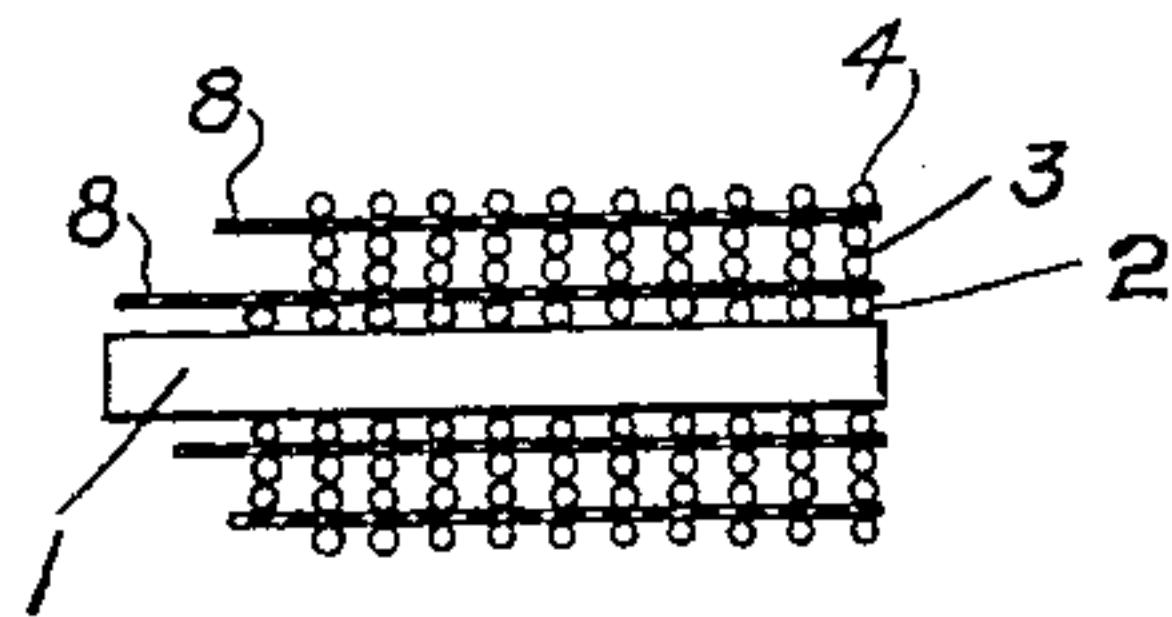


H. K. BEASLEY.  
DIFFERENTIALLY WOUND ELECTROMAGNET.  
APPLICATION FILED JULY 13, 1918.

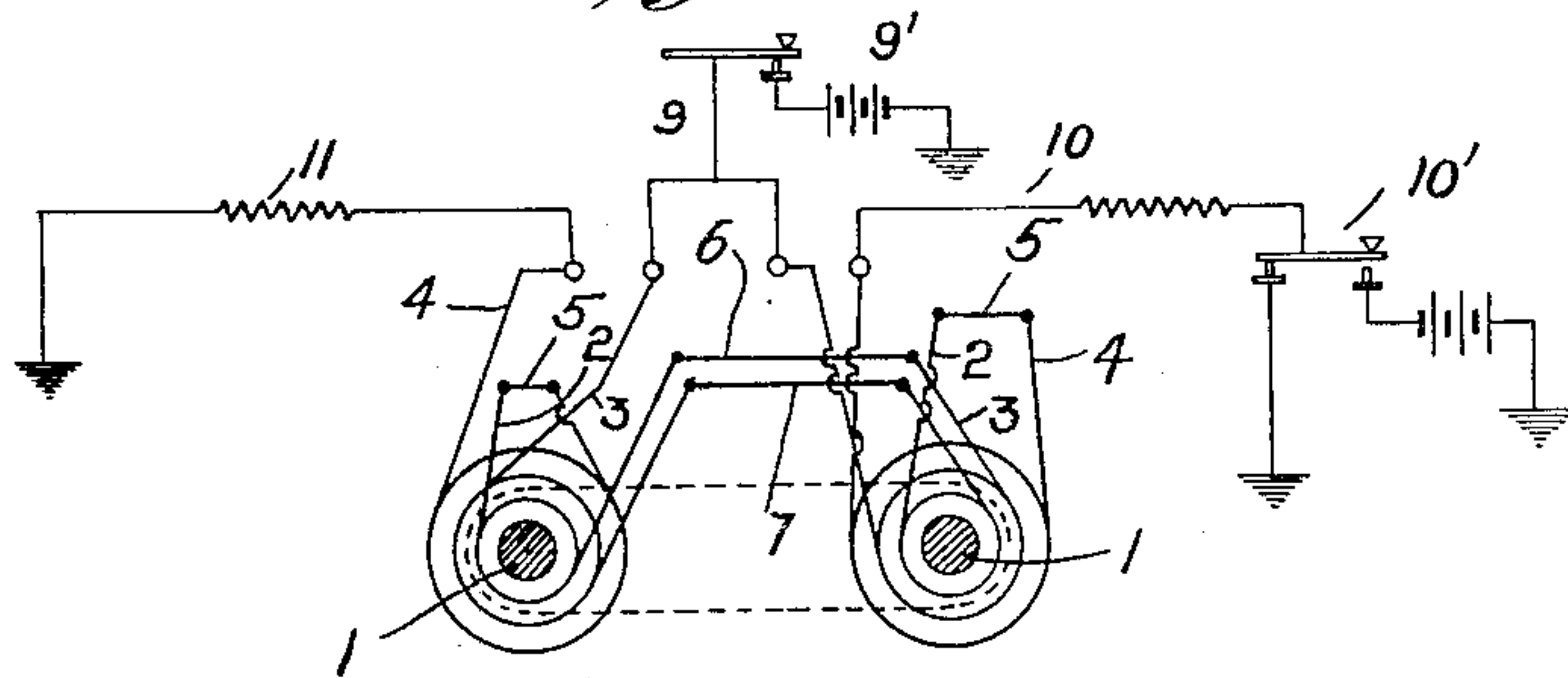
1,355,085.

Patented Oct. 5, 1920.

*Fig. 1.*



*Fig. 2.*



WITNESS  
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# UNITED STATES PATENT OFFICE.

HARRY K. BEASLEY, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN UNION TELEGRAPH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

## DIFFERENTIALLY-WOUND ELECTROMAGNET.

1,355,085.

Specification of Letters Patent.

Patented Oct. 5, 1920.

Application filed July 13, 1918. Serial No. 244,782.

*To all whom it may concern:*

Be it known that I, HARRY K. BEASLEY, a citizen of the United States of America, and a resident of borough of Queens, county of Queens, city and State of New York, have invented Differentially-Wound Electromagnets, of which the following is a specification.

My invention relates to differentially wound electromagnets, such, for example, as are employed in telegraphy, and consists in a novel arrangement of the windings of such magnets, whereby the resistances and the electromagnetic effects of such windings are equalized more perfectly than has been practicable according to former methods of winding such magnets.

The object of my invention is to obtain more perfect balancing of the opposing windings of differentially wound electromagnets than has been practicable with former methods of winding, and to accomplish this object in a simple manner.

I will now proceed to describe my invention with reference to the accompanying drawing, in which an electromagnet embodying my invention is illustrated, more or less diagrammatically.

In said drawing Figure 1 shows, diagrammatically, an axial section of the windings of one core of a differential magnet embodying my invention, and Fig. 2 shows, diagrammatically, a transverse section of a horseshoe magnet having windings such as shown in Fig. 1, the connections of the various coils of the two cores of the magnet being shown in Fig. 2.

In most telegraph instruments in which differentially wound electromagnets are employed, the magnet comprises two cores, each having two windings, and each of the windings of one core being connected to one of the windings of the other core, in such manner that when equal currents flow through the two windings of each core in proper direction, the magnetic effects of the two windings of such core are balanced against one another, and tend to produce neutralization, one with respect to the other. But the obtaining of such neutralization with windings of desired compactness, has proved to be extremely difficult. In one common method of winding such magnets, the two lengths of magnet wire to form the two opposing windings are wound side by side

upon the same core or spool, each layer containing an equal number of convolutions of each of the two wires. To this construction there is the objection that for instruments in which fairly high working voltages are used, it is necessary to employ rather thick insulation upon the magnet wires in order to avoid breakdowns of the insulation and resulting short circuits between the two windings. Any increase in the thickness of the insulation of the magnet wires, of course, reduces the number of convolutions which can be included in a given winding space; and in telegraph instruments, in particular, this is a rather serious objection.

According to another method of winding such magnets, the two lengths of magnet wire are wound in separate compartments of the spool, one-half of the length of the winding space of each core being devoted to the one wire and the remaining half to the other wire. To this method there is the objection that the two windings so applied tend to form consequent magnetic poles at the central point in the length of each core. To reduce the liability of the formation of such poles, the number of compartments on each core is sometimes greatly increased from the minimum of two, the resulting windings then consisting of many "pancake" coils; but because of the winding space lost by reason of the necessary inclusion of insulating separators between the compartments or "pancakes", this method is rather inefficient for telegraph magnets in particular.

It has therefore become quite a common practice in recent years to wind the magnets of telegraph instruments by the so-called "superimposed" method. In this method each core is first wound with a specified number of convolutions of one magnet wire, forming what is termed the "inner" winding; and over this "inner" winding is then wound the same number of turns of the other magnet wire forming the so-called "outer" winding. Between these inner and outer windings of each core, a few layers of insulating material, such as paper, are usually placed. The inner winding of each core naturally consists of a shorter length of magnet wire than the outer winding, and as a result, the inner winding is always of lower resistance than the outer winding. In connecting up the windings of the instruments, the inner winding of one core



is usually connected in series with the outer winding of the other core, so that the two combinations of windings thus obtained are of approximately equal resistance. It has  
5 been found, however, that in instruments having short electromagnet cores with windings of comparatively large diameter, such as are used in neutral relays intended for quadruplex working, the said superimposed  
10 method of winding results in an objectionable degree of nondifferentiability, due to the fact that the magnetic flux set up by the outer winding of each core is not entirely neutralized by that set up by the inner  
15 winding. The invention herein described overcomes this difficulty.

According to the present invention, the superimposed method of winding is modified to include three windings on each core,  
20 which may be designated respectively as the inner, middle, and outer windings; the inner and outer windings each have usually the same number of turns, which is one-half the number of turns in the middle winding.  
25 For example, in a particular instance, the inner winding consists of 1100 turns, the middle winding of 2200 turns, and the outer winding of 1100 turns. The inner and outer windings are connected in series to assist  
30 each other, and when connected in a differential telegraph circuit, the effect of the 2200 turns thus obtained from the connection in series of the inner and outer windings, is found to neutralize the effect of the  
35 2200 turns of the middle winding to a much greater extent than is possible with the ordinary form of superimposed winding. This is in accord with theory, because with a given current energizing either the middle  
40 winding alone or the inner and outer windings in series, the magnetic field set up will be the same, since the mean turn for either the middle winding or the combination of inner and outer windings will be of the same  
45 diameter and consequently of equal length. On the contrary, a core wound according to the old superimposed method will give a magnetic field, due to the outer winding, stronger than that set up for the inner winding,  
50 ing, for equal currents.

A further advantage of the new arrangement, involving three superimposed windings, is that the resistance of the combined inner and outer windings is always practically equal to that of the middle winding.

Referring now to the accompanying drawing: Numeral 1 designates the core or

cores, 2 the inner winding, 3 the middle winding, and 4 the outer winding. As illustrated particularly in Fig. 2, the inner 60 and outer windings of each core there shown are connected at 5 and the combined inner-outer winding of the one core is connected at 6 to the middle winding of the other core, while the middle winding of the first 65 core is connected at 7 to the combined inner-outer winding of the other core. The two sets of connected windings thus formed are then connected for differential operation, 9 being a connection to the home transmitter 70 9' (indicated diagrammatically), 10 the connection to line and thence to the distant transmitter 10', and 11 the connection to the artificial line.

Numerals 8 designate insulation between 75 the several windings.

My invention is not limited to a magnet comprising two cores with windings arranged as described, but is inclusive of a single core magnet so wound. 80

What I claim is:

1. A differentially wound electromagnet comprising inner, middle, and outer windings, the middle winding insulated from the inner and outer windings and said inner 85 and outer windings connected in series, the two sets of windings thus formed being connected for differential operation.

2. A differentially wound multi-core electromagnet comprising a plurality of cores 90 each having inner, middle, and outer windings insulated from one another, the inner and outer windings of each core connected in series one to the other and also connected in series to a winding of another core, the 95 two sets of windings thus formed being connected for differential operation.

3. A differentially wound multi-core electromagnet comprising a plurality of cores each having inner, middle and outer wind- 100 ings insulated one from another, the inner and outer windings of each core connected in series one to the other and also connected in series to the middle winding of the other core, the two sets of windings thus formed 105 being connected for differential operation.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

HARRY K. BEASLEY.

Witnesses:

PATRICK T. MACNAMARA,  
HENRY BEHRMAN.