Oct. 18, 1966 E. PANNEN 3,280,244

TRANSPOSED CONDUCTOR BAR

Filed July 17, 1963

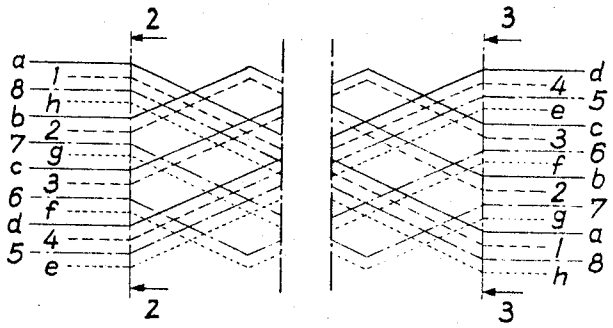

Fig. 1

Fig. 2

Fig. 3

I	II	III	IV
a	1	8	h
b	2	7	g
c	3	6	f
d	4	5	e

I	II	III	IV
e	5	4	d
f	6	3	c
g	7	2	b
h	8	1	a

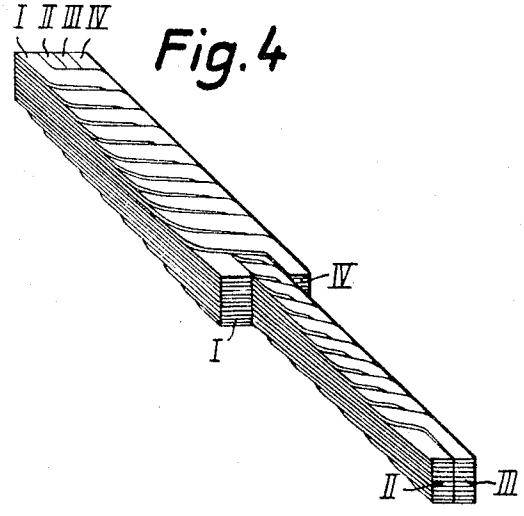

Fig. 4

Inventor:
Egon Pannen
By: Spencer & Kaye
Attorneys

United States Patent Office

3,280,244

Patented Oct. 18, 1966

3,280,244

TRANSPOSED CONDUCTOR BAR

Egon Pannen, Mulheim (Ruhr), Germany, assignor to Licentia Patent-Verwaltungs-G.m.b.H., Frankfurt am Main, Germany

Filed July 17, 1963, Ser. No. 295,762
Claims priority, application Germany, July 18, 1962, L 42,482
2 Claims. (Cl. 174—34)

Magnetic flux leakages produce a cross field in the slots of an electrical machine which crowds to one side the currents in the massive windings, such as bars or straps, within the slots. This unequal current distribution results in increased copper losses. In order to minimize this disadvantageous effect of the cross field, it has long since been the practice to replace the massive stator bars by a plurality of individual, mutually insulated conductors or strands, the latter furthermore being transposed in such a manner that the voltages induced by the stray flux in loops each constituted by two individual strands cancel each other. Such conductor rods, sometimes known as Roebel-type conductor bars or rods, which are transposed by 360° and sometimes by more than 360°, for example, by 540°, are well known in the art.

In order to avoid eddy current losses due to radial leakage fields in very wide slots containing correspondingly wide individual conductors and also to simplify the manufacture of the machines, it has previously been proposed to arrange in such wide slots two parallelly connected individual conductor bars, these bars being transposed by 360° or 540°. In such an arrangement, however, the leakage field induces a voltage between the two conductor bars, as a result of which an eddy-current is made to flow therethrough.

It is, therefore, a basic object of the present invention to provide an arrangement in which the above-mentioned drawback is avoided, i.e., an arrangement in which the flow of an eddy-current between the two independently transposed bars arranged in wide slots is avoided.

With the above object in view, the present invention resides in an arrangement wherein a winding conductor bar which is constituted by a plurality of individual conductors or strands, and which is transposed in any desired manner, has four planes, of which the conductors of the second and third planes are transposed in the usual manner while the conductors of the first and fourth planes are transposed about the second and third planes.

Such a four-plane bar incorporating, for example, the conventional 360° transposition for the second and third and for the first and fourth planes, has the following advantage as compared to a two-plane bar: thanks to the fact that the width of the individual conductors is halved, the additional losses (eddy currents) which are caused by the radial leakage field in each individual conductor itself are reduced to one quarter. Consequently, the additional losses produced in the bar as a whole are only half as large as compared to those in a conventional two-plane conductor. It will thus be seen that the additional losses are reduced not because of the type of transposition as such, but because the bar instead of being a two-plane bar is a four-plane bar, in consequence of which the width of the individual conductors is halved. Furthermore, the four-plane conductor bar according to the

present invention can be made by simplified manufacturing techniques inasmuch as it does not consist of two disconnected halves but, due to the interconnection and combination of all four planes, of a single cohesive structure. The conductor bar according to the present invention offers particular advantages when used in conjunction with the conventional 540°-transposition, because such an arrangement completely cancels the effect of the cross field in the slots and the front leakage fields of any direction and magnitude. In such a conductor bar, all of the eddy-currents which are induced by the front leakage field and the cross field are completely cancelled both between the individual strands as well as between the four planes.

Additional objects and advantages of the present invention will became apparent upon consideration of the following description when taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a schematic longitudinal view of a conductor bar according to the instant invention.

FIGURES 2 and 3 are sectional views taken on lines 2—2 and 3—3, respectively, of FIGURE 1.

FIGURE 4 is a perspective view of a conductor bar portion according to the present invention.

Referring now to the drawing, the same illustrates the present invention on the basis of a 540°-transposition. For the sake of simplicity, only the starting and end regions of the over-all interlacing are shown.

As is apparent from FIGURES 2 and 3, the conductor bar consists of four planes I, II, III, and IV each having four individual conductors or strands. The two outer planes I and IV consist of four strands *a, b, c, d,* and *e, f, g, h,* respectively, while the two inner planes II and III consist of four strands **1, 2, 3, 4,** and **5, 6, 7, 8,** respectively. While the conductors of the two inner planes II and III are transposed, in conventional manner, by 540° as is apparent from the changed positions of the strands **1** through **8** in FIGURE 3, the two outer planes I and IV with their strands *a* through *h* are transposed about the 540°-transposed inner planes II and III such that the strands *a* through *h* occupy the position shown in FIGURE 3.

In contridistinction to the prior art, in which the conductor bar as a whole consists of two disconnected elements, one having the planes I and II and the other the planes III and IV, the conductor bar of the present invention, having the planes I, II, III and IV, constitutes a single, connected structural entity. Furthermore, due to the fact that the conductors of the two outer planes are transposed about the two inner planes, the losses in the strands caused by the radial field and the front leakage field are considerably reduced.

The above-described winding arrangement while applicable to alternating current motors and generators in general, is particularly suited for use with turbo-generators.

FIGURE 4 shows the structural arrangement of the above-described conductor bar.

It will be understood that the above description of the present invention is susceptible to various modifications, changes, and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

What is claimed is:

1. For use in electric machines, a winding conductor bar composed of a plurality of strands, said conductor bar as a whole having first, second, third, and fourth planes, the strands of the said second and third planes being transposed and the strands of the said first and fourth planes being transposed about said second and third planes.

2. A winding conductor bar as defined in claim 1 wherein the strands of the said first and fourth planes as well as the strands of the said second and third planes are transposed by 540°.

References Cited by the Examiner

UNITED STATES PATENTS

2,821,641	1/1958	Ringland	310—213
2,830,208	4/1958	Staats	310—213
3,118,015	1/1964	Willyoung	174—33
3,188,377	6/1965	Hughes	174—33

LEWIS H. MYERS, *Primary Examiner.*

ROBERT K. SCHAEFER, *Examiner.*

H. HUBERFELD, *Assistant Examiner.*