

Nov. 29, 1938.

A. CASALE

2,138,292

ARMATURE COIL FOR DYNAMO-ELECTRIC MACHINES

Filed March 27, 1936

Fig. 1.

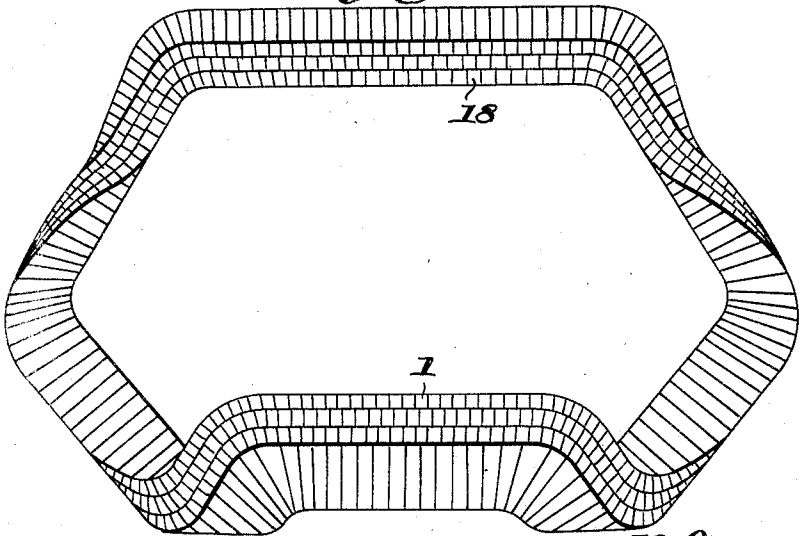


Fig. 2.

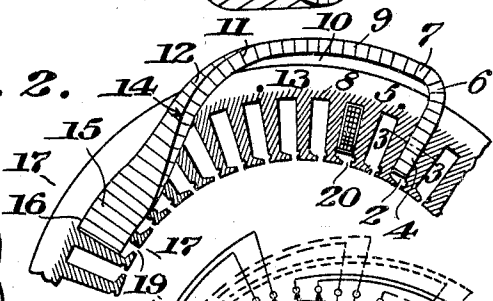


Fig. 3.

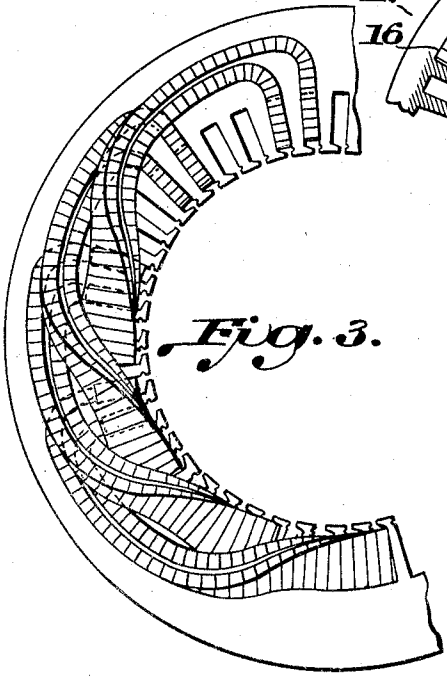


Fig. 4.

Inventor;
A. Casale
Glascock Downing & Seebold
attys.

By

UNITED STATES PATENT OFFICE

2,138,292

ARMATURE COIL FOR DYNAMO-ELECTRIC
MACHINES

Aurelio Casale, Genoa, Italy

Application March 27, 1936, Serial No. 71,270
In Italy April 13, 1935

2 Claims. (Cl. 171—206)

It is known that the winding of a three-phase motor is effected nowadays either with wooden formers that are applied laterally of the motor and by means of which the coil is wound within the grooves of the said motor, or by winding a coil around a former more or less round or of like shape, and by materially driving the coil into the grooves of the stator, the portions of the winding projecting out of the grooves being subsequently deformed by hand so as to cause them to adhere more or less to the shell of the motor, such adherence being however always disordered and little perfect; sometimes the coils are wound around the formers with a given shape and subsequently they are deformed, with pressure, by means of other formers and devices in such a manner as to cause them to assume the definite form they will have to present when being fitted to the electric machine.

Such embodiments present various inconveniences and first of all that due to an incomplete utilization (filling up) of the space available within the groove inasmuch as the fitting effected manually, on account of the manner itself wherein it is carried out, is not so perfect as to assure the complete filling up of the space of the grooves by the conducting wires housed within the grooves themselves. On the other hand, the said inconvenience of incomplete filling up of the motor grooves, is due to the fact that, a round wire being used as conductor, such conductor when fitted into the grooves in the aforesaid manner cannot fill up them completely, but only partially.

Further, the operation effected manually in the second case indicated above implies necessarily an irregular arrangement of the conductors so that the difference of potential between two adjacent turns may in some cases attain very considerable values.

Another serious inconvenience that is set up by adopting the well-known proceedings indicated above consists in the fact that the winding is not arranged in a manner to permit an efficient ventilation thereof.

Finally, when the coils are wound upon a former and subsequently deformed by means of pressing or like devices in order to cause them to assume the definite conformation they will have to present when applied to the electric machine, in addition to the aforesaid inconveniences there are also the following ones: deterioration of the insulation material during the pressing operation; hardening of the

material due to the deformation; unappropriate disposition of the various turns relatively to the adjacent ones, etc.

Furthermore, in the case of big constructions, with the old systems it is impossible to realize a balanced winding with shortened average pitch because the inactive portion of the coil must be sensibly increased thus neutralizing the advantage that was obtainable by shortening the pitch itself. It has been tried to devise a shortened pitch and to simultaneously house within each groove two bundles of conductors of different phases, but this system necessitates greater insulations and causes the inconvenience due to the neutralization of the effects of two bundles of conductors housed within the same groove and traversed by currents flowing in opposite direction.

The present invention obviates the above inconveniences through the employment, for the winding of the three-phase stator, of coils constructed separately upon formers with the definite conformation that they should present when they have to be fitted to the machine, and in a special manner as hereinafter described, and by constituting the said coils with wire of square or rectangular shape, or in general of such shape to permit a side of the transverse section of a turn to come to adhere, through the insulators, perfectly and thoroughly to the corresponding side of the adjacent turn of the same coil.

The coils so constituted may be very easily and surely so wound upon suitable formers that the transverse section of the active useful portion of the coil (that is to say, of the portion destined to be contained inside the groove of the stator) correspond exactly to the shape of the transverse section of the stator groove destined to receive the said active portion. In this manner a perfect utilization of the room available in the said groove is secured, and therefore, at equal dimensions, the power and starting torque of the motor are increased.

The regularity of the arrangement of the turns of a coil realized in accordance with the present invention also secures the permanent existence between two adjacent turns of the same coil of a regular and not high difference of potential.

In order to obtain a winding with the various phases of the same length and with the shortened pitch without having to house within one same groove two bundles of conductors of different phases, and in order to secure the

advantages consisting in a ready and easy application of the coils and in a strong ventilation of the winding applied to the stator, the coils according to the invention incorporate the particular curves and features hereinafter specified.

Each coil presents the two parallel, straight and facing active portions which have to be housed within the interior of the two corresponding grooves of the stator armature; the said two portions are connected together by means of curved portions presenting the following particular conformation: At the egress of one of the active portions from the groove in correspondence to one of the lateral faces of the stator, a curve is arranged which is contained within the same radial plane of the stator including the groove, such curve having its centre towards the stator and the coil portion being directed towards the exterior of the stator itself; subsequently, the coil presents a curve made relatively to an axis normal to the preceding, so that the corresponding final portion of coil is directed circumferentially in a concentric manner to the former of the stator; to the above there follows a connection portion of conformation substantially curved and concentric to the axis of the stator; after the last mentioned portion there follows another portion presenting a double curvature, and more exactly a curvature having a helicoidal (torsional) direction around the longitudinal axis of the set of conductors constituting the coil, and a curvature which lowers again the said set of conductors as far as to bring same to correspond with the successive groove into which the other active straight side of the coil must be introduced; still subsequently, the set of conductors receives a curvature around an axis normal to that of the stator, thanks to which curvature the final portion of coil is brought into the direction parallel to the axis of the stator; then there follows the second active portion of the coil and successively the curvatures as indicated above take place again.

From the foregoing and remembering the manner in which the coils have to be applied within the grooves of the stator, it follows:—

(a) That the coils, once applied separately upon the former, do not necessitate any manual deformation to cause same to adhere to the sides of the stator;

(b) And that such coils, once applied within the groove of the stator, present the various turns out of the stator so that they result each regularly surrounded by free air facilitating sensibly the ventilation thereof.

(c) Consequently, the strength of the current that may be sent to the winding of the stator is greater than the normal one on account of the greater ventilation the turns may enjoy.

(d) Even in the case of big and mean constructions, it is possible to usefully realize a balanced winding with the three phases of a same length and such as to simultaneously present a shortened average pitch because of the fact that, for each coil, one half of the inactive portions upon one side of the stator has the possibility of remaining comparatively close to the stator as each inoperative portion of a turn enters the space left free by the portions of the adjacent turns directed at right angle to the preceding.

The accompanying drawing illustrates one embodiment of the object of the present invention and a diagram of the winding that may be

realized, the whole being referred to the particular case of a stator, though the invention may also be applied to the rotors; more particularly, Fig. 1 shows in perspective view a coil that has been wound separately upon a former; Fig. 2 shows how such coil is housed within the grooves of the stator, and how the interior of such groove is completely utilized and filled up by the square-section conductor constituting the coil. Fig. 3 is an example of winding for a three-phase motor stator made with the coils conceived in accordance with the present invention, and finally Fig. 4 shows a diagram of winding for the stator of a three-phase motor, carried out with the coils of Fig. 1 and in which the lengths of the three phases are equal to each other (whereby the winding is balanced), while the average pitch is shortened so that the length of each phase is shortened with the known advantages deriving from such shortening.

Referring more particularly to the embodiment illustrated only by way of example, it will be seen that a coil is conformed in the following manner:—

The active straight portion 1 to be housed within one of the stator grooves 2 is followed, Fig. 2, by a curved portion the axis of which 3, 3 lies between the curved portion 4 of the coil and the stator; successively, there follows a portion 6 terminating at 7 beyond the outer edge 8 of the grooves 2 and the axis of which is perpendicular to the plane of the drawing and meets with such plane in correspondence to the point 5; then, there is a portion substantially circular or of like shape 9, in which the long side of the transverse section of the coil is substantially parallel to the axis of the motor stator 10. Such portion extends as far as 11, after which there is a curved portion 12 in which the coil presents a double curvature, and more exactly a curve deriving both from a curvature around an axis traced upon the drawing approximately at 13, and from a curvature with helicoidal (torsional) path around the axis of the portion of coil according to the arrow 14, thus obtaining that the long side of the transverse section of the coil may dispose itself gradually normal to the axis of the stator 10. After the section 15, wherein the above is realized, the successive portion 16 of the coil is curved around the axis 17 substantially normal to the axis of the stator 10 and included between the coil and the stator, so that such portion may become connected to the active straight portion 18 destined to be housed within the other groove 19 of the stator. After the rectilinear portion 18, the curvatures of the following portions of the coil have the same sequence as that previously indicated, the said sequence being however reversed.

As particularly indicated in the transverse section illustrated, the interior of the groove 23 of the stator is entirely filled up, excepting the minimum thickness due to the insulations, of conducting material the transverse section of which is substantially rectangular, so as to avoid the formation of inutilized spaces.

In Fig. 4, the three phases of the triphase star winding of the stator are respectively represented with a full line, a line with long dashes and a line with short dashes. The winding relates to the case of 48 channels with an average pitch of 1 to 11. If such winding is compared with the corresponding ones known nowadays, it will be seen that it presents simultaneously: All the three phases of equal length, and thus the advantage

that the winding has like characteristics in each phase and consequently it is balanced; the conductor with which each phase is made has a length shorter than that which, at equal dimensions and other particularities, would be obtained in any other type of coils or windings, thus securing the well-known advantages notoriously resulting from such shortening; the whole takes place without altering the conditions (number and section of the channels, etc.) as well as the useful electric and magnetic effects (flux of excitation, induced currents, etc.) of the machine, as compared with the other known types.

Though for descriptive reasons the present invention has been based upon the foregoing specification and the accompanying drawing, yet many modifications may be made in the embodiment of the invention without departing from the basic ideas of the invention itself, as set forth in the following claims.

Having now particularly described and ascertained the nature of the present invention and in what manner the same is to be performed, I declare that what I claim is:

1. In a winding for a three-phase motor, an active straight portion located within a groove of the motor; at each side of the motor a curved portion contained in the same radial plane of the motor including the groove, the axis of the said curve being situated between the said curved portion and the motor so that the end of such curved portion is directed towards the exterior

of the motor; a portion curved about an axis normal to the first mentioned axis, the second mentioned curved portion terminating externally of the grooves of the motor; a curved portion disposed concentric to the axis of the motor; a portion presenting a combined helicoidal curvature and a curvature curved toward the motor groove with axis normal to the axis of the motor, a straight portion at the end of the last mentioned curved portion located in another groove of the motor.

2. In a winding for a stator of an electric motor, an active straight portion located within a groove of the motor at each side of the motor, a curved portion contained in the same radial plane of the motor including the groove, the axis of the said curve being situated between the said curved portion and the motor so that the end of such curved portion is directed towards the exterior of the motor, a portion curved about an axis normal to the first mentioned axis, the second mentioned curved portion terminating externally of the grooves of the motor, a curved portion disposed concentric to the axis of the motor, a portion presenting a combined helicoidal curvature and a curvature toward the motor groove, a portion curved toward the motor groove with axis normal to the axis of the motor, a straight portion at the end of the last mentioned curved portion located in another groove of the motor.

AURELIO CASALE.