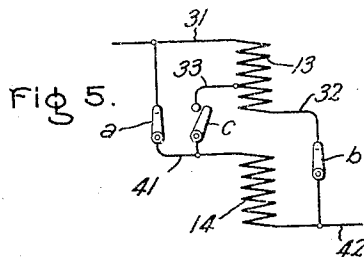
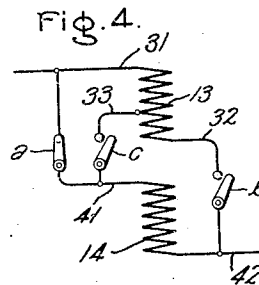
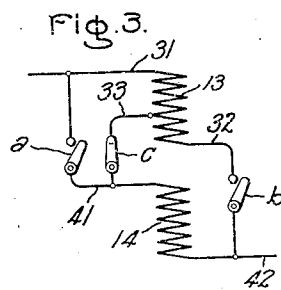
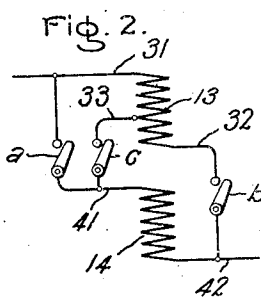
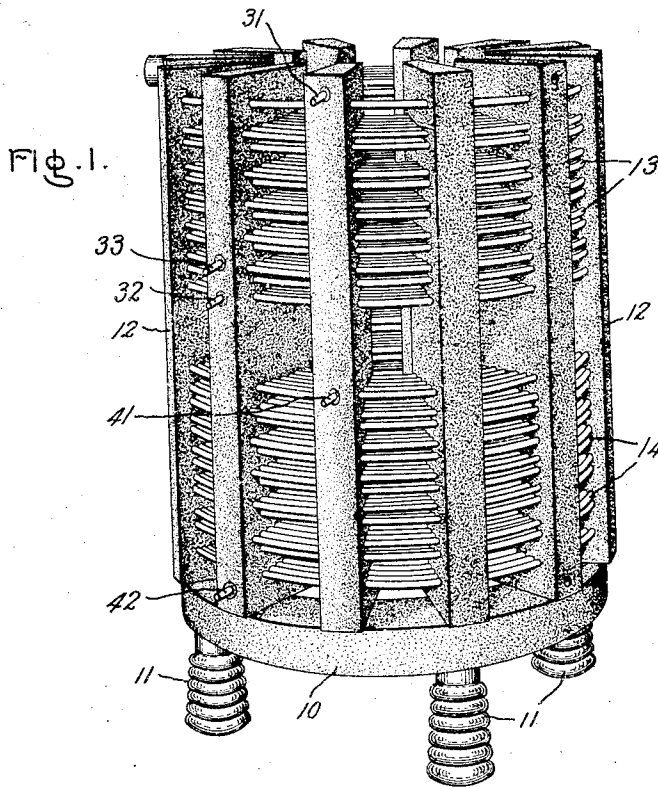


F. H. KIERSTEAD.
VARIABLE REACTANCE REACTOR.
APPLICATION FILED MAR. 27, 1920.

1,362,492.

Patented Dec. 14, 1920.



Inventor:
Friend H. Kierstead,
by *Arthur G. Davis*
His Attorney.

UNITED STATES PATENT OFFICE.

FRIEND H. KIERSTEAD, OF PITTSFIELD, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

VARIABLE-REACTANCE REACTOR.

1,362,492.

Specification of Letters Patent.

Patented Dec. 14, 1920.

Application filed March 27, 1920. Serial No. 369,328.

To all whom it may concern:

Be it known that I, FRIEND H. KIERSTEAD, a citizen of the United States, residing at Pittsfield, county of Berkshire, State of Massachusetts, have invented certain new and useful Improvements in Variable-Reactance Reactors, of which the following is a specification.

My invention relates to reactors and the like arranged to function as current limiting and controlling devices.

In controlling arc furnaces, and particularly those of the Birkland-Eyde type, it is desirable that the drop across the arc shall be kept substantially constant for all values of the current. The stabilizing reactance customarily employed in series with an arc to control the current in this type of furnace prior to my invention, was composed of a plurality of units mounted side by side and arranged to be connected singly or with two or more in multiple to admit starting and running currents of different values to the furnace. For large furnaces, three reactors were generally used for this purpose.

The object of my invention is to provide an improved reactance, which accomplishes the desired current control and at the same time effects a saving both in the materials employed and in operating losses.

In accomplishing this object, I construct, as a single unit, a reactor composed of a plurality of winding sections arranged coaxially in mutual inductive relation but spaced apart in such a manner as to give a resultant reactance when the sections are connected either in series or in multiple, which is materially greater than would be had from such sections if they were independent units. With the proper spacing, a plurality of desired values of the resultant reactance for controlling currents may be had from the series and multiple connections of these sections with the result that for a given range of current values, less copper and other materials of construction are required for the practice of my invention than when separate units, as heretofore, are employed.

For a more complete understanding of the nature and object of my invention, reference should be had to the following detailed description taken in connection with the accompanying drawing in which:

Figure 1 shows in perspective an air-core

type reactor constructed in accordance with my invention, while Figs. 2 to 5 are explanatory diagrams of the connections employed.

Referring now to the drawings, 10 denotes a base supported on insulating members 11. The base in turn supports the vertical supporting members 12, which have embedded therein the turns or convolutions of the winding sections 13 and 14. The sections 13 and 14 are shown arranged coaxially and spaced apart a predetermined distance, so as to give the desired resultant reactances, as will be hereinafter more fully pointed out. The supporting members 12 for the sections 13 and 14 are preferably made of a molded plastic based on cement, although any suitable material may be used.

The turns of the sections 13 and 14 are preferably arranged in layers, which are somewhat dished, giving them a conical appearance in order to utilize the available space to better advantage in obtaining electrical clearance. The terminals of these sections are preferably embedded in the supporting members 12, and project as shown on the exterior thereof. The terminals for section 13 are indicated at 31 and 32, while those for section 14 are indicated at 41 and 42. One or more taps may be employed such as I have indicated at 33 for the section 13, the use of such tap being frequently desirable in order to secure further desired value of the reactance in addition to those had solely from the spacing of the winding sections.

An arrangement of switches or other circuit closing means for effecting the desired series and multiple connections of the winding sections is shown in Fig. 2. Here switches *a* and *b* effect the multiple arrangement by conductively connecting terminal 31 with 41, and terminal 32 with 42 respectively. The switch *c* effects the series arrangement by conductively connecting section 13 through the tap 33 to the terminal 41 of section 14. In Fig. 4 only switch *a* is closed so that only section 14 is connected individually in the circuit, while in Fig. 5 both switches *a* and *b* are shown closed for effecting the multiple connection of the sections.

Since reactance, by the well known law, varies directly as the square of the number of turns and inversely as the reluctance of

the magnetic circuit, the sections 13 and 14 according to my invention are so spaced that desired values of the reactance are had from a single section connected alone and from the multiple connection of the sections and also from the series connection. From this law it is readily seen that the resultant reactance for the sections connected in multiple is less than that of a single section but greater than that of a single section divided by the number of sections. The desired value of the reactance for the series connection of the winding sections in comparison with the single section however is often in excess of the desired value, but it is to be obtained by the use of a tap as shown at 33 on one of the sections for cutting out active turns or vice versa.

The practice and operation of my invention will be readily comprehended from a consideration of the following numerical example. Let us assume a constant reactive drop of 4200 volts is desired at all times across the controlling reactance; and let us further assume that currents of 350,700 and 1050 amperes respectively are required under different operating conditions of an arc furnace, for example, so that it is necessary to design the reactor to yield 12, 6 and 4 ohms of effective reactance respectively.

The two sections 13 and 14 would then be designed so that they each have a reactance of 6 ohms when either one of them alone is connected in the circuit. By reason of the mutual inductive action of one co-axial section on the other the effective value of the reactance of each section is increased either when they are connected in series or in multiple; but in accordance with the law of reactance, as mentioned above, a spacing for the sections may be found which yields a resultant reactance when the sections are connected in multiple which is greater than 3 ohms and less than 6 ohms. The particular value desired for the example under consideration is 4 ohms. Now it is desirable that this value should be had solely from the spacing of the sections, since the current passing through the reactor for this connection is the running current and the most economical use of the copper to be employed demands that there shall be no idle copper in this connection.

The first or 12 ohm value of the reactance is had when the sections are in series, but by reason of their mutual induction this series value will be more than twice that of a single section. The tap 33 is, therefore, provided to cut out active turns from the section 13 in order to reduce the full series value of the reactance to the desired value of substantially twice that of a single section.

The spacing of the two sections ordinarily

is not so great but that little more copper is required in them to give the desired value of the reactance from the series connection than was formerly employed in the one reactor controlling the first value of the starting current to an arc furnace.

It will of course be understood that these values of the reactance are relative and were chosen merely for illustration and that the provision of one or more suitable taps will yield various desired ratios of the current in a single reactor built in accordance with my invention employing a plurality of inductively arranged winding sections.

Having now described an embodiment of my invention which is at present the best means known to me for carrying the same into effect, I would have it understood that this is merely illustrative and that I do not mean to be limited thereby to the precise details shown, nor restricted in the choice of recognized equivalents except as defined in my claims hereunto annexed.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. A current limiting and controlling reactor comprising a plurality of winding sections disposed coaxially in mutual inductive relation and spaced apart in a predetermined manner to secure a desired reactance when the sections are connected in multiple less than the reactance of a single section and greater than the reactance of a single section divided by the number of the sections.

2. A current limiting and controlling reactor comprising a plurality of winding sections disposed coaxially in mutual inductive relation, and spaced apart in a predetermined manner to secure a desired ratio between the effective values of reactance for the multiple connections of said sections compared with that of a single section, and means for effecting the individual and multiple connections of said sections.

3. A current limiting and controlling reactor comprising two winding sections arranged coaxially and spaced apart a predetermined distance to secure a desired ratio between the effective reactance for a single section and that for the multiple arrangement of the sections, and means for effecting the series, individual and multiple connections of said sections.

4. An air core type reactor comprising two equal winding sections arranged coaxially in mutual inductive relation and spaced apart a predetermined distance to obtain a desired effective value of the reactance for the multiple arrangement of said sections, and means for effecting the series, individual and multiple connections of said sections.

5. An air core type reactor comprising two equal winding sections arranged coaxially in mutual inductive relation and

spaced apart a predetermined distance to obtain a desired effective value of the reactance for the multiple arrangement of said sections intermediate one-half of and the
5 full value of that of one section, means for cutting out active turns from one section to secure another desired value of the reactance

for the series arrangement of said sections, and means for effecting the series, individual and multiple connections of said sections. 10

In witness whereof, I have hereunto set my hand this 24th day of March, 1920.

FRIEND H. KIERSTEAD.