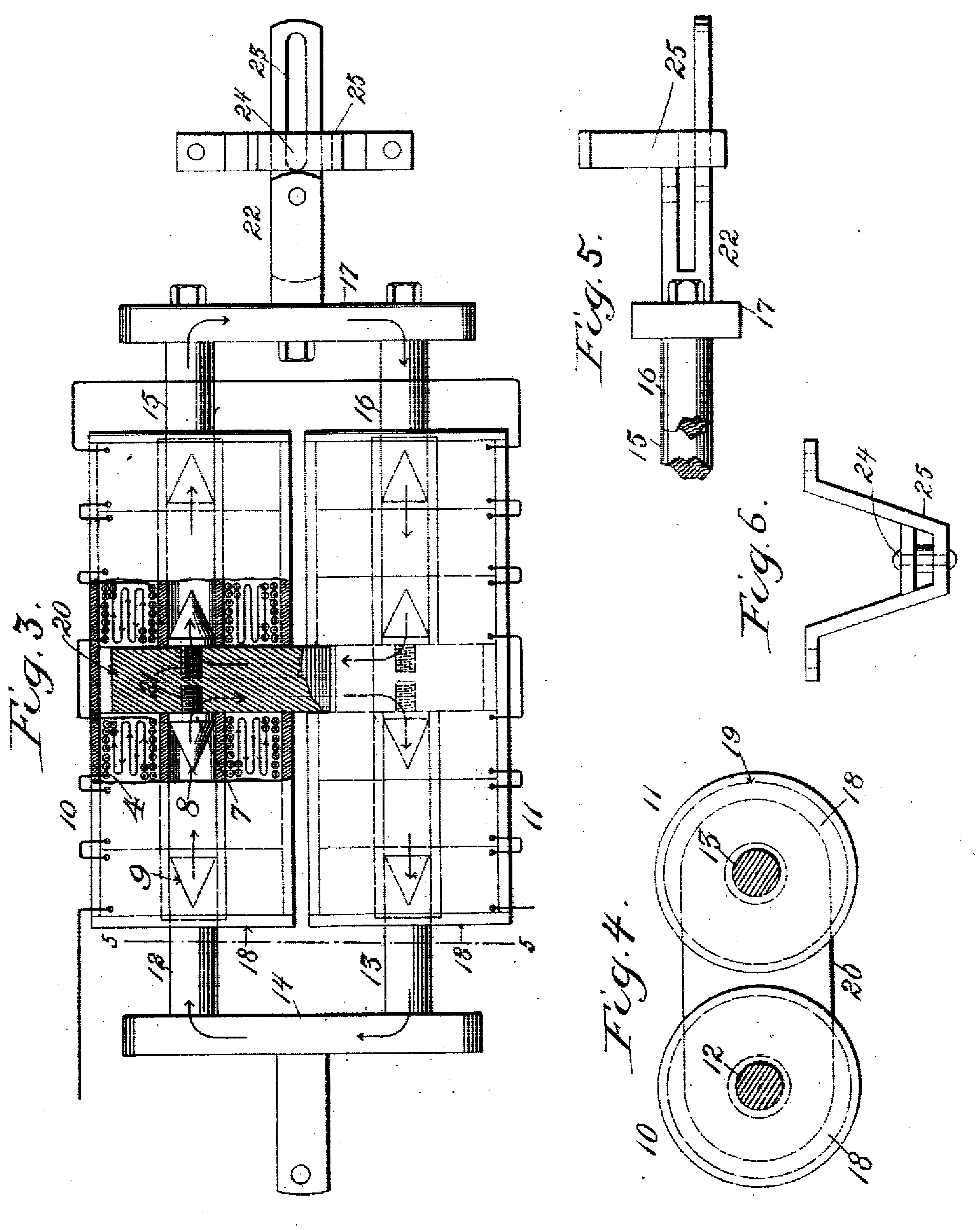
No. 815,365. PATENTED MAR. 20, 1906.

E. H. MILLER.

ELECTROMAGNET.

APPLICATION FILED NOV. 26, 1904.

2 SHEETS—SHEET 2.



Witnesses;
Alle Brndine
Paul A. Blair

Inventor;
Ernest H. Miller
by Julian C. Dowell & Son
Attys.

UNITED STATES PATENT OFFICE.

ERNEST H. MILLER, OF LANCASTER, PENNSYLVANIA, ASSIGNOR OF ONE-THIRD TO JOHN W. HOLMAN AND ONE-THIRD TO CHARLES V. ROTE, OF LANCASTER, PENNSYLVANIA.

ELECTROMAGNET.

No. 815,365. Specification of Letters Patent. Patented March 20, 1906.

Application filed November 26, 1904. Serial No. 234,423.

To all whom it may concern:

Be it known that I, ERNEST H. MILLER, a citizen of the United States, residing at Lancaster, in the county of Lancaster and State of Pennsylvania, have invented certain new and useful Improvements in Electromagnets; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to electromotive power devices, and especially to solenoids that are used to produce a rectilinear movement of a core for the purpose of imparting a similar movement to some connected piece of apparatus—such, for instance, as a railway-brake.

The object of the invention is to produce a solenoid having a concentrated field of force with small magnetic reluctance, so that the power developed will be large for a given size of solenoid. This result is accomplished by the construction and arrangement hereinafter set forth, and particularly pointed out in the claims.

In the accompanying drawings, Figure 1 is a side elevation of a solenoid, partly in section, embodying my improvements. Fig. 2 is a plan view of a double solenoid. Fig. 3 is a similar view of a modification of the same, partly in section. Fig. 4 is a cross-section on the line 5 5, Fig. 3. Fig. 5 is a side elevation of one end of Fig. 3, and Fig. 6 is an end elevation of the same.

Referring first to Fig. 1, the spool 1 is made of some non-magnetic material, such as brass or copper. Its ends 2 are preferably of iron, as is also the incasing shell 3. The winding is divided into a plurality of sections, six being shown. The insulated wire 4 is wound in each section back and forth in concentric layers like the thread on a spool of thread, and the outer terminal of one section is connected with the inner terminal of the next section, so that all the sections are in series. The several sections may be separated by thin partitions 5, of fiber or the like. This mode of construction enables me to strengthen or weaken any given solenoid by merely adding or taking away one or more sections, as the case may be. The cores 6 are simple cylinders of soft iron, adapted to slide freely within the spool 1. It will be seen that the magnetic circuit is through the ends 2 and shell 3, the portions of the cores within the spool 1, and the air-gap between the inner ends of the cores. In order to reduce the magnetic reluctance of this latter portion of the circuit, I may introduce an iron plug 7 midway of the spool, said plug serving, as it were, as a stepping-stone for the magnetic flux. The plug is preferably solid, as shown; but it may be tubular, if desired. The air-gap between it and the cores may be still further reduced by providing these parts with coöperating tapered projections 8 and recesses 9, the projections being preferably on the plug and the recesses in the cores, as shown.

When large sizes of these solenoids are desired, it is found that the iron shell must be made very thick in order to provide a good magnetic circuit. In order to avoid the expense of so heavy a structure, I prefer to employ two smaller solenoids arranged side by side and acting on cores that are yoked together. Such a structure is shown in Figs. 2 and 3. The windings of the two solenoids 10 11 are connected in series like the coils on a horseshoe-electromagnet, so that the north pole of solenoid 10 is adjacent to the south pole of solenoid 11, and vice versa. The cores 12 13 at one end are rigidly connected by an iron yoke 14, and similarly the cores 15 16 at the other end are rigidly connected by a yoke 17. The yokes may be fastened to the cores or cast integral therewith. The end pieces 18 of the solenoids are in this case made of non-magnetic material, such as brass, and the shells 19 may also be made of similar material. The object of this is to compel the magnetic flux to pass only through the cores 12 13 15 16, the yokes 14 17, and the air-gaps inside the spools. The yokes are made of sufficient cross-section to carry the flux easily.

If desired, these solenoids may be provided with the midway plugs 7, preferably provided with the tapering projections 8. In Fig. 3 these plugs are carried by a plug yoke or bridge 20, which is interposed between the middle sections of the coils and passes through openings cut in the shells. This bridge is of iron, and a convenient way of attaching the plugs to it is to provide them

with screw-threaded shanks 21, engaging with tapped holes in the bridge. A small portion of each plug is preferably made cylindrical to fit the end of the spool, the opposite end of which is let into the end plate of the solenoid.

By preference suitable guides are provided to keep the cores in position. For example, a bifurcated bar 22 may be fastened to the yoke, one jaw being longer than the other and provided with a longitudinal slot 23, which engages with a stud or roller 24, supported by a stationary bracket 25. In case one of the solenoids should become inoperative, as by short-circuiting, this guide will hold the cores in proper alinement and enable the operative solenoid to do effective work. It also prevents the outer ends of the cores from sagging when in their outermost position. The guide also forms a convenient means for the attachment of the lever or other agency through which the pull of the solenoids is transmitted to the desired mechanism.

It will be understood, of course, that my invention may be embodied in various forms, and various changes may be made in the details and arrangement of parts without departing from the spirit and scope of my invention, of which the several embodiments shown and described herein are desirable forms.

Having thus described my invention, what I claim is—

1. A solenoid for power purposes, comprising a tubular spool of non-magnetic material, a magnetic plug midway of said spool, a plurality of coil-sections wound on said spool and connected in series, and movable cores entering said spool, said plug and cores having coöperating projections and recesses.

2. An electromotive power device, comprising two solenoids side by side, each having a plurality of coil-sections connected in series, and adjacent ends of the windings on said solenoids being connected, movable cores entering the opposite ends of said solenoids, and yokes connecting adjacent cores.

3. An electromotive power device, comprising two solenoids side by side, each having a plurality of coil-sections connected in series, and adjacent ends of the windings on said solenoids being connected, magnetic plugs midway of said solenoids, movable cores entering the opposite ends of said solenoids, and yokes rigidly connecting adjacent cores.

4. The combination with two solenoids arranged side by side, of a bridge of magnetic material arranged midway thereof and movable cores yoked together entering the opposite ends thereof.

5. The combination with two solenoids arranged side by side and each composed of a plurality of coil-sections connected in series, of a magnetic bridge interposed between the middle sections, and movable cores yoked together entering the opposite ends of said solenoids.

6. The combination with two solenoids arranged side by side and each composed of a plurality of coil-sections connected in series, the windings on the two solenoids being also connected in series, of a magnetic bridge interposed between the middle coil-sections, and movable cores entering the ends of said solenoids and connected by rigid yokes, said bridge and cores having coöperating projections and recesses.

7. The combination with two solenoids arranged side by side and connected in series, of movable cores entering the opposite ends thereof, a yoke at each end of the solenoids to which said cores are connected, and a guide for each yoke.

8. The combination with two solenoids arranged side by side and connected in series, of movable cores entering the ends thereof, a yoke at each end to which said cores are connected, a bifurcated slotted bar fastened to each yoke, and a stud engaging with said slot.

9. The combination with two solenoids arranged side by side, of a magnetic bridge arranged intermediate the ends of each solenoid, and connected movable cores entering opposite ends of said solenoids.

10. The combination with two solenoids arranged side by side, each composed of a plurality of coil-sections connected in series, of a magnetic bridge interposed between the middle coil-sections, and connected movable cores entering opposite ends of said solenoids.

11. The combination of two solenoids arranged side by side, each comprising a tubular spool of non-magnetic material, a plurality of removable coil-sections wound thereon side by side and connected in series, and movable cores entering the opposite ends of said spools.

In testimony whereof I affix my signature in presence of two witnesses.

ERNEST H. MILLER.

Witnesses:
GEO. A. LANE,
C. G. BASSLER.