July 4, 1939. M. I. TOPALOV 2,164,964

DIRECT CURRENT TRANSFORMER

Filed Aug. 10, 1936

FIG. 1.

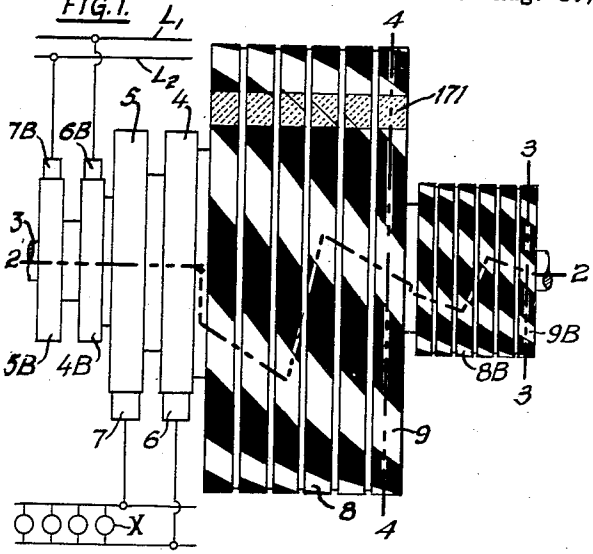


FIG. 2

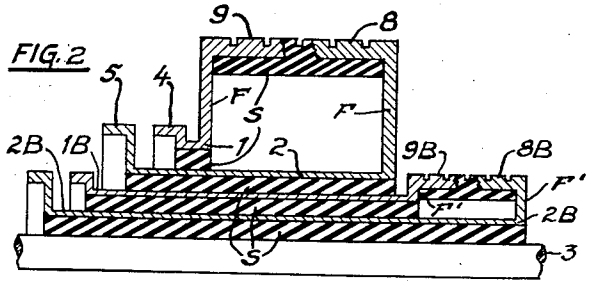


FIG. 3

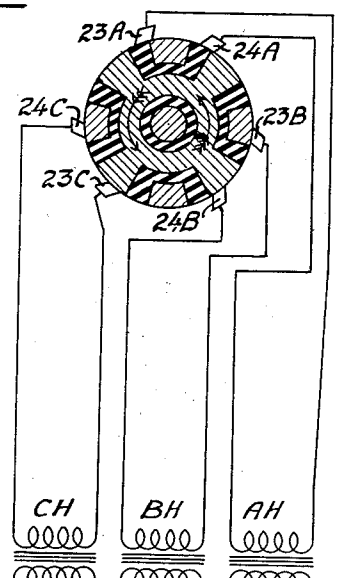


FIG. 4

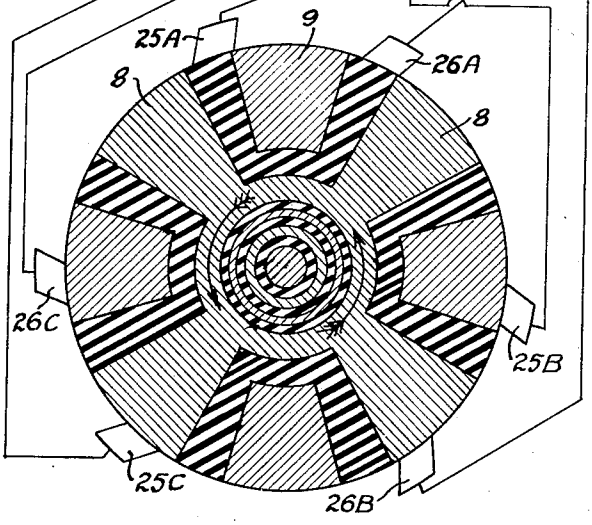


FIG. 5

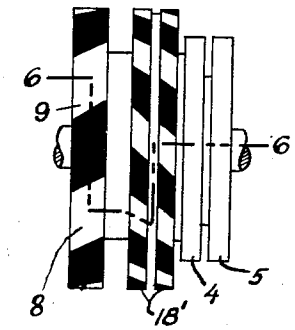
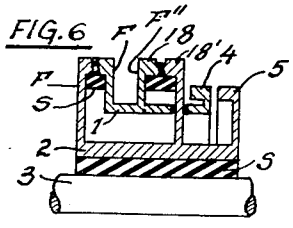


FIG. 6



Michael I. Topalov
INVENTOR

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2,164,964

DIRECT CURRENT TRANSFORMER

Michael I. Topalov, Detroit, Mich.

Application August 10, 1936, Serial No. 95,160

8 Claims. (Cl. 171—97)

My invention relates to apparatus for the conversion, inversion, rectification and/or transformation of electrical currents.

It is an object of my invention to provide electrical current transforming apparatus comprising an improved commutator of a simplified construction which also provides for improved capacity, wave form and phasing.

The invention itself, however, both as to its organization and its operation, together with additional objects and advantages thereof will best be understood from the following description, when read in connection with the accompanying drawing, in which:

Figure 1 is a side elevation view of a polyphase converter-rectifier, with associated circuit connections represented diagrammatically;

Figure 2 is a cross sectional view taken upon zigzagged line 2—2 of Figure 1, showing the manner of connection between the slip rings and the contact segments;

Figure 3 is a partially diagrammatic view showing the circuit connections through a cross-section of the commutator taken on line 3—3 of Figure 1;

Figure 4 is a partially diagrammatic view showing the circuit connections through a cross-section of the commutator taken on line 4—4 of Figure 1;

Figure 5 is a side elevational view showing another embodiment of my converter; and

Figure 6 is a sectional view taken along line 6—6 thereof.

Referring more specifically to Figures 1, 2, 3 and 4 of the drawing, my improved current changing or transforming apparatus comprises an improved commutator construction consisting of a plurality of electrically conductive elements 1, 2, 1B, 2B of cylindrical conformations of different diameters mounted on a rotatable shaft 3 in concentric spaced apart relation with any suitable insulation material S disposed therebetween. The cylindrical conductive elements are of different lengths axially and are arranged in progressively projecting relation, with the longest cylindrical element adjacent the shaft.

A pair of slip rings 4 and 5 are supported on the adjacent ends of the shorter cylindrical elements 1 and 2, and a second pair of slip rings 4B and 5B are supported on the adjacent ends of the longer cylindrical elements. The two slip rings of each pair of rings are preferably of equal diameters, and the rings may be supported in axially spaced relations for conveniently engaging stationary brushes 6, 7, 6B and 7B, as shown in Figure 1.

From the opposite ends of the shorter pair of cylindrical elements 1 and 2, a pair of annular flanges F extend in axially spaced apart relation, as shown in Fig. 2. The outer rims of the annular flanges F carry contact segments 8 and 9 extending in alternately spaced relation disposed equidistantly about one or several circular paths to define a contact drum. The contact drum so formed is engaged by a plurality of spaced stationary brushes 25A, 25B, 25C, 26A, 26B and 26C, shown in Figure 4. Similarly from the opposite ends of the longer pair of cylindrical elements 1B and 2B, spaced annular flanges F' extend to support contact segments 8B and 9B in alternately spaced relation for similarly forming a smaller contact drum having one or several circular paths engaged by a plurality of spaced brushes, such as the brushes 23A, 23B, 23C and 24A, 24B and 24C shown in Figure 3.

The areas of the contacting surfaces of the segments 8, 9, 8B and 9B are made proportioned to the amplitude of the current in the parallel circuits through the commutator. Also, as may be seen in Figure 1, the shape of the contacting surface of each segment is such it has a maximum contacting area in the middle and is tapered at both the leading and lagging ends in the direction of rotation, effecting a desired increase or decrease in contact area with the engaging brushes, increasing or decreasing by this action gradually the current density, and providing for the desired proportions of the sine-wave curve of alternations. The brushes are made a little shorter than the length of the space between the contact segments to prevent short circuiting. The dimensions of different parts of the drums are proportional to the current and inversely proportional to the voltages to be applied.

Figures 1, 2, 3 and 4 show my improved device utilized in a system for direct current transformation. For this purpose the brushes 6B and 7B are connected by suitable conductors with the available source of direct current, which may be service line conductors L1 and L2, whereby the elements 1B and 2B are provided with constant and opposite polarity, and the associated contact drum comprises a series of oppositely charged contact segments. As shown, the brushes 6 and 7 are connected for energizing any load X which is to be energized by direct current of a higher voltage than available from the direct current service lines L1 and L2.

Upon each circumferential path of each of said drums bear the six brushes previously referred to, which are connected as three pairs of brushes as shown; the centers of brushes of the same pair are spaced at a distance equal to the distance between the centers of two adjacent contact-segments of opposite polarity; each pair of brushes with respect to the others in the same path is set up in advance 120 electrical degrees. The relative position of brushes is shown by the hatched squares 171. Each pair of brushes of the small drum is in circuit with the primary of one of the transformer coils as shown at AH, BH and CH, also the corresponding pair of brushes of the large drum is in circuit with the secondary of the same transformer coil.

The operation of this system of direct-current transformation is as follows: The primary direct-current is supplied to slip-rings 4B and 5B of the rotating converter-rectifier which are connected with the respective contact-segments. By means of said contact-segments and the stationary brushes bearing upon them the current is distributed among eighteen primary parallel circuits in the time sequence of the eighteen-phase alternating current. Only three of said circuits are shown for the sake of clearness. For example, a pair of brushes 23A—24A which begins to come in contact with the positive-negative pair of adjacent contact-segments will gradually increase the contact area and the current density in the AH branch circuit until they attain a maximum at the center of the segment, then the contact area will gradually decrease, decreasing the current density until the brushes attain a neutral position between the segments, thus making a positive half of a cycle, or 180 electrical degrees. Thereupon both said brushes begin contacting the next pair of segments which is negative-positive, so the current in said branch circuit is reversed, repeating the increase, the maximum, the decrease and the neutral position and completing the negative half of the cycle. These halves of the current cycle passing through the primary winding AH induce in the secondary winding AL the halves of transformed current cycles in opposite directions. The connections with the segments of converting drum and the connections with the segments of rectifying drum with their respective induction coils being changed or advanced simultaneously, the negative half of the secondary cycle is always supplied to the positive segment of the rectifying drum and the positive half of the same cycle to the negative segment. Also all the successive half cycles of alternations in various phases are fed to segments of the proper polarity of the rectifying drum and to its slip-rings 4—5 from which the direct current of a changed voltage is collected by the brushes 6—7 of the secondary direct-current line. Since the contact segments of like polarity enter in contact with the brushes gradually, one contact beginning while the others are in continuation and since a number of circuits is always in contact with respective segments, the primary and the secondary direct-currents are kept uninterrupted, though in the parallel branches the current is made alternating. For the same reason the current density in the individual contact-segments remains low and unchanged although the contact area with a particular brush is gradually decreasing until the contact ceases entirely, inasmuch as a free path for the current is provided in the copper of several other circuits continuing at the instant of the contact with respective pairs of brushes. The current having several free paths in the copper would not jump through the air following the brushes changing the segments.

Thus the excessive sparking in this apparatus is prevented by the provision of a free and uninterrupted path for the current in the copper of a number of acting circuits.

The direct current changer may be designed to operate on a smaller or greater number of phases, but the larger number of phases is more effective because this operates to decrease the heating of the device, increasing its capacity. The capacity of such current changers is limited generally by the temperatures to which the various parts may be allowed to rise with safety. The decrease in heating is directly proportional to the difference between the square of the main current and the sum of the squares of currents flowing in the parallel branches. Thus the larger number of phases makes possible a greater capacity for a given size of unit.

In Figures 5 and 6 I have shown an embodiment comprising only two of the cylindrical electrically conductive elements 1 and 2 mounted in concentric spaced apart relation on a rotatable shaft 3. As in the previous embodiments, one of the cylindrical elements 2 is of smaller diameter and being longer axially it projects from both ends of the shorter but larger element. Two adjacent ends of the cylindrical elements 1 and 2 carry annular flanges F in axially spaced relation and contact segments 8 and 9 project therebetween in circumferential equally spaced relation for defining a contact drum, as in the previously described embodiment.

A pair of slip rings 4 and 5 is similarly supported in axially spaced relation from the opposite ends of the elements 1 and 2 for engaging brushes (not shown). An intermediate contact drum is formed by an annular flange F'' carried on an intermediate portion of the cylindrical element 1 to which it may be secured in any suitable manner. Contact segments 18 extend axially from the outer rim of the flange F'' in circumferentially spaced relation and interposed therebetween are contact segments 18' which pass through apertures in the outer cylindrical element 1 for conductive attachment on the inner cylindrical element 2, in any suitable manner. The contact segments 18' are divided to form two circular paths for engaging brushes (not shown) arranged in two sets, as for dividing alternating current to a greater number of phases and the like. The size and spacing of the contact segments is arranged with proper consideration of the voltage and current to be applied therethrough and each brush engaging area is of a tapered conformation at its leading and lagging ends. The frequency is determined by the speed at which the commutator is rotated, and the number and angular spacing of the contact segments provided.

By disposing suitable sets of brushes engaging the end contact drum and the intermediate contact drum, the simplified construction of Figures 5 and 6, may be conveniently utilized for various purposes such as changing a two-phase current of a certain voltage, frequency and amplitude to a three-phase or to a six-phase current of a different voltage frequency, and amplitude and vice versa, as will be readily understood. Also by utilizing the slip rings for direct current connection, this simplified device can be utilized for converting direct current to alternating current

of various frequencies, and vice versa. The number of contact segments provided, and the speed at which the shaft 3 is rotated bears a predetermined relation to the frequency of the alternating current which is to be inverted, converted or transformed, which will be readily understood.

For certain purposes the intermediate contact drum 18' is unnecessary and may be omitted thus providing a simplified construction consisting only of the pair of cylindrical elements 1 and 2, having the pair of slip rings at one end, and a single circular path of contact segments. This simplified arrangement is sufficient to accomplish the purpose of changing direct current to alternating current, or vice versa, as will be readily understood.

It is obvious that various modifications may be made both in the apparatus and circuit connections herein shown and described, without departing from the principle of my invention, and those which are shown are only examples explaining the various modes of use of the same converter-rectifier.

I claim:

1. A commutator for mechanical polyphase converters comprising, a shaft, a pair of electrically conductive cylindrical elements of different diameters disposed in insulated concentric relation on said shaft, the cylindrical element of smallest diameter being longest in axial length for extending at one end beyond one end of the short cylindrical element, a pair of slip rings disposed on the unequally extended ends of said cylindrical elements for continuously engaging brushes of different polarity, and contact segments extending from the other ends of said cylinders in alternately spaced relation in a circular path around the commutator for engaging a plurality of spaced brushes.

2. A commutator for a mechanical polyphase converter comprising, a shaft, a pair of insulated metallic elements of cylindrical conformation of different diameters disposed in concentric relation on said shaft, the cylindrical element of smallest diameter being longest for extending beyond the ends of the short cylindrical element, a pair of slip rings of substantially equal diameters disposed on adjacent ends of said cylindrical elements in axially spaced relation for continuously engaging a pair of axially spaced brushes, contact segments extending from the other end of one of said cylinders in a circular path around the commutator, and contact segments extending from the adjacent end of the other one of said cylinders in alternately spaced relation between said first mentioned contact segments.

3. A commutator for a mechanical polyphase converter comprising, a shaft, a pair of cylindrical metallic elements of different diameters disposed in insulated concentric relation on said shaft, the cylindrical element of smallest diameter being longest for extending beyond the ends of the short cylindrical element, a pair of slip rings disposed on adjacent ends of said cylindrical elements for continuously engaging brushes, spaced annular flanges projecting laterally from the other axially spaced ends of said pair of cylinders, and contact segments projecting from the outer rims of said flanges respectively in alternately spaced relation to define a contact drum for engaging a plurality of spaced brushes.

4. A commutator for a mechanical direct current transformer comprising, a shaft, four electrically conductive cylindrical elements of different diameters disposed in insulated concentric relation on said shaft, said cylindrical elements being of different lengths with the longest cylindrical elements adjacent said shaft and projecting progressively beyond the encircling elements, slip rings supported on the ends of said cylindrical elements projecting progressively toward one end of the shaft, contact segments extending from the other ends of the larger pair of cylinders in alternately spaced relation defining a circumferential path around the commutator for engaging a plurality of brushes, and contact segments extending from the other ends of the smaller pair of cylinders in alternately spaced relation defining a circumferential path around the commutator in axially off-set relation from the first mentioned path for engaging a second set of brushes.

5. A commutator for a mechanical direct current transformer comprising, a shaft, four electrically conductive cylindrical elements of different diameters disposed in insulated concentric relation on said shaft, said cylindrical elements being of different lengths arranged in progressively projecting relation with the longest cylindrical element adjacent said shaft, slip rings supported on the ends of the cylindrical elements which project progressively toward one end of the shaft, four spaced annular flanges projecting respectively from the other axially spaced ends of said cylindrical elements in two pairs of substantially equal diameters, and contact segments projecting from the respective rims of said pairs of flanges in alternately spaced relation to define two contact drums for engaging a plurality of spaced brushes.

6. A commutator for a mechanical polyphase converter comprising, a shaft, a pair of metallic elements of cylindrical conformation having different lengths and diameters, said elements being mounted in insulated concentric relation on said shaft with the longest element disposed next adjacent the shaft, a pair of slip rings disposed on unequally extended ends of said cylindrical elements for continuously engaging brushes of different polarity, contact segments extending from the other end of one of said cylindrical elements in a circular path around the commutator contact segments extending from the adjacent end of the other one of said cylindrical elements in alternately spaced relation between the first mentioned contact segments to define a contact drum for engaging a plurality of spaced brushes, and each one of said contact segments having a contact surface of a conformation tapering on both the leading and the lagging extremities thereof.

7. A commutator for a mechanical polyphase converter comprising, a shaft, a pair of metallic elements of cylindrical conformation having different lengths and diameters, said elements being mounted in insulated concentric relation on said shaft with the longest element disposed next adjacent the shaft, a pair of slip rings disposed on unequally extended ends of said cylindrical elements for continuously engaging brushes of different polarity, contact segments extending from the other end of one of said cylindrical elements in a circular path around the commutator, a plurality of contact areas on each one of said contact segments for defining a plurality of circumferential paths around the commutator as it rotates, contact segments extending from the ad-

jacent end of the other one of said cylinders in alternately spaced relation between the first mentioned contact segments, a plurality of contact areas on each one of the contact segments extending from said other one of said cylinders, said second mentioned contact areas being disposed in axial alignment with the first mentioned contact areas whereby a plurality of circumferential paths are described as the commutator rotates for contacting a plurality of sets of spaced brushes and thus dividing the current from the commutator.

8. A commutator for a mechanical polyphase converter comprising the combination defined in claim 7; in which each one of the contact areas is of a size proportional to the size of the brushes to be used, and each contact area has a contact surface of a conformation tapering on both the leading and the lagging extremities thereof.

MICHAEL I. TOPALOV.