W. KELLER.

METHOD OF MANUFACTURING ELECTRICAL INSTRUMENT COILS.

APPLICATION FILED FEB. 27, 1911.

1,041,293.

Patented Oct. 15, 1912.

Fig. 1.

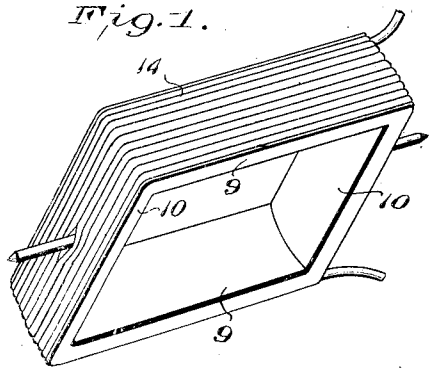


Fig. 2.

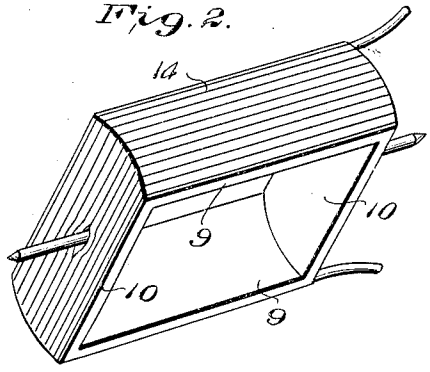


Fig. 3.

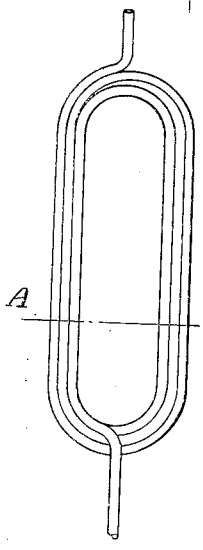


Fig. 4.

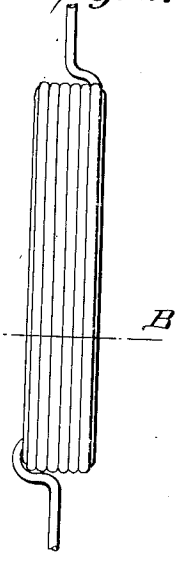


Fig. 5.

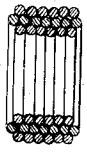


Fig. 6.

Fig. 7.

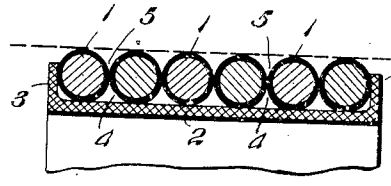


Fig. 8.

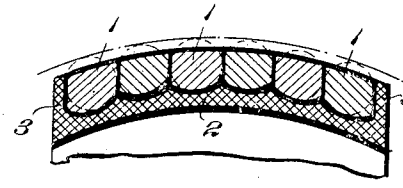


Fig. 9.

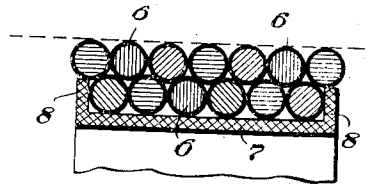
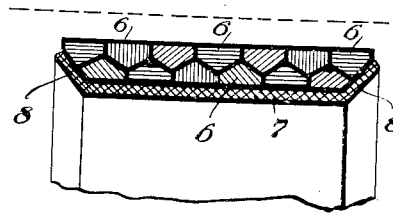


Fig. 10.



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METHOD OF MANUFACTURING ELECTRICAL-INSTRUMENT COILS.

1,041,293. Specification of Letters Patent. Patented Oct. 15, 1912.

Original application filed June 8, 1905, Serial No. 264,297. Divided and this application filed February 27, 1911. Serial No. 611,040½.

To all whom it may concern:

Be it known that I, WILHELM KELLER, a subject of the German Emperor, and a resident of Frankfort-on-the-Main, Germany, have invented certain new and useful Improvements in Methods of Manufacturing Electrical-Instrument Coils, of which the following is a specification.

There are many cases, particularly in electrical measuring instruments or devices, where it is desirable, that wire coils, either stationary or movable, should occupy the least possible space, in order to attain certain advantages, which may vary according to the circumstances.

My invention relates to a method of reducing the thickness of wire coils, either alone, or on frames, patterns or the like of metal or insulating material, so that the so compressed wire coils will occupy a minimum space.

I will now proceed to describe my method with reference to the accompanying drawing, in which—

Figure 1 is a perspective view of a wire coil on a rectangular turnable frame, such as is used in certain electrical measuring instruments. Fig. 2 is a similar perspective view, after the wire coil and the turnable frame have been compressed. Fig. 3 is an elevation of a flat wire coil without any frame. Fig. 4 is a side view of the same. Fig. 5 is a horizontal section through the same on the line A—B of Figs. 3 and 4. Fig. 6 is a similar horizontal section, after the wire coil has been compressed. Fig. 7 is a cross section through a part of a wire coil in one layer on a frame prior to compression. Fig. 8 is a similar cross section after compression. Fig. 9 is a cross section through a part of a wire coil in two layers on a frame prior to compression, and Fig. 10 is a similar cross section after compression.

Similar letters of reference refer to similar parts throughout the several views.

The covered or bare wires, from which the wire coils are made, may have any cross sections, but they are preferably made round as usual. In case the coil is initially formed from bare wires it will be understood that suitable insulating material will be applied to the coil and in the spaces between the wires before it is compressed, as hereinafter described. When several windings, 1, 1, of a wire coil are placed on a frame 2 between the two flanges 3, 3, of the latter as shown in Fig. 7, there will be spaces 4, 4, filled with air between the several windings and the frame and flanges, also the external face of the coil will not be smooth, since furrows 5, 5, are left between the several windings 1, 1. A coil composed of a frame and wire arranged in the manner shown in this figure is undesirably thick. The thickness of the wire coil alone is equal to the diameter of the wire 1 and its insulation and in addition the thickness of the frame 2 has to be taken into consideration. When the windings 1, 1, of the coil are subjected to a suitable pressure they can be so much compressed, as not only to reduce to naught the air spaces 4, 4, but also to render the outer surface or faces of the coil perfectly smooth, as is shown at Fig. 8, where the original shape of the windings is indicated by dotted circles. Of course, also the frame 2 will be compressed in an irregular manner, as its thickness will be reduced the most in the middle of each winding 1. Fig. 8 clearly shows the reduction in the thickness of the wire coil and the frame by the difference between the smooth upper face and the initial face indicated by the dotted straight line.

When a wire coil is placed in two layers of windings 6, 6, on a frame 7 between two flanges 8, 8, of course there will be a greater number of air spaces between the several windings 6, 6, and between them and the frame 7 and flanges 8, 8. To further reduce the thickness of the wire coil and the frame, the latter may be made of a comparatively soft material (for instance aluminium). Then under the compression the frame 7 will also be widened or stretched, so that it attains a greater breadth than before, as is clearly shown at Fig. 10. Where so preferred, during the compression the two flanges 8, 8, of the frame 7 may be bent in the manner shown. The dotted straight line in Fig. 10 indicates the initial upper face (see also Fig. 9), so that it will be ap-

parent how great a reduction in the thickness of the coil and frame can be obtained by the compression.

The compression may be effected in any known press or similar machine tool with the aid of convenient molds or combination dies of any known construction. The wire coil may be compressed either as a whole or in sections. It depends upon the kind of the wire coil, whether it is to be compressed in several planes or partly in planes and partly in cylindrical faces or otherwise. The frame, pattern or the like when employed may be of a convenient metal, either, hard or soft, or it may be of any insulating material. The molds or combination dies may be so arranged as to either prevent the frame, pattern or the like from widening and lengthening or stretching under the compression, or to permit it to widen or to stretch either in one direction only or in two directions at right angles to each other. In any case the molds or combination dies should be so arranged as to give the compressed wire coil, either alone or in combination with the frame, pattern or the like, the desired shape as shown in Fig. 8. The working faces of the molds or combination dies are preferably polished, so as to produce on the compressed wire coils perfectly smooth faces without any furrows or spaces, so that no dust nor fibers may be able to adhere. The so compressed wire coils will be found most suitable for electrical measuring instruments or devices with narrow permanent magnetic fields.

Fig. 1 shows for example a wire coil 14 wound in a single layer over a turnable rectangular frame with end sections 10, 10 and side sections 9, 9 at right angles to each other. The frame is assumed to be made of a soft metal such as aluminium. The molds or combination dies (not shown) of any known construction may be so arranged, that their respective parts come in contact with the whole internal face of the frame and with the external faces of the coil 14. During the compression of the wire coil 14 and the frame in any known press or similar machine tool, with the aid of the said molds or combination dies, the windings of the coil 14 will be mostly flattened and reduced in their thickness in a similar manner as in Fig. 8, and at the same time the frame sections will be stretched in the cross direction only in a similar manner as in Fig. 10. The shape of the so compressed coil and frame is clearly shown at Fig. 2. Where preferred, of course the molds or combination dies may be so arranged, as to prevent all sections of the frame from stretching during the compression.

Figs. 3 and 4 show a wire coil without any frame, pattern or the like prior to the compression, as is clearly shown by Fig. 5, which is a cross section through the line A—B. After the compression the thickness of the coil will be reduced, as is shown at Fig. 6.

Hitherto I have shown two different wire coils, but it is obvious, that wire coils of every description, whether stationary or movable, may be compressed according to my method, either wholly or partly. The essential point is, that all the air spaces between the windings be reduced to naught and the thickness of the wire coil, either alone or in combination with a frame, pattern or the like be reduced, in the direction of the pressure exerted on the coil or the coil and the frame so that the wire coil or the wire coil and the frame or the like occupy less space than hitherto in the direction of the exerted pressure and may be arranged to engage in a much narrower space. Wire coils compressed according to my method are preferably used as rotating coils for electrical measuring instruments or devices with a narrow permanent magnetic field. By the compression flat wire coils will also be rendered stiffer and more durable.

It is evident, that for a given number of windings a compressed wire of a greater cross section, that is of a smaller electrical resistance, may be employed, than if the wire were left uncompressed, as the space offered is too limited. Thus it is possible to employ for a given electrical resistance and a given number of windings a wire from a metal of a smaller specific weight, than hitherto to lighten the coil-winding or to employ the wire from the said material for a given number of windings and a given weight of the coil to reduce the electrical resistance. For a given cross section of the wire it is also with the aid of the compression possible to considerably increase the number of windings in a coil to be arranged within a given space.

The improved coil produced by the invention hereinbefore described. constitutes the subject matter of Letters Patent of the United States No. 985,420, granted February 28, 1911, the present application being a division of the application for said Letters Patent.

I am aware that prior to my invention it has been proposed to manufacture large conductors for dynamo electric machines and wires for winding armatures by subjecting a plurality of interwoven wires to pressure to give to a normally substantially cylindrical strand a rectangular form in cross section. Also that the cable and terminal of an electric railway bond have been united by subjecting the same to a high pressure. Such methods of making articles which differ greatly as regards their construction, method of use. etc. from coils of the nature

hereinbefore described did not suggest the method constituting the present invention. The coils of electrical instruments are formed from insulated wires, while the conductors, armature windings and rail bonds just referred to are formed by bare wires which also are commonly of considerably greater diameter than the wire of coils made according to the present invention, and further it is of great importance, as before pointed out, that such instrument coils shall occupy a minimum amount of space. Both of these objects are effected by the method hereinbefore described.

What I claim as my invention, and desire to secure by Letters-Patent, is—

1. The hereindescribed method of manufacturing an electrical instrument coil comprising forming a coil of insulated wire and subjecting such coil to pressure to eliminate the spaces between the windings and produce smooth exterior faces on the coil.

2. The hereindescribed method of manufacturing an electrical instrument coil comprising winding an insulated wire about a frame and subjecting the coil thus formed and the frame to pressure to eliminate the air spaces between the several windings and between the windings and frame and to produce smooth exterior faces on the coil.

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

WILHELM KELLER.

Witnesses:
ERWIN DIPPEL,
MICHAEL VOLK.