United States Patent [19]

Ioffe et al.

[11] **3,924,211**

[45] **Dec. 2, 1975**

[54] **METHOD OF ORIENTING ELECTRICALLY CONDUCTIVE BODIES, PREFERABLY NON-MAGNETIC ONES, IN A MAGNETIC FIELD AND APPARATUS FOR PERFORMING SAME**

[76] Inventors: **Benyamin Alexandrovich Ioffe,** ulitsa Raunas, 45/2, kv. 81; **Robert Karlovich Kalnin,** ulitsa Gorkogo, 53, kv. 19; **Vyacheslav Semenovich Dorofeev,** ulitsa Frunzes, II, kv. 5; **Viktor Georgievich Sirotenko,** ulitsa Strelnieku, 19, kv. 3, all of Riga; **Vladimir Borisovich Larin,** ulitsa Lomonosova, 2/72, kv. 30, Smolensk; **Gunar Yanovich Sermons,** ulitsa Skolas, 22, kv. 17; **Alexandr Alexandrovich Shevchenko,** ulitsa Suvorova, 23, kv. 4, both of Riga, all of U.S.S.R.

[22] Filed: **Dec. 15, 1969**

[21] Appl. No.: **885,190**

[30] **Foreign Application Priority Data**

Dec. 25, 1968 U.S.S.R. 1289054
Dec. 25, 1968 U.S.S.R. 1289056

[52] **U.S. Cl.** **335/284;** 335/250; 335/281; 335/282; 335/299

[51] **Int. Cl.** **H01f 13/00**

[58] **Field of Search** 209/215; 214/152; 198/41; 335/284, 299, 250, 229, 234, 281, 282, 297, 250

[56] **References Cited**

UNITED STATES PATENTS

698,027	4/1902	Knapp	335/234
2,079,241	5/1937	Burt	335/297
2,400,869	5/1946	Lovell	335/250
2,423,524	7/1947	Side	335/179 X
3,054,026	9/1962	Lovell	335/250

FOREIGN PATENTS OR APPLICATIONS

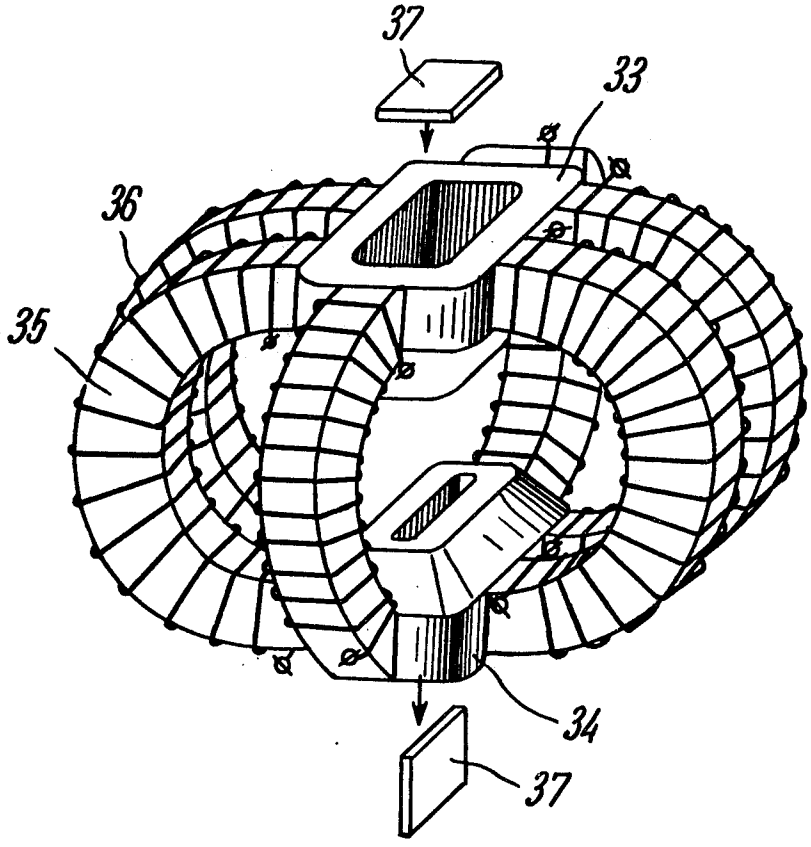
181,481	10/1964	U.S.S.R.	335/229
985,815	4/1951	France	335/297

Primary Examiner—J. D. Miller
Assistant Examiner—Fred E. Bell
Attorney, Agent, or Firm—Waters, Schwartz & Nissen

[57] **ABSTRACT**

A method of orienting electrically conductive bodies, preferably, non-magnetic ones, in a magnetic field and apparatus for performing such method, wherein a body is oriented under the action thereupon of a non-uniform magnetic field induced by an alternating electric current, by means of electromagnets connected to an alternating current supply, the pole pieces of these magnets defining therebetween an orientation zone, whereby a body can be oriented both from an arbitrary position and from any intermediate position into a predetermined final spatial position, with the final oriented position of the body being retained.

3 Claims, 9 Drawing Figures



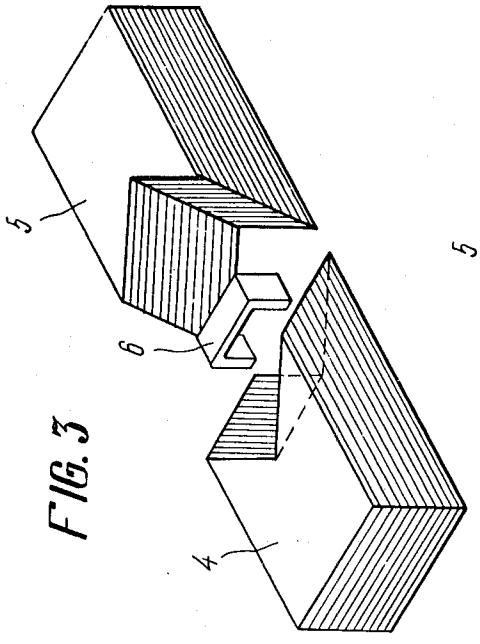


FIG. 3

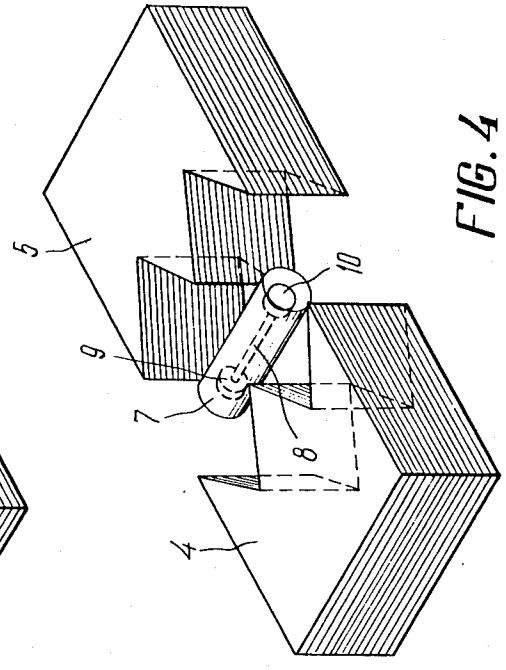


FIG. 4

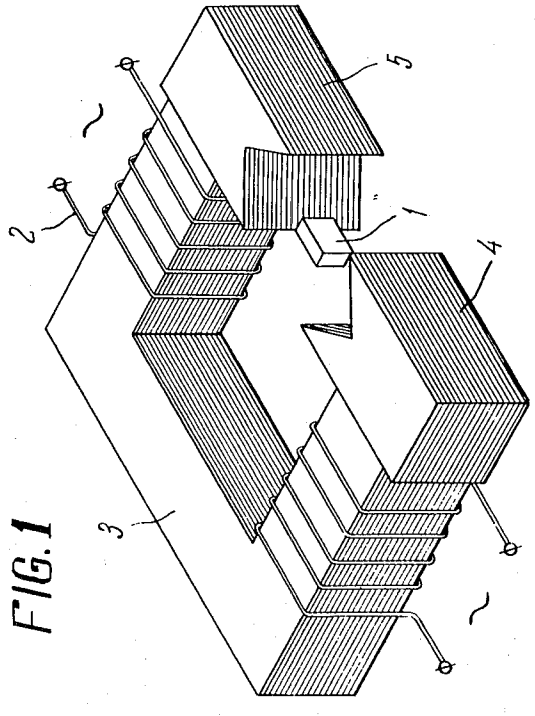


FIG. 1

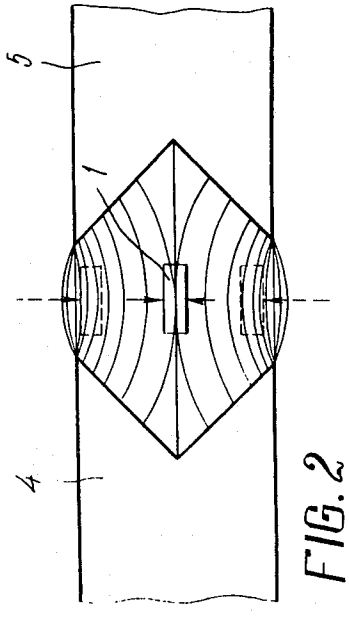


FIG. 2

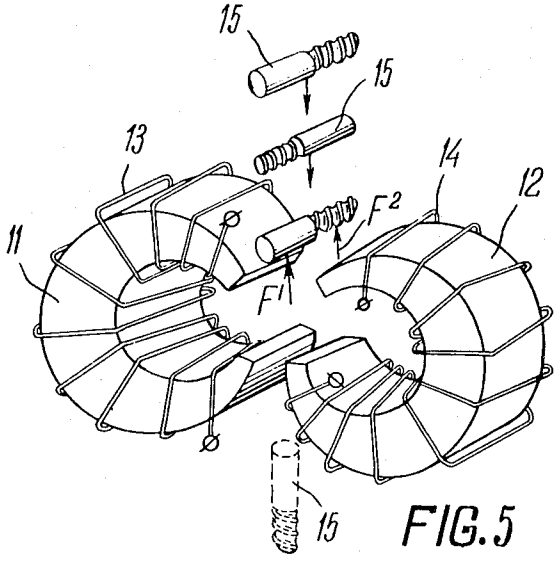
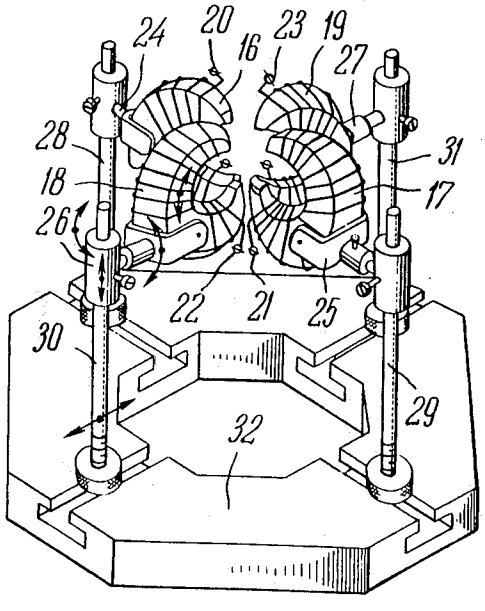

15
15
13
14
12
11
F2
F1
15

FIG. 5


15

FIG. 6


24
20
16
23
19
27
28
31
18
17
26
22
21
25
30
29
32

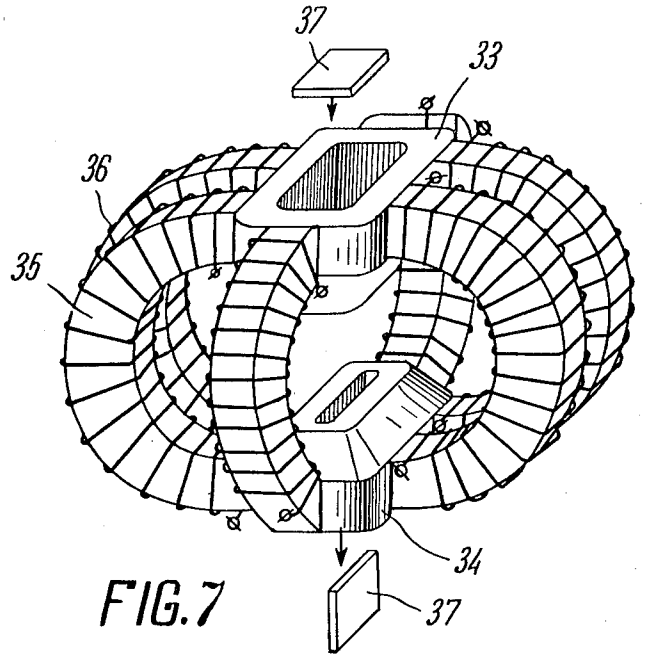


FIG. 7

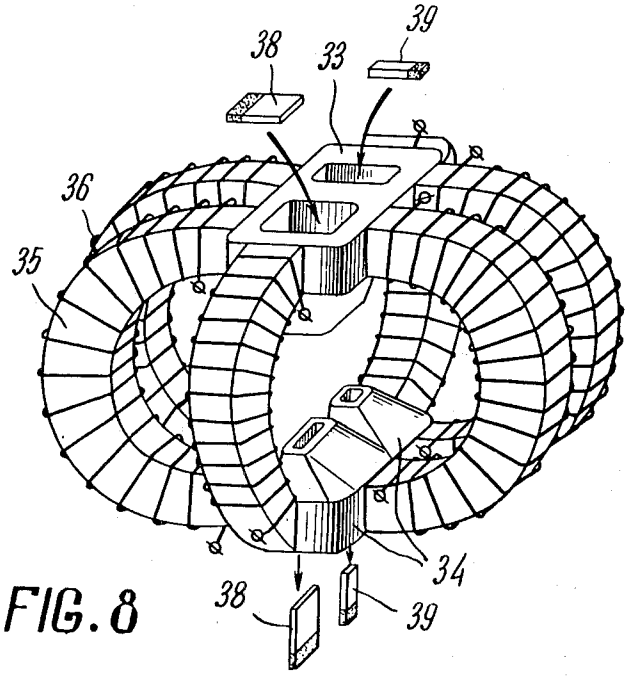


FIG. 8

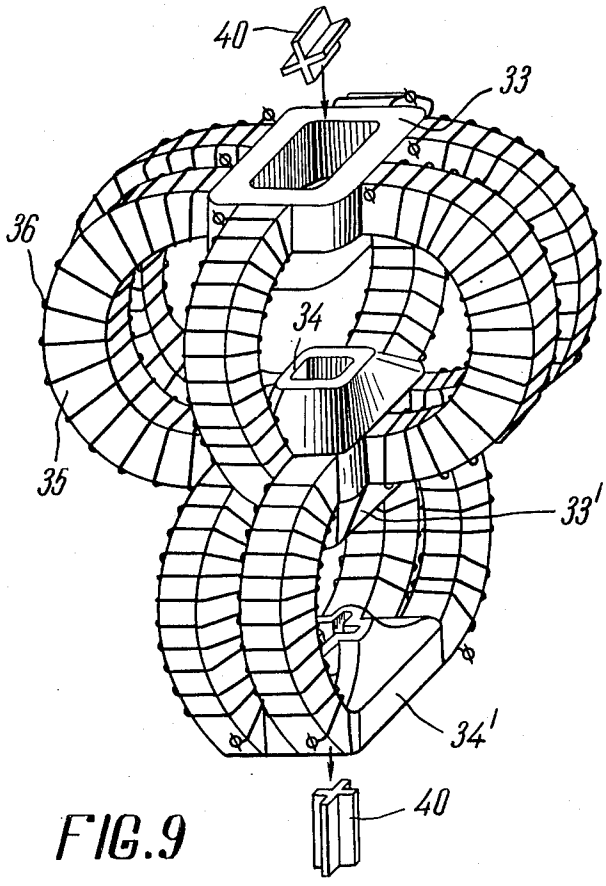


FIG. 9

METHOD OF ORIENTING ELECTRICALLY CONDUCTIVE BODIES, PREFERABLY NON-MAGNETIC ONES, IN A MAGNETIC FIELD AND APPARATUS FOR PERFORMING SAME

The present invention relates to a method of orienting electrically conductive bodies, including non-magnetic ones, in a magnetic field and to apparatus for performing the same, and is useful in various industries in which electrically conductive bodies are to be oriented for further treatment. The invention can be widely used for introducing automation into processes in which various articles and workpieces are to be oriented in the course of their being manufactured or assembled into units, machines, apparatus and so forth.

A method of orienting electrically conductive bodies is known, according to which the orientation operation is performed due to an interaction of the magnetic field of a permanent magnet with alternating electric currents induced in the bodies being oriented.

This known method, however, provides merely for orienting successive bodies or workpieces from an arbitrary position into a single predetermined intermediate position, and does not provide for orienting a body into a desired final position both from an arbitrary position and from any intermediate position, depending on a characteristic feature of said body, e.g. a projection, an aperture, a groove or slit in one of the sides of the body, a structural difference between the portions of the body, and so forth. Additionally this known method is incapable of retaining the bodies being oriented in a desired position, which is essential for the majority of production processes.

It is an object of the present invention to overcome the disadvantages of the known method.

The present invention has as a more specific object the provision of a method of orienting electrically conductive bodies, including non-magnetic ones, in a magnetic field, and of apparatus for performing the same, which method should provide for a body's being simultaneously oriented and retained in an oriented position, relative to two or more perpendicular reference planes. This method should further provide for simple and efficient control of the parameters of the magnetic field created in the zone where said bodies are oriented, and should additionally provide for either simultaneous orientation of several streams of successive bodies, or for orienting successively supplied bodies under the action of different types of non-uniformity of a magnetic field, as these bodies are falling through a plurality of serially arranged magnetic systems.

According to the present invention, a method is provided for orienting electrically conductive bodies, wherein a body is oriented under the action of a non-uniform magnetic field induced by an alternating electric current, the inductance of said field decreasing in a direction toward the central portion of the orientation zone.

It is advantageous for the frequency of said alternating electric current inducing said magnetic field to be selected in accordance with a predetermined ratio of the inductive reactance to the resistance of said body being oriented.

A method, embodying the present invention, may be performed by the following types of apparatus:

an apparatus comprising at least one electromagnet having a winding adapted to be connected to an alternating current supply source and a magnetic core including at least one pair of pole pieces defining therebetween an orientation zone, said pole pieces being shaped and arranged relative to each other to create a non-uniform magnetic field of which the inductance decreases toward the central portion of said orientation zone; each one of said pole pieces preferably having at least one V-shaped cut facing said orientation zone;

an apparatus comprising at least two electromagnets, each including a C-shaped magnetic core, said respective magnetic cores being adjustably mounted for selective positioning thereof relative to one another, each one of said electromagnets being adapted to be connected to a source of alternating electric current of adjustable frequency;

an apparatus comprising an electromagnet including a plurality of generally C-shaped magnetic cores, all of said magnetic cores being associated with a pair of pole pieces, the first one of said pair of pole pieces being disposed above the second one of said pair of pole pieces, said first pole piece having at least one passage therethrough through which a body can be introduced into an orientation zone, said second pole piece having at least one aperture therethrough through which a body can leave said orientation zone after the orientation operation.

In a further modification of the last-mentioned type of apparatus, the magnetic core assembly may be a multi-level one, having a respective pole piece at each of the levels thereof, all of said apertured pole pieces being preferably shaped as truncated pyramids, the small bases of said truncated pyramids of the adjacent ones of said pole pieces facing each other, the cross-sectional shape of each one of said apertures through which a body can leave said orientation zone corresponding to the contour of said body in a plan view.

The herein disclosed method of orienting electrically conductive bodies in a magnetic field and the apparatus performing same have been found to attain successfully the above-specified aims and objects.

The present invention will be better understood from the following detailed description of some of the preferred embodiments of a method of orienting electrically conductive bodies in a magnetic field, as well as of several embodiments of apparatus for performing the same, with due reference being had to the accompanying drawings, wherein:

FIG. **1** shows schematically and in perspective a general view of an apparatus, embodying the invention, with pole pieces having a V-shaped cutaway portion;

FIG. **2** illustrates the distribution of the magnetic flux in the space between the pole pieces and indicates the forces acting upon a body in the respective areas of the orientation zone;

FIG. **3** shows in detail the pole pieces of an apparatus, according to FIG. **1**, having their respective V-shaped cuts slanting relative to a vertical plane, defining an orientation zone which flares upwardly;

FIG. **4** shows in detail the pole pieces of an apparatus, as shown in FIG. **1**, each of the pole pieces having a pair of adjacent V-shaped cuts;

FIG. **5** shows an apparatus, embodying the invention, having a pair of electromagnets, each with a C-shaped magnetic core;

FIG. **6** shows a structure wherein a plurality of apparatus of the kind shown in FIG. **5** are mounted for relative adjustable positioning;

FIG. 7 shows the general view of an apparatus, embodying the invention, including an electromagnet with a plurality of individual C-shaped magnetic cores associated with a single pair of pole pieces, adapted for orienting a single stream of successive bodies;

FIG. 8 shows a view similar to that in FIG. 7, with pole pieces adapted for orienting simultaneously two parallel streams of successively fed bodies; and

FIG. 9 shows an apparatus, of the kind shown in FIG. 7, having a multi-level magnetic core, with a pole piece at each level.

Referring now in particular to the appended drawing, the herein disclosed method of orienting electrically conductive bodies resides in the following:

A body 1 (FIG. 1) is introduced into the space between the pole pieces, where a non-uniform magnetic field created by an alternating electric current acts thereupon, whereby the body 1 is oriented in a desired direction. In the herein dislosed example, the non-uniform electric field is created by an electromagnet having a winding 2 connected to an alternating-current supply, and a magnetic core 3 with a pair of pole pieces 4 and 5, defining therebetween an orientation zone for the body 1. It is essential that this non-uniform magnetic field created by the alternating current should have its inductance decreasing toward the central portion of the orientation zone, which can be attained by shaping the pole pieces correspondingly, and also by appropriately positioning them relative to each other. In the apparatus illustrated in FIG. 1, this feature is attained by the pole pieces 4 and 5 being provided each with a V-shaped cutaway portion, or cut facing the orientation zone. Such configuration of the pole pieces is responsible for the creation of a distinct retaining plane (i.e. a plane where a body is retained in an oriented position thereof), which plane, as can be seen in FIG. 2, is disposed in the central portion of the space between the pole pieces, intermediate the spaced apices of the V-shaped cuts. The inductance in this portion of the orientation zone is lower than in any other portion thereof. The herein disclosed method provides for adjusting the torque acting upon the body being oriented, by means of controlling correspondingly in any known way the frequency of the alternating current creating the magnetic field. It is possible, for example, to select a frequency so that the inductive reactance and the resistance of the body equal each other, in which case the torque acting upon the body acquires a maximal value.

The V-shaped cuts in the pole pieces 4 and 5 can be made slanting relative to a vertical plane, as is shown in FIG. 3, in which case an upwardly flaring orientation zone is defined, whereby a body is finally retained in an oriented position at a given point. The body 6 shown by way of example in FIG. 3 is a yoke, which in the orientation zone of the kind herein illustrated would be oriented from any initial position into the finally oriented position shown, and this oriented position would be retained.

The angular value of the V-shaped cut and the degree of the slanting thereof relative to a vertical plane are selected in order to obtain a distinct retaining plane, in accordance with the actual spacing of the pole pieces.

The pole pieces may have two or even more V-shaped cuts each, as is shown in FIG. 4. In this manner it becomes possible to retain a body in an oriented position, depending on several characteristic features thereof simultaneously, e.g. by several features. Shown by way of example in FIG. 4 is a cylinder-shaped body having a dielectric housing 7 receiving thereinside an electrically conductive non-magnetic member including a thin rod 8 carrying two discs 9 and 10. Bodies of this kind can be oriented by the herein disclosed method and can be retained in an oriented position, depending on the position of their internal members. To this end, the distance between the apices of the two V-shaped cuts of each of the two pole pieces is made equal to the spacing between the discs 9 and 10 of the internal member of the body. Moreover, an orientation zone of the last-mentioned shape can be used for orienting and retaining more than two streams of successive bodies simultaneously, provided the dimensions of the bodies correspond to the spacing between the respective pairs of V-shaped cuts facing each other, and that the bodies are oriented depending on a single characteristic feature thereof.

The herein disclosed method of orientating electrically conductive bodies can be performed by another, basically similar apparatus, wherein a non-uniform magnetic field acting upon the bodies being oriented is created by two electromagnets including their respective C-shaped magnetic cores 11 and 12 (FIG. 5) and windings 13 and 14 adapted to be supplied with an alternating electric current. The two electromagnets are so positioned, that their similar pole-pieces are brought adjacent to each other and create a common magnetic field in the orientation zone. In the example illustrated in FIG. 5 the body being oriented is an asymmetrical stem 15 heaving a threaded end, whereby the two end portions of the stem 15 feature different electrical conductivity, and, therefore, are oriented in the magnetic field with the desired one of the two ends leading.

A structure including two electromagnets is particularly suitable for establishing a desired degree of the non-uniformity of the magnetic field in the orientation zone, which is attained by placing the lower pair of the pole pieces of the two electromagnets at a distance from each other, which is slightly greater than the respective dimension of the body to be oriented, while the other, upper pair of the electrodes is spaced from each other by a distance which is experimentally found to be the most suitable for accurate orientation. Owing to interaction of such fanshaped non-uniform magnetic field with the body being oriented, there are applied to the opposite end portions of the body the two unequal resultant components of the electrodynamic forces, F_1 and F_2, respectively, which tend to oust the body from the orientation zone, whereby the inequality of these components produce a torque which turns the body into a position indicated by a dotted line in FIG. 5. By turning the two electromagnets relative to each other in a given plane and spacing them suitably in the same plane, it is easy to form a non-uniform magnetic field in this very plane of the orientation zone, whereas for forming an orientation zone featuring a three-dimensionally non-uniform magnetic field, it is advisable to employ more than two C-shaped electromagnets.

Illustrated in FIG. 6 is yet another apparatus, embodying the invention, which comprises four electromagnets with their respective magnetic cores 16, 17, 18, 19 and windings 20, 21, 22, 23 which latter are either connected to a single source of single-phase alternating current, or else are connected to their respective individual sources, and thus create the respective mag-

netic fields characterized by different frequencies. The respective adjustable clamps **24, 25, 26, 27** carried by the upright supports **28, 29, 30, 31** hold the four electromagnets above the base **32,** so that the positions of the electromagnets can be selectively adjusted relative to one another. With the electromagnets thus arranged, successive bodies in the shape of, for example, square cups may be not only oriented for their butt ends to acquire a desired position, but they may be simultaneously rotated into a desired position of their side walls.

A method of orienting successive bodies, embodying the present invention, can also be performed by an apparatus illustrated in FIG. **7.** As can be seen from FIG. **7,** the electromagnet in the last-mentioned apparatus comprises a core assembly including a plurality of individual C-shaped core members **35** associated with a single pair of pole pieces **33** and **34.** The pole piece **33** is positioned above the pole piece **35,** and each of the plurality of cores **35** has wound thereabout a respective winding **36** having a limited number of coils. The upper pole piece **33** has a vertical passage therethrough for a body **37** to be introduced into the orientation zone, whereas the lower pole piece **34** has its own vertical passage, through which the body can leave the orientation zone after the orientation operation, the cross-sectional shape of the passage in the lower pole piece corresponding to the contour of the body in a plan view, in a desired oriented position of this body. The pole pieces **33** and **34** are shaped as truncated pyramids, the lower bases of the two pyramids facing each other, whereby the magnetic flux is concentrated within the peripheral outline of the body **37** in any initial position thereof. With the magnetic core thus arranged, there is a funnel-shaped non-uniform magnetic field created in the orientation zone, which field provides for orienting successive bodies even in the course of their short-distance descent through the orientation zone. By the cores **35** being arranged about the whole periphery of the pole pieces **33** and **34,** it becomes possible to attain a magnetic field which is more evenly distributed in the orientation zone, the inductance of the field decreasing toward the central portion of the zone.

The magnetic core structure of the kind shown in FIG. **7** can be readily built up from a desired number of easily attachable core members **35.** By having in stock a comparatively small set of such core members, it becomes possible to build up various apparatus of a similar kind with extreme ease and flexibility.

An apparatus of the last-mentioned kind can be used also for orienting simultaneously several streams of successively fed asymmetrical bodies. For example, for orienting simultaneously two streams of bodies **38** and **39,** respectively (FIG. **8**), the apparatus features two orientation zones, each of them being similar to the orientation zone illustrated in FIG. **7.**

Moreover, an apparatus of the last-mentioned kind may be a multi-level one, which arrangement shows utmost efficiency, when a body cannot be oriented into a final desired position within a single space between a pair of pole pieces.

Illustrated in FIG. **9** is an apparatus with a two-level magnetic core structure, which apparatus is meant for orienting, for example, cross-shaped pieces **40.** The first stage, or level of this apparatus reliably orients the body **40** by one of the planes thereof relative to the direction of its descent through the apparatus, whereas in the second stage, or level of the apparatus, i.e. in the orientation zone defined between the pole pieces **33'** and **34'**, the body is rotated into a desired spatial position of its cross-shaped cross-section about the axis off its descent.

All of the above-described kinds of apparatus can be easily associated with known feeding arrangements and can be trusted for high efficiency and speed of their operation.

What is claimed is:

1. An apparatus for orienting electrically conductive bodies, said apparatus comprising an electromagnetic including magnetic core means including a plurality of generally C-shaped magnetic core members cooperatively defining an orientation zone, said electromagnet also comprising winding means adapted to be connected to an alternating electric current source, a pair of pole pieces, all of said plurality of magnetic core members being associated with said pair of pole pieces, a first one of said pole pieces being disposed above a second one of said pole pieces, said first pole piece provided with at least one passage extending therethrough, through which a body can be introduced into said orientation zone to be oriented therein, said second pole piece being provided with at least one passage extending therethrough, through which said body can leave said orientation zone after the orientation operation.

2. An apparatus, as set forth in claim **1,** wherein said magnetic core means including said plurality of generally C-shaped magnetic core members is associated with a plurality of pole pieces, said magnetic core means being of a multi-level structure, with a respective one of said plurality of pole pieces being disposed at each level of said magnetic core means.

3. An apparatus, as set forth in claim **1,** wherein each of said pole pieces is shaped as a truncated pyramid having a smaller base and a greater base, the smaller bases facing each other, the cross-sectional shape of each said passage through which said body can leave the respective orientation zone corresponding to the contour of said body in a plan view.

* * * * *