

[54] **METHOD OF ORIENTATION OF
NONMAGNETIC CURRENT-
CONDUCTING BODIES MAGNETIC
FIELD AND DEVICES FOR CARRYING
SAME INTO EFFECT**

[72] Inventors: **Bruno Domenikovich Zheigur**, ulitsa Miera, 18, kv. 7, Poselok Salaspils Rizhsky raion; **Robert Karlovich Kalnin**, ulitsa Gorkogo, 53, kv. 19; **Benyamin Alexandrovich Ioffe**, ulitsa Raunas, 45/2, kv. 81; **Alexandr Alexandrovich Shevchenko**, ulitsa Suvorova, 23, kv. 4; **Vyacheslav Semenovich Dorofeev**, ulitsa Frunzes, 11, kv. 5, all of, Riga; **Artur Eduardovich Mikelson**, ulitsa Miera, 16, kv. 36, Poselok Salaspils Rizhsky raion; **Igor Mikhailovich Kirko**, ulitsa Kr. Barona, 78, kv. 1, Riga, all of U.S.S.R.

[22] Filed: **Dec. 16, 1969**

[21] Appl. No.: **885,534**

[30] **Foreign Application Priority Data**

Dec. 25, 1968	U.S.S.R.	1289052
Dec. 25, 1968	U.S.S.R.	1289060
Dec. 25, 1968	U.S.S.R.	1289062

[52] U.S. Cl. 198/33 AB, 198/33 AD
[51] Int. Cl. B65g 47/24
[58] Field of Search 198/33 R, 33 AA, 33 AB, 33 AC,
198/41; 271/18.1; 221/156

[56] **References Cited**

UNITED STATES PATENTS

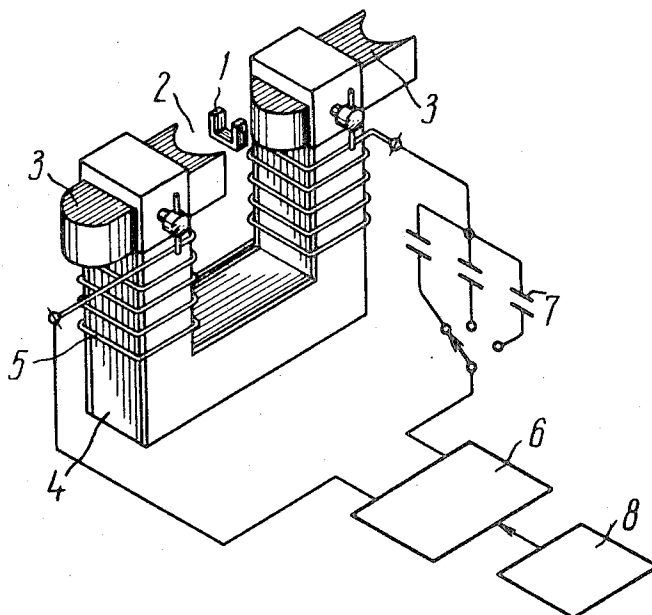
2,940,583	6/1960	Louercheck	198/41
3,353,822	11/1967	Dangelmaier	271/18.1

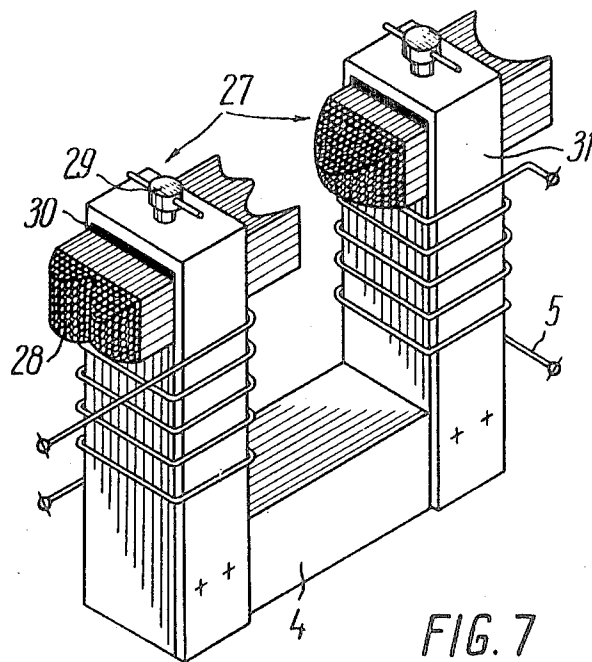
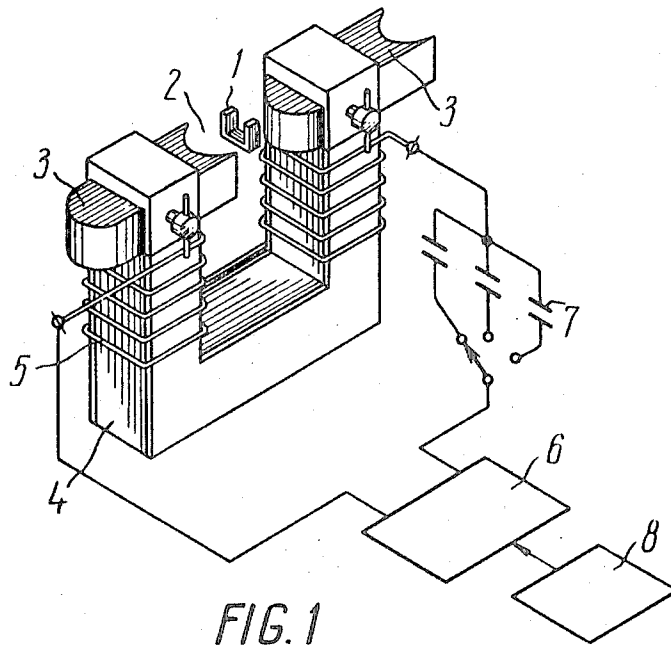
Primary Examiner—Richard E. Aegerter
Attorney—Waters, Roditi, Schwartz & Nissen

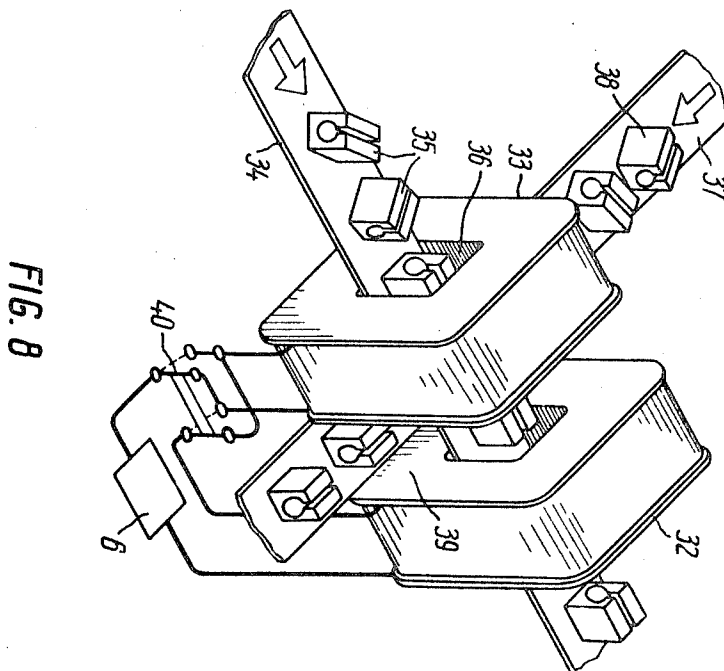
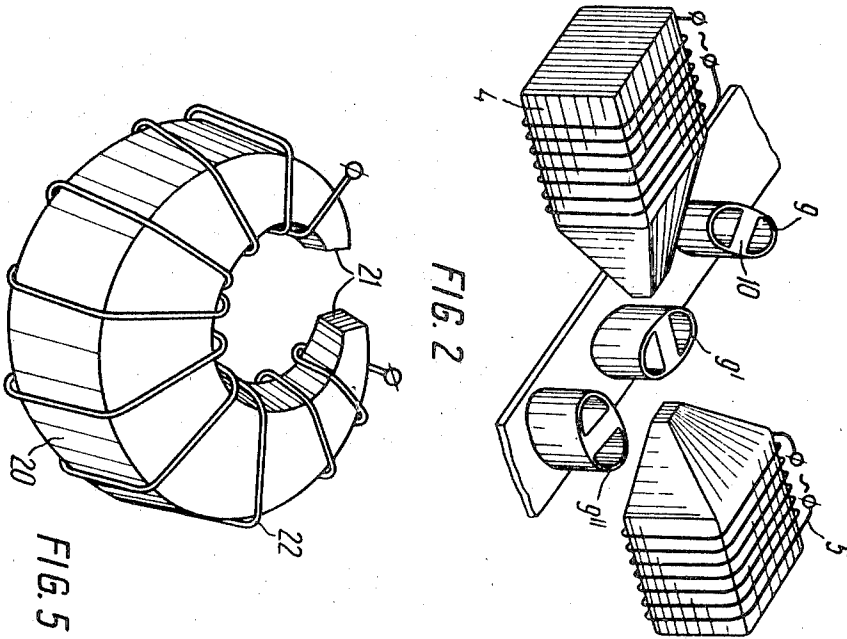
[57] **ABSTRACT**

The present invention relates to methods for orientation of current-conducting bodies and devices for carrying into effect the methods. One of such devices comprise an electromagnet having a magnetic core including poles spaced to define an electromagnet having a magnetic core including poles spaced to define an orientation zone, a capacitor, a winding operatively associated with the core and connected in series with the capacitor, an AC supply source having a frequency corresponding to a selected relationship between the inductive and pure resistance of the bodies to be oriented and a conveyor system to move the bodies through the zone.

14 Claims, 8 Drawing Figures







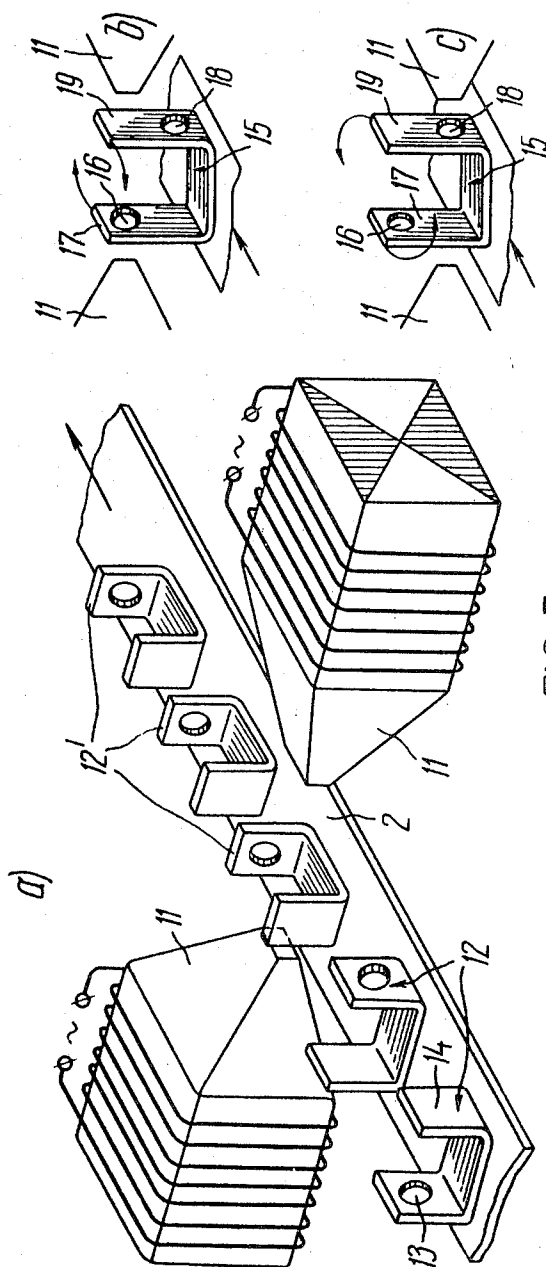


FIG 3

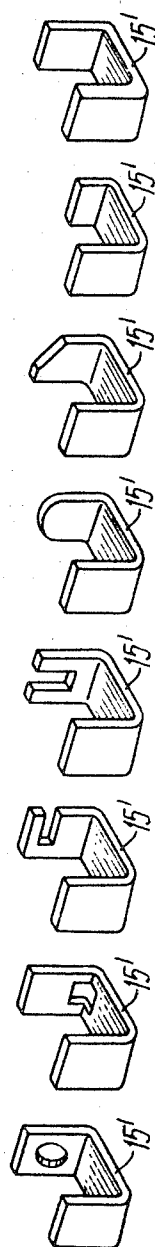
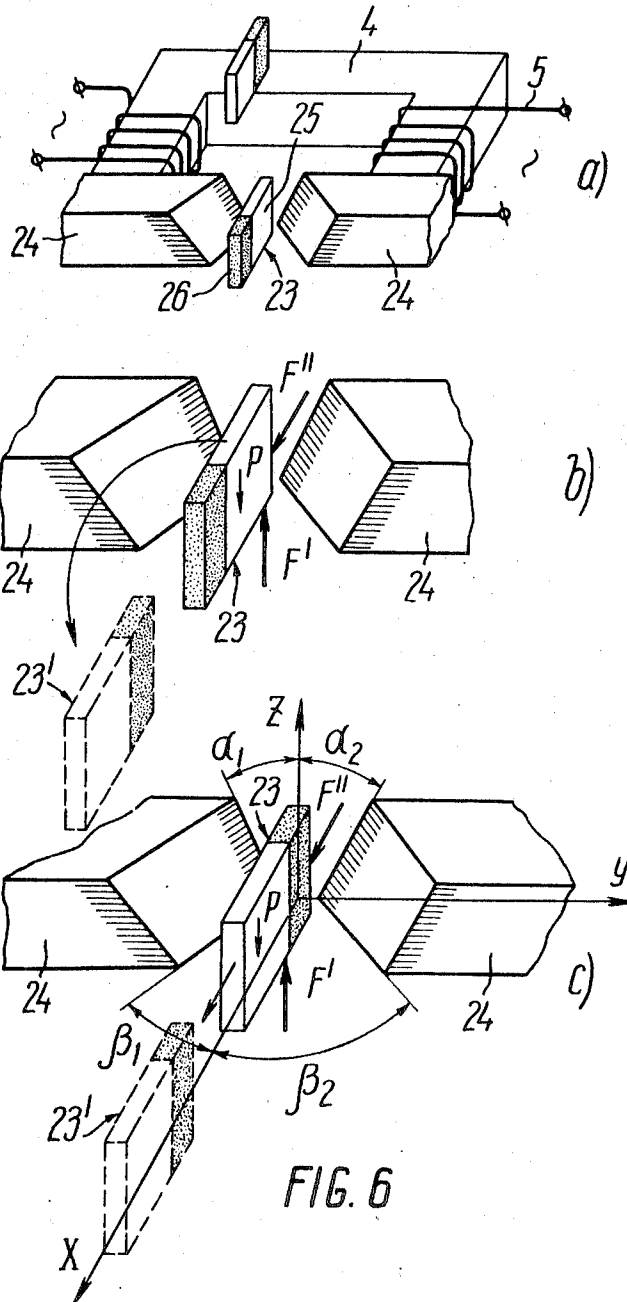


FIG. 4



METHOD OF ORIENTATION OF NONMAGNETIC CURRENT-CONDUCTING BODIES MAGNETIC FIELD AND DEVICES FOR CARRYING SAME INTO EFFECT

The invention is useful in various branches of technology such as in the automation of manufacturing processes, for the orientation of a variety of component members or parts in the course of their manufacture and also while using them for assembling various units, machines, apparatus and instruments.

Known in the art is a method for the orientation of current-conducting bodies based upon the interaction between a magnetic field created by a permanent magnet and alternating currents induced in the bodies to be oriented.

The above mentioned method is subject to a number of material disadvantages. Its application is limited since the bodies to be oriented must have a shape which provides for the flowing of currents induced therein in particular directions. Also said method fails to provide precise orientation of the current-conducting bodies due to vibration thereof. Further the devices adapted to carry said method into effect are complicated.

It is an object of the present invention to eliminate the above mentioned disadvantages.

The invention provides a method which would make it possible to obtain precise orientation of a variety of current-conducting bodies, mostly of nonmagnetic bodies, by resorting to simple means, and to provide devices for carrying said method into effect.

This object is accomplished by the fact that in the proposed method for the orientation of current-conducting bodies, mostly made of nonmagnetic material, by a magnetic field, according to the present invention, the bodies are oriented by an AC magnetic field, the frequency of the alternating current being selected depending upon the preselected relationship between the inductive and pure resistances of the bodies to be oriented.

It is preferred that the bodies to be oriented be acted upon by a nonuniform magnetic field whose induction is increased in the direction toward the orientation zone. The direction of orientation of the body involved may be changed by changing the direction of the magnetic field by varying the current frequency.

The bodies to be oriented are preferably to be acted upon by a magnetic field created by a group of AC pulses with the duration of each of the groups being not less than a current period of the selected frequency. In this case, the duration of the interval between the groups of the pulses is selected depending upon the condition that the body to be oriented, when in the orientation zone, be acted upon by a magnetic field which is created at least by one group of pulses.

The device for carrying into effect the method for orientation of current-conducting bodies may be essentially an electromagnet provided with a magnetic core, the orientation zone lying between the poles thereof, and with a winding connected in series with a capacitor both forming an oscillatory circuit tuned to the frequency of an AC supply source adapted to supply the aforementioned electromagnet and a controlled key switch which provides a pulse supply for the electromagnet.

In the above-mentioned device, the poles of the electromagnet may be in the shape of pyramids whose apices face one another.

It is preferred that the magnetic core be of a variable cross section, smoothly decreasing toward the poles. It is likewise advantageous that the poles be of such a shape that the orientation zone should widen in the direction from the beginning toward the end of said orientation zone. It is also preferred that the pole sides facing the orientation zone be essentially planes arranged vertically and/or at a certain angle to the vertical.

It is advantageous that the pole sides facing the orientation zone be essentially double-curvature surfaces.

The magnetic core is to be preferably provided with at least one pole tip made of separate wires adjustably rearrangeable

and fixable with respect to each other, the number and the diameter of said wires being selected depending upon the requirements of the preselected accuracy of approximation of the desired shape of the pole tip.

It is further preferred that the electromagnet winding turns be distributed along the entire magnetic core.

The device for orientation of current-conducting bodies may likewise be made in accordance with the invention with at least two coaxially arranged coils, with the orientation zones lying in the middle and between the end faces thereof.

The herein-disclosed method may be implemented through the use of simple and universal means. This method offers quite a number of opportunities to orient various component members or parts of a variety of shapes, such as cramps, boxes, bushes or bushings with apertures or splines, whose orientation by the prior art methods is either impossible or presents difficulties.

The proposed method makes it possible, through the use of simple means, to orient nonsymmetric component members or parts, such as bushes or bushings with apertures or splines, to orient symmetric and nonsymmetric component members or parts according to their external design features, such as projections, apertures, etc., and internal (concealed) design features, such as ribs, partitions, etc., to provide orientation from any position to a desired one for both moving and stationary component members or parts.

The herein-disclosed devices for orientation of current-conducting bodies are simple in design and convenient in service, dependable in operation, inexpensive and universal in application.

Said devices provide precise orientation of component members or parts without vibration thereof. Further, said devices make it possible to orient component members or parts both on a solid foundation (support) and under conditions of weightlessness such as under the conditions of free falling and microflight above a vibrating chute, when said component members or parts are within the orientation zone.

The invention will be more apparent from a detailed description of the proposed method and exemplary embodiments of the invention in the form of devices for the orientation of current-conducting bodies, with due reference to the accompanying drawings, wherein:

FIG. 1 represents a schematic view of a device for the orientation of current-conducting bodies in accordance with one embodiment of the invention;

FIG. 2 illustrates the effect of AC frequency upon the direction of orientation of a body;

FIGS. 3a, b, and c are views of the orientation device with poles having the shape of pyramids, and also illustrate the principle of operation;

FIG. 4 is a perspective view of cramps featuring various characteristic design features according to which they may be oriented through the use of the device of FIG. 3;

FIG. 5 is a perspective view of an electromagnet used in the orientation device whose magnetic core has a variable cross section smoothly decreasing toward the poles thereof;

FIGS. 6a, b, and c are views of an orientation device with poles whose shapes provides widening of the orientation zone in the direction toward the end of said zone, and also illustrates the principle of operation;

FIG. 7 is a perspective view of an electromagnetic device having a pole tip made up of separate wires adjustably rearrangeable and fixable with respect to each other; and

FIG. 8 is a schematic perspective view of an orientation device comprising two coaxially arranged windings.

A body such as, for example a cramp 1 (FIG. 1), is to be oriented by a variable magnetic field. For this purpose, the body is introduced into an orientation zone 2 lying between pole tips 3 of the electromagnet whose magnetic core 4 carries a winding 5. The winding 5 is supplied from an AC supply source 6 whose voltage and frequency may be varied by any conventional method.

The current frequency is selected depending upon a preselected relationship between the inductive and pure resistance of the body to be oriented. Usually it is preferred to select such a current frequency that the pure and inductive resistances are equal in magnitude. In this case, a maximum moment is created which acts upon the body to be oriented.

For example, in the case of a 10×10×15 mm. aluminum cramp of the shape shown in FIG. 1 and which is made of a 1.5 mm. thick sheet material, the pure resistance will be equal to the inductive resistance at a frequency of 850 c.p.s. The fact that the capacitors 7 are connected in series with the winding 5 forming an oscillatory circuit therewith, tuned to the selected frequency of the supply source 6, contributes to a more effective orientation of the bodies involved and to a decrease in required dimensions of the orientation shown in FIG. 1.

By changing the configuration of the pole tips 3, the required nonuniformity of the magnetic field within the orientation zone is provided. Shown in FIG. 1 are pole tips made up of a plurality of flat plates adjustably rearrangeable and fixable with respect to each other, so that said pole tips can be easily given any required shape. By imparting a wedgelike shape to the pole tips, it is possible to increase induction in the direction toward the orientation zone and thus to create a concentrated magnetic flux, whereby various component members or parts may be oriented according to one of their characteristic features.

To change the direction of orientation of the bodies involved, the direction of the magnetic field is changed. This is achieved by changing the configuration of the pole tips and their position with respect to one another.

By monitoring a supply source 6 with the help of the controlled key switch 8, the winding 5 of the electromagnet is supplied with alternating current not in a continuous mode, but in groups of pulses which are in fact oscillations of the alternating current of the selected frequency. In this case, with the same power drain as with continuous power supply to the electromagnet winding 5, it is possible due to the increase of current intensity of the supply source 6 when the latter operates on pulse duty, to substantially increase the moment of forces acting upon the body (component member or part) to be oriented, and, consequently, to considerably increase the efficiency of orientation.

Based on the assumption that it is necessary to keep the same moment of forces which act upon the body (component member or part) to be oriented as with continuous power supply, the power consumed by the electromagnet under pulse power supply duty will be substantially decreased. In this case, the dimensions of the device may be substantially reduced. Considerable savings are likewise obtainable due to the fact that power supply to the electromagnet by current pulses is accomplished only while the component member or part is within the orientation zone.

The duration for power supply of the electromagnet under pulse duty must be not less than one cycle at the selected frequency. The groups of pulses must follow at such a frequency that, while the part is within the orientation zone, not less than one AC pulse (i.e., one oscillation of the alternating current of the selected frequency) should flow through the electromagnet winding 5.

To change the direction of orientation of particular component members or parts having both external and internal characteristic features, it is advantageous to vary the AC frequency. Considering, for example, the process of orientation of a component member or part 9 (FIG. 2) with the electromagnet being fed by a low-frequency current with surface effect practically negligible and with the magnetic flux passing through the entire part 9, the determining factor for the orientation process will be the interaction between the magnetic field and the currents induced by the field within the inner rib 10 of the part 9. The latter will be set with its rib along the field, thereby assuming the position 9'. If the electromagnet is instead fed with a current of higher frequency, at which, due

to the surface effect, the magnetic flux does not pass through the envelope of the part to its inner rib 10, the part 9 will be oriented in position 9''. This is due to the fact that, in this case, the factor determining the orientation process is the interaction between the magnetic field and the currents induced by said magnetic field in the sides of the envelope with a larger surface. If the part is supplied into the orientation zone having been already oriented, its position is not changed upon leaving the orientation zone.

It should be noted that the device for carrying the proposed method into effect, such as that shown in FIG. 1, provides for dispersion of the parts approaching the orientation zone in a flow irrespective of their mutual arrangement before the orientation zone (even if the parts are arranged close to one another). Certain spaces between the parts to be oriented are preserved, which is very convenient for the automation of various manufacturing processes such as the automatic feeding of machines.

The device shown in FIG. 3 is characterized by the fact that the poles 11 of the electromagnet have the shape of pyramids between the apices of which is the orientation zone 2. Such a shape of the pole tips makes it possible to provide a concentration of the magnetic flux into a narrow bunch. By feeding the parts to be oriented into the orientation zone so that the characteristic feature according to which they are to be oriented be on the level of the magnetic flux concentrated into a narrow bunch, it is possible to provide exact orientation of parts according to a preselected design feature.

For example, in case of orientation of symmetrical cramps 12 (FIG. 3a) with an aperture 13 made in one of the bent portions of the cramp, said cramps are so delivered into the orientation zone that the apertures 13 are on the level of the apices of the poles 11.

In this case magnetic flux induces the currents differing in intensity in the bent portions of the cramp, since the bent portion provided with the aperture 13 has a higher resistance than the solid bent portion 14.

As a result of the interaction between the induced currents within the bent portions of the part 12 and the magnetic field, the latter are transferred from any nonoriented position to an oriented position 12', with the aperture 13 in the direction indicated by the arrow A as viewed along the flow of parts.

FIGS. 3b and c illustrate the process of orientation of a cramp 15 provided with an aperture 16 made in the upper region of bent portion 17 and with an aperture 18 made in the lower region of bent portion 19. In this case, when arranging the cramp 15 within the orientation zone with its aperture 16 on the level of the apices of the electromagnet poles 11 (FIG. 3b) it is possible to effect turning the cramp clockwise. When arranging the cramp 15 within the orientation zone with its aperture 18 on the level of the apices of the electromagnet poles 11 (FIG. 3c) it is possible to effect turning of said cramp counterclockwise.

Analogously, the hereinabove-described device provides an orientation of a wide variety of parts such as cramps 15' shown in FIG. 4 according to the design feature which provides a difference in electrical conductances of particular portions of the parts in question.

In FIG. 5 is shown one of the embodiments of the invention including an electromagnet with a magnetic core 20 having a variable cross section which decreases toward poles 21. Winding 22 of said electromagnet is uniformly distributed along the entire magnetic core. Such a design of the electromagnet provides higher concentration of the magnetic flux within the interpole space where the orientation zone is located. Moreover, devices for the orientation of component members or parts by a magnetic field with such a magnet prove to be more compact. In the device for orientation of current-conducting bodies (component members or parts) shown in FIGS. 6 (a), (b) and (c) the shape of its poles is such that is provides widening of the orientation zone in the direction from the beginning toward the end of said zone. The part located within the orientation zone is acted upon not only by the force of

gravity but also is under the effect of electrodynamic forces along several axes of coordinates, which fact provides more effective orientation of the part.

By varying the angles characterizing the degree of widening of the orientation zone, it is possible to control the direction and the value of electrodynamic forces, thereby insuring the desired position of the part to be oriented.

For example, if a plate 25 (FIG. 6(a)) is introduced into the orientation zone disposed between the poles 24, whose one portion 25 has a higher conductivity than the other portion 26, a moment which is the resultant of the force of gravity P (FIG. 6(b)) and the electrodynamic force (vertical component) F is created which turns said plate. Moreover, the plate 23 is under the effect of the horizontal component F' of the electrodynamic force. Due to the effect of the above-mentioned forces, the plate 23 is transferred to the final oriented position 23'.

FIG. 6c illustrates the case where the part 23 is delivered into the orientation zone being already oriented. In this case the part 23 is not turned but is at once transferred in the initial position 23.

In the herein above-described embodiment the, sides of the poles 24 facing the orientation zone are in fact the planes arranged at angles α_1 and α_2 to the vertical and at angles β_1 and β_2 to the horizontal, respectively.

The sides of the poles facing the orientation zone may be made as a double-curvature surfaces. Such shape of the poles provides the required distribution of the components of the electrodynamic forces and makes it possible to set the values of said forces, depending upon the position desired for the part to be oriented.

The above embodiments for orientation of current-conducting bodies by a magnetic field illustrate the importance of the shape of the electromagnet poles for the creation of a variable magnetic field with desired parameters which characterize its nonuniformity.

To solve the problem of orientation of a large variety of parts with various design features, it is necessary to impart a diversity of shapes to the electromagnet poles. Therefore it is advantageous to provide an electromagnet with pole tips 27 (FIG. 7) made up of separate wires 28 of a ferromagnetic material which are adjustably rearrangeable and fixable with respect to each other. In case of a large number of wires of a comparatively small diameter it is possible to obtain any desired shape of the pole tip by rearranging the wires properly with respect to each other. To facilitate the preparatory procedure, use should be advantageously made of templates. Upon finishing the procedure of rearranging the wires 28 the latter are fixed with respect to each other by means of a screw 29 operating through a spacer 30. All the wires of each pole tip are enclosed in a holder 31.

The device for orientation of current-conducting bodies by a magnetic field shown in FIG. 8 comprises two coaxially arranged coils 32 and 33. Running through said coils is a conveyor 34 which is adapted to feed parts 35 into a first orientation zone 36 which is disposed inside the coils, and to take the already oriented parts away. Running through the coils 32 and 33 is a second conveyor 37 which is adapted to feed parts 38 into a second orientation zone 39 which is disposed between the aforementioned coils.

With an appropriate connection of the coils 32 and 33 the parts 38 in the second orientation zone 39 are disposed across the conveyor 37, while with the opposite connection of the coils 32 and 33 the direction of the magnetic flux within the second orientation zone 39 will change through 90° , and the parts 38 will be oriented so as to be located along the conveyor 37 as is shown in FIG. 8.

Switching over of the coils 32 and 33 is effected by a switch 40 which is adapted to supply power to said coils from the AC supply source 6.

We claim:

1. A method for the orientation of current-conducting bodies having nonuniform dimensions along at least one plane

passing therethrough, said method comprising generating an AC magnetic field within an orientation zone, moving the bodies to be oriented into said zone and controlling the frequency of the field in accordance with a selected relationship between the inductive and pure resistances of the bodies to be oriented and such that said bodies each have approximately equal pure and inductive resistances.

2. A method as claimed in claim 1 comprising generating said field in the form of a nonuniform magnetic field whose induction increases in the direction of movement of the bodies through the orientation zone to concentrate the magnetic flux at the characteristic feature of each body according to which the same is to be oriented.

3. A method as claimed in claim 1 comprising changing the direction of orientation by changing the direction of the magnetic field, each body being in an oriented position when the current induced therein has a minimum value and a magnetic moment coinciding with the direction of the field.

4. A method as claimed in claim 1 comprising changing the direction of orientation by changing the frequency and to insure the greatest current in that portion of each body according to which the same is oriented.

5. A method as claimed in claim 1 wherein the magnetic field is generated as a group of AC pulses with a duration of each group being not less than one cycle of the current of the selected frequency, an interval being provided between the groups of pulses depending upon the condition that each body to be oriented, while within the orientation zone, is to be under the effect of the magnetic flux created by at least one group of pulses.

6. A device for the orientation of current-conducting bodies comprising: an electromagnet including a magnetic core including poles spaced to define an orientation zone, a capacitor, a winding operatively associated with said core and connected in series with said capacitor, an AC supply source having a frequency corresponding to a selected relationship between the inductive and pure resistances of the bodies to be oriented, said winding and said capacitor forming an oscillatory circuit tuned to the frequency of said AC supply source; and a controlled key switch coupled to said source to provide a pulse supply to the winding of said electromagnet.

7. A device as claimed in claim 6, wherein the bodies have a path of flow and the poles have the shape of pyramids having peaks located relative to said path such as to be coincident with the characteristic feature of the bodies according to which they are to be oriented.

8. A device as claimed in claim 6, wherein the magnetic core has a variable cross section smoothly decreasing toward the poles thereby concentrating the magnetic flux in the thick portion of the magnetic core.

9. A device as claimed in claim 6, wherein the poles have a shape which provides a widening of the orientation zone in a direction from the beginning toward the end of said zone thereby enabling a simultaneous orientation of the bodies and a removal thereof from said zone by the same magnetic field.

10. A device as claimed in claim 9, wherein the poles have sides which are planar facing the orientation zone and arranged vertically and/or at an angle to the vertical which is proportional to the required gradient of the magnetic field.

11. A device as claimed in claim 9, wherein the poles have sides facing the orientation zone which are surfaces of double curvature thereby enabling provision of a selected nonuniformity of the magnetic field at any point in said zone.

12. A device as claimed in claim 6, wherein the magnetic core of the electromagnet is provided with at least one pole tip including wires adjustably rearrangeable and fixable with respect to each other.

13. A device as claimed in claim 6, wherein the winding includes turns uniformly distributed along the entire core thereby improving the cooling of the winding, providing free access to the interpole space in said zone and enabling assembly from a plurality of identical magnets.

14. A device as claimed in claim 6, wherein said winding includes at least two coaxially arranged coils, in the middle and between the end faces of which orientation zones are located thereby enabling the simultaneous orientation of bodies supplied in different flows.

* * * * *

5
10
15
20
25
30
35
40
45
50
55
60
65
70
75