Oct. 4, 1927. 1,644,135

W. B. KIRKE

REACTOR

Filed Oct. 9, 1925 2 Sheets-Sheet 1

Fig. 1.

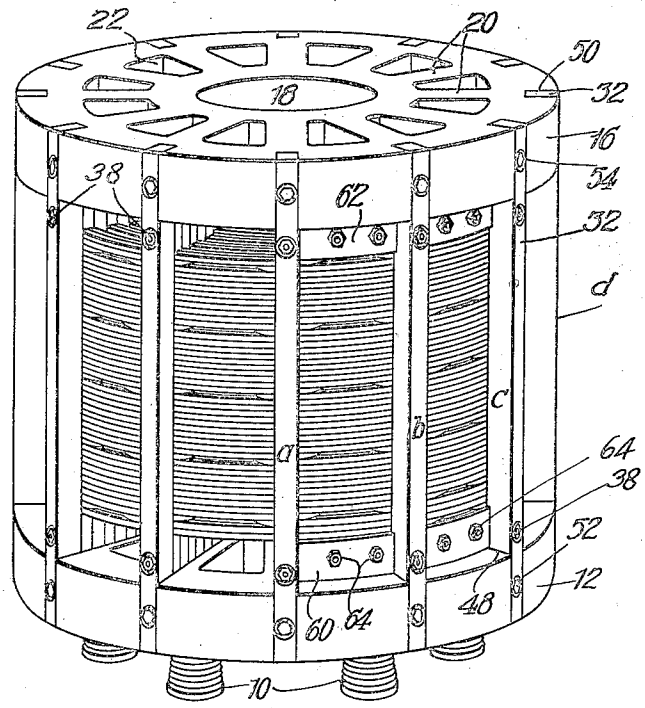
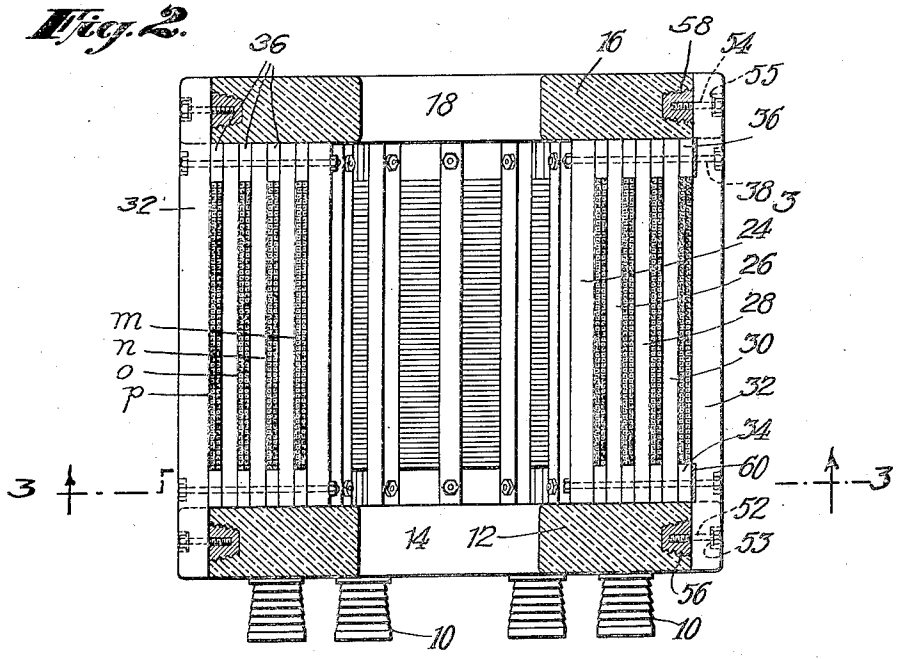


Fig. 2.



Inventor
Wallace B. Kirke.

By His Attorney
D. Anthony Hains

Oct. 4, 1927. 1,644,135

W. B. KIRKE

REACTOR

Filed Oct. 9, 1925 2 Sheets-Sheet 2

Fig. 3.

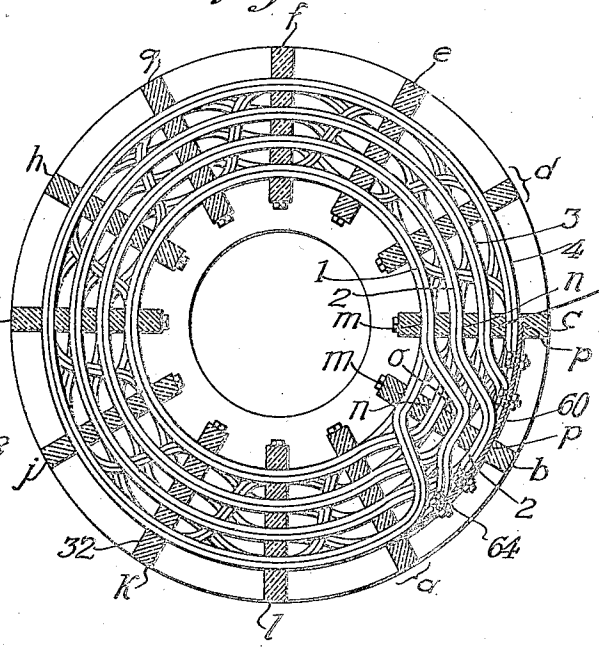


Fig. 4.

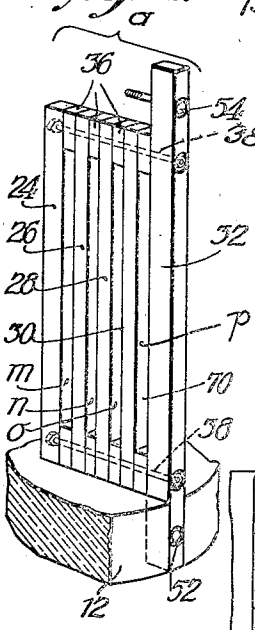


Fig. 5.

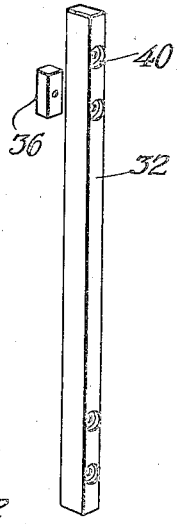
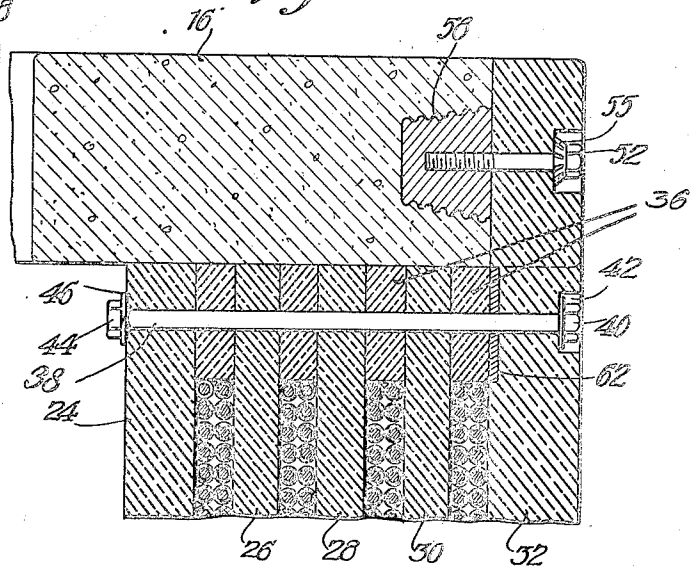


Fig. 6.



Inventor
Wallace B. Kirke.
By His Attorney
D. Anthony Reina

Patented Oct. 4, 1927. 1,644,135

UNITED STATES PATENT OFFICE.

WALLACE B. KIRKE, OF BRONXVILLE, NEW YORK.

REACTOR.

Application filed October 9, 1925. Serial No. 61,523.

The invention relates to improvements in the construction of reactors of high current and KVA capacity such as are utilized in circuits of alternating current generators or between different sections of the busses connected with such generators.

The invention aims to provide an improved type of reactor which for a given capacity occupies less space than reactors heretofore used and also aims to provide an improved winding supporting structure in which the bolts are placed radially with respect to the axis of the winding and so disposed that there is practically no chance of the bolts providing a path for short circuiting currents. I also provide a novel form of intermeshed helical coil which cuts down both current and heating losses. The various features of the invention will be apparent from the following specification when read in connection with the accompanying drawings and novel characteristics of the invention will be pointed out with particularity in the appended claims. In the drawings—

Fig. 1 is a perspective view of a reactor embodying my invention;

Fig. 2 is a vertical longitudinal section through the reactor;

Fig. 3 is a horizontal section on line 3—3 of Fig. 2;

Fig. 4 is a detail perspective view illustrating a portion of the winding supporting structure of the reactor with the winding omitted;

Fig. 5 is a perspective of certain parts shown in Fig. 4;

Fig. 6 is an enlarged vertical section illustrating details of construction.

Referring in detail to the drawings, numerals 10 represent a series of insulators which rest on a floor or suitable foundation and form supports for the bottom end head 12 of the reactor. This head may conveniently be made of concrete or other moldable material and is preferably provided with a central opening 14 to permit the circulation of air. An upper head 16 which is preferably a duplicate of the head 12 is also provided, this being formed with a central opening 18, both heads being provided with radial arms 20 leaving open spaces 22 for the circulation of air. It is to be understood, however, openings 22 may be omitted if desired as the type of winding can be cooled sufficiently without these openings, the chief reason for using such openings being to reduce the weight of the structure.

Heads 12 and 16 are supported in spaced relationship by a plurality of radially arranged coil supports. These coil supports are made of what I term insulating boards. They are formed either of wood, asbestos composition or other suitable material having a fair degree of insulating value and the ability to resist compressive strains. For convience of description, the radial supports will be indicated as a whole by reference letters *a*, *b*, *c*, etc., the term radial support being intended to include the several insulating boards 24, 26, 28, 30 and 32. These boards are spaced apart from one another at the bottom by spacer blocks 34 and at the top by similar spacer blocks 36. The several boards and spacer blocks are secured together at the top and bottom by means of radial bolts 38, the heads 40 of which are seated within counterbores 42 and the nuts 44 of which preferably are seated on washers 46 seated against the inner surfaces of the inner insulating boards 24. It is noted that the boards 24, 26, 28, and 30 may be said to form columns which rest on the lower head 12 and support the upper head 16. The outer boards 32 of each radial support are longer than the inner boards as indicated clearly in Figs. 1, 4 and 6, the extremities of said outer boards 32 being seated in radial slots 48 and 50 formed respectively in the heads 12 and 16. Radial bolts 52 and 54 pass through suitable holes near the lower and upper ends respectively of the boards 32 and engage threads formed in suitable inserts 56 and 58 molded or otherwise secured in the heads 12 and 16. The bolts 52 and 54 bear against spring washers 53 and 55 respectively so as to allow for a certain relative movement between the winding supports and the header due to expansion and contraction caused by the heating and cooling of the coil.

The spaces between the boards 24, 26, 28 and 30 of the various radial supports *a*, *b*, *c*, *d–1* form slots arranged in a circular fashion as will be understood for the accommodation of the reactor winding which is built up in a novel manner so as to form a plurality of intermeshed helical coils as will be apparent from the following.

In assembling the reactor the insulating boards 24, 26, 28, 30 and 32 of each of the radial supports *a*, *b*, *c*, etc. are first bolted to-

gether at the bottom by means of the respective radial bolts 38 and the lower bolt 52 of each radial support is secured so as to form what we might term a skeleton winding support for receiving the reactor winding.

Adjacent the upper surface of the lower head 12 and secured to a number of the outer boards 32, I provide a terminal plate or connector 60. A similar terminal plate 62 is provided adjacent the underside of the upper header 16. These plates provide means for leading the current in at one end of the coil and taking it off at the other end of the coil. The reactance coil itself is built up in a novel manner so as to minimize both current and heating losses. These advantages are gained because of the peculiar arrangement of the various parts or convolutions of the coil. The construction and arrangement of the coil will be best understood by describing the manner of winding the same particularly with reference to Figs. 3 and 6. The coil illustrated by way of example consists of four pairs of conductors indicated by numerals 1, 2, 3 and 4. The lower ends of these coils are bolted to the terminal plate 60 by suitable binding screws 64. The conductors are insulated to withstand the maximum potential that will exist between the turns of the winding and the spacing between the adjacent boards, as determined by the width of the spacer blocks 36, is just sufficient to accommodate each pair of conductors with a fairly snug fit. In building up the coil, it has been found convenient to place the lower head 12 on a turntable and then to lay up the pairs of conductors while the table is slowly rotated. Coil number 1 is carried from the binding post 64 of the terminal plate 60 through the slot *o* between the boards 28 and 30 of the radial support *b*, then through the slot *m* between the boards 24 and 26 of the radial support *c*. The conductor then follows around for practically one complete revolution through the innermost slots *m* of the radial supports *c*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, *k*, *l* and *a*. This coil is then stepped outward to the radial slot *n* of the radial support *b*.

The lower end of the coil 2 is secured to the lower terminal plate 60, passes through the slot *p* of the radial support *b*, is then carried in to the slot *n* of the support *c*, then carries around for practically a complete revolution to the slots *n* of supports *d*, *e*, *f*, *g*, *h*, *i*, *j*, *k*, *l* and *a*, and for the beginning of the next turn it starts from the slot *o* and follows this radial location from the radial support *b* all around. The coil 3 similarly starts from the terminal plate 60 is passed to the slot *o* of the radial support *c* and is wound practically concentric for one turn and starts its next revolution in one of the outermost slots *p*. Similarly, the coil 4 starts at the terminal plate 60 and is placed in the outermost slots *p* of the radial supports *c*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, *k*, *l*, *a* and is then brought inward for the start of the next turn to the innermost slot *m* of the radial support *b* and carried around for practically one complete turn through the innermost slots *m* of the radial supports *c*, *d*, *e*, *f*, *g*, etc. This manner of winding is continued, the transportation occurring one position earlier on each successive turn until a complete winding is formed and sufficient amount of coil is built up to provide the required amount of reactance. The conductors 1, 2, 3 and 4 are then secured to the upper terminal plate 62 and fastened by the binding screws 64. The upper spacer blocks 36 are then placed in position and secured by the radial bolts 38, thus rigidly clamping the winding. The upper header 16 is then put in place, the upper ends of the upright boards 32 being accommodated in the slots 50 and bolts 54 being screwed home to permanently tie the structure together as one rigid unit.

While in the drawings, I have indicated a reactor provided with twelve radial supports, and have shown a winding made up of four coils connected in multiple and supported in four slots formed in the radial supports, it is to be understood that I am not limited thereto as the number of supports and the number of conductors in multiple as well as the size of each conductor may be varied at will depending on the total current that the winding has to carry. By having the transportation occur at the completion of each turn of the separate conductors the most efficient balancing effect is ensured, although obviously satisfactory results may be obtained in many cases with somewhat less frequent transpositions. The number of conductors located between the insulating boards may also be varied to suit requirements of design and to secure economies gained by the use of some specific size of conductor. A reactor of the design above described possesses the desirable advantage over reactors heretofore used having winding supports of built up insulating material, that it has no bolts parallel to the axis of the winding. The radial bolts necessary for holding the parts together in my design are so disposed with respect to the winding that they do not add to the diameter of the reactor. Since all the conductors adjacent to the bolts are at the same potential, the bolts need not be provided with insulation. Such a construction reduces the size of my improved reactor as compared with designs where outside through-bolts (parallel to the winding axis) are necessary for mechanical strength, which through-bolts must be electrically insulated from the coil to prevent a short circuit of the winding. My improved winding support formed of relatively few pieces of

insulating boards of rectangular cross-section permits of a flexibility of design and materially cuts down the cost as compared with reactors of other designs.

The improved winding formed of a plurality of intermeshed helical coils which have frequent transpositions provides multiple circuits which have the same average radius and, therefore, the same inductance where each circuit is wound with the same number of turns. This form of winding insures equal current distribution between the several circuits forming the winding and brings current losses and heating to a minimum. Mechanical forces due to expansion and contraction are taken care of by allowing a relative movement to take place between the winding and its radial supports. Because of the peculiar connection between the headers and the coil support, said headers are relieved of the forces which tend to expand the coil under short circuit conditions, the arrangement being such that those forces are transferred to the conductors themselves. This arrangement permits the use of headers of comparatively light construction which need only be of sufficient strength to support the weight of the coil.

In the drawings and throughout the description and in the claims as well, I refer to radial supports of built up insulating material. It is, of course, to be understood that this term radial is to be interpreted broadly and it is not intended to limit me to a support which is arranged in a true radial line with respect to the center or axis of the reactor but is intended to include any support which points toward a central part of the reactor as it will be apparent that the winding can be built up if desired about a series of supports so located that their projected center lines lie tangent to a small circle concentric with the axis of the reactor.

While I have described with great particularity specific details of construction, and the arrangement of parts of the specific embodiment of the invention illustrated, it is not to be construed that I am limited thereto as various modifications and substitution of equivalents may be made by those skilled in the art without departing from the invention as defined in the appended claims.

What I claim is:—

1. A reactor comprising end heads and a series of radial supports between said heads, each radial support comprising a plurality of longitudinal members spaced apart to receive separate convolutions of the winding and said winding comprising a plurality of conductors connected in multiple and the separate convolutions of the winding being so disposed that a given conductor lies the same radial distance from the central axis of the coil for a given turn and lies at a different radial distance for another turn in a different plane.

2. A device of the character described including an electric winding of helical coils connected in multiple, a plurality of longitudinal winding supports, heads adjacent the latter, said supports being connected to the heads by means of bolts extending radial to the axis of the winding.

3. A device of the character described including an electric winding of helical coils connected in multiple, top and bottom heads having slots parallel to the axis of the winding and a plurality of longitudinal winding supports certain of which are seated in said slots.

4. A device of the character described including an electric winding of helical coils connected in multiple, longitudinal winding supports, a top and a bottom head having peripheral slots wherein said winding supports are held by means of radial bolts, and means arranged to permit a movement to take place between the longitudinal winding supports and the headers.

5. A device of the character described including an electric winding of helical coils connected in multiple, a plurality of longitudinal winding supports of insulating material, said supports being arranged in radial groups and held together by radially extending bolts.

6. A reactor having end heads and a winding supporting structure comprising a plurality of members between said heads, said members being arranged in radially disposed groups and each group being secured together by radially extending bolts, and the outer member of each group being longer than its companions and being secured at least at one end to one of said heads by a transversely extending bolt.

7. A reactor comprising end heads having located between them a series of radial supports for the winding, each of said radial supports including a plurality of longitudinal members of substantially rectangular cross-section with spacer blocks between them and having transversely extending bolts for holding them in assembled relationship.

8. A reactor comprising end heads formed with slots therein and a winding support comprising a multiplicity of longitudinally extending members most of which are located wholly between said heads and certain of which are longer and are secured in said slots.

9. A reactor winding of the character described comprising a number of layers, each layer consisting of concentric coils of different radii, all lying in substantially the same plane, each concentric coil of one layer be-

ing connected in series with a coil of a different radius in an adjacent layer.

10. A reactor of the character described including upper and lower heads spaced apart by radial supports each support comprising a plurality of longitudinal members with spacers between them to accommodate the winding and the winding comprising a number of layers of concentric coils of different diameter, the coils in each layer being separated by said longitudinal supports, the coils of a given diameter in one layer being connected with coils of a different diameter in another layer.

11. A reactor comprising end heads of insulating material, a plurality of radial supports for the winding, each of said radial supports comprising a plurality of longitudinally extending members of insulating material secured together in spaced relation to accommodate the winding, most of which are located wholly between said heads, and at least one of which has at least one of its ends projecting beyond the corresponding ends of the others, and means for securing each of said projecting ends of said members of the several supports to the head adjacent thereto.

12. A reactor comprising a winding made up of a plurality of conductors connected in multiple, each conductor having different portions thereof coiled concentrically to the axis of the winding at different radial distances from said axis and successively arranged along said axis, corresponding concentric portions of the several conductors being arranged one within the other and spaced apart, and the transpositions from one concentric portion to another of each conductor occurring at different points spaced about the axis of the winding, and a skeleton support for said winding comprising a plurality of members of insulating material extending longitudinally through said spaces between said concentric portions of the winding.

In witness whereof, I have hereunto signed my name.

WALLACE B. KIRKE.

Certificate of Correction.

Patent No. 1,644,135. Granted October 4, 1927, to WALLACE B. KIRKE.

It is hereby certified that error appears in the printed specification of the above-numbered patent requiring correction as follows: Page 2, lines 74 and 100, for the word "transportation" read *transposition;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of November, A. D. 1927.

[SEAL.]

M. J. MOORE,
Acting Commissioner of Patents.