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(54) **Rail heating device**

(57) A rail heating device for heating rails of a railroad track comprising at least two magnetic field generators (1,2) each having two free ends (6) adapted to be arranged so that they are facing the rail to be heated, said magnetic field generators are controlled by a control means such that they are adapted to generate alternating magnetic fields in said rail, wherein the magnetic fields are converted into heat in the rail. The free ends of the magnetic field generators are arranged in a linear row and that said magnetic fields being such that the magnetic field through one of said free ends has an opposite direction as compared to the magnetic fields through the other free ends.

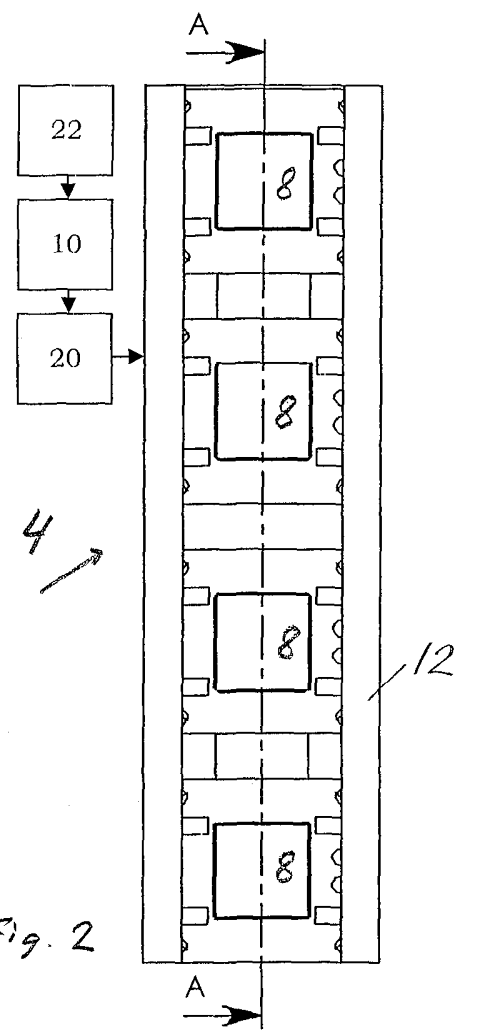

Fig. 2

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Description

Field of the invention

[0001] The present invention relates to a rail heating device according to the preamble of the independent claim.
The rail heating device is intended to eliminate a situation where rail points that are covered by ice and/or snow are rendered immovable for switching.

Background of the invention

[0002] Conventionally constructed rail points, when covered with ice/ snow, are frequently inoperable for switching. To cope with this, many types of heating apparatus have been used. Among those heating apparatus, the snow-melting apparatus using electric heaters has predominately been used. These heaters are used in a state that the heaters are mounted on sleepers or basic rails. Heat generated by the heaters is transmitted to the sleepers or basic rails, thereby melting ice and snow from the rails. In this construction, a relatively large heat quantity, which should be transferred to the rails, is dissipated to the atmosphere. The snow-melting apparatus thus unsatisfactorily functions in the snow-melting performance. Thus, the conventional snow-melting apparatus is not only inefficient but also consumes much electric power.
To solve the disadvantages of the snow-melting apparatus of the heater type, a snow-melting apparatus based on another principle, i.e., electromagnetic induction, that is, a snow-melting apparatus of the electromagnetic induction heating type, has been proposed.
In US-5,389,766 a rail snow-melting apparatus by electromagnetic induction heating is disclosed. This known apparatus comprises a high frequency power source, a pair of conductive cables wound in at least one turn around a segment of each rail and through through-holes which are formed through side walls of the rail. Current is supplied from a power source to the conductive cable, thereby heating the rail by the flow of electromagnetically induced current in the rail segment.
EP-1,227,186 discloses a line switch part snow melting device for railway track points constituted by connecting a heating coil wound around a floor plate for heating the floor plate by induction to an inverter device for supplying highfrequency current to the heating coil.

[0003] Although the induction heating apparatuses disclosed in the above-cited patent documents remove some of the drawbacks of the traditionally used electric heaters there exist still a demand for a more energy efficient heating that is more easy to handle than the rather complicated structures disclosed above and that fulfils the extremely high demands with regard to withstand the tough weather conditions with low temperatures in combination with snow, ice and rain.

[0004] The object of the present invention is to achieve a device that fulfils all these demands and that may be manufactured to a low cost.

[0005] The device according to the present invention generally uses a magnetic heating principle that will be discussed in the following.

[0006] Initially a general background of magnetic heating will be disclosed.
It has been known that there are only a few basic mechanisms systems or methods for creating heat in a metallic part. Convection heating can be used which may include direct flame, immersion, radiation, electrical resistance where the heating of the metal is caused by the flow of the electricity and heat may be created by mechanical stresses or friction. Included among these has been induction heating where the heating is caused by use of magnetic fields. As is well known in the induction heating art, a metal workpiece is placed in a coil (or on the surface of the coil supplied with alternating current and the workpiece and the coil are linked by a magnetic field so that an induced current is present in the metal. This induced current heats the metal because of resistive losses similar to any electrical resistance heating. The coil normally becomes heated and must be cooled in order to make the heating of the workpiece as effective as possible. The density of the induced current is greatest at the surface of the workpiece and reduces as the distance from the surface increases. This phenomenon is known as the skin effect and is important because it is only within this depth that the majority of the total energy is induced and is available for heating. Typical maximum skin depths are 40% of one inch (8-10 mm) and three to four inches (8-10 cm) for low frequency applications. In all induction heating applications, the heating begins at the surface due to the eddy currents and conduction carries heat into the body of the workpiece.

[0007] Another method of heating metal parts using magnetic fields is called transfer flux heating. This method is commonly used in heating relatively thin strips of metal and transfers flux heat by a rearrangement of the induction coils so that the magnetic flux passes through the workpiece at right angles to the workpiece rather than around the workpiece as in normal induction heating. Magnetic flux passing through the workpiece induces flux lines to circulate in the plane of the strip and this results in the same eddy current loss and heating of the workpiece.

[0008] In US-5,025,124 is disclosed an electromagnetic device for heating metal elements where the heating is accomplished by utilizing a magnetic loop for creating a high density alternating magnetic field in a metal part to be heated. The US-patent is based on the knowledge of replacing, in a magnetic loop, a part of the magnetic core by the metal part to be heated. In this known method the metal part is placed between the magnetic poles and may not be used in applications where it is desired to heat the metal parts from one side.

[0009] In US-3,980,858 an exciter for induction heating apparatus is disclosed provided with a number of magnetic poles and excitation windings wound on the magnetic poles. The used excitation currents are applied by a phase difference between the current applied to a central magnetic pole and current applied to peripheral magnetic poles.

[0010] Thus, the general objects of the present invention are to achieve a rail heating device that enables a more accurate control of the heating, more even heating and a more power efficient arrangement and that also fulfils the demands discussed above.

Summary of the invention

[0011] The above-mentioned objects are achieved by the present invention according to the independent claim.

[0012] Preferred embodiments are set forth in the dependent claims.

[0013] The present invention is based on a principle where the metal part in form of a rail or a ferromagnetic planar sheet is heated from one side by turning the magnetic field 90 degrees with regard to the magnetic field generated by the magnetic field generator.

[0014] Advantageously one or many metals, both paramagnetic and ferromagnetic, may be combined in the same heating application.

[0015] This result in that the magnetic field runs in the direction of the ferromagnetic material and then is deflected once again 90 degrees to a magnetic "receiver", i.e. an identical magnetic field generator having an opposite direction of the magnetic field. This counter-directed field is generated by reversing the polarity for one of the magnetic coils of the magnetic field generator.

[0016] Another advantage with the present invention compared to the conventional heating elements is the fast heating time. An electrical element according to the present invention has a heating time that is in the order of a couple of minutes compared to tenth of minutes for the electrical elements.

Short description of the appended drawings

[0017]

Figure 1 is a schematic illustration of a cross-section of a rail provided with a rail heating device according to the present invention;

Figure 2 shows, from below, a schematic illustration of a magnetic module according to the present invention;

Figure 3 shows a cross-sectional view along line A-A of the magnetic module disclosed in figure 2;

Figure 4 shows a cross-sectional view of the magnetic module disclosed in figure 2 according to a preferred first embodiment;

Figure 5 shows a cross-sectional view of a magnetic module according to a preferred second embodiment;

Figure 6 is a schematic illustration of the electric energy feeding of one magnetic module;

Figures 7 and 9 schematically illustrate the magnetic field deflections in a magnetic module, seen from below, during opposite phases of a cycle, and

Figures 8 and 10 schematically illustrate in cross-sectional views the magnetic field deflections along A-A in figures 7 and 9, respectively.

[0018] Like numbers refer to like elements throughout the description of the drawings.

Detailed description of preferred embodiments of the invention

[0019] Figure 1 is a schematic illustration of a cross-section of a rail 2 provided with a rail heating device 4 according to the present invention.

The width of the base of the rail is approximately 13-15 cm and the height is approximately 15-17 cm. The rail heating device has a size, preferably essentially a rectangular or square cross-section with a side length about 2,5-5 cm, preferably 3,5 cm, adapted to easily be positioned as indicated in the figure. Other positions are naturally possible, e.g. further up or further down.

[0020] The invention will now be described in detail with references in particular to figures 2-5.

[0021] Thus, the present invention relates to a rail heating device for heating rails 2 of a railroad track, comprising at least two magnetic field generators 6 each having two free ends 8 adapted to be arranged so that they are facing the rail to be heated. The magnetic field generators are controlled by a control means 10 such that they are adapted to generate alternating magnetic fields in said rail, wherein the magnetic fields are converted into heat in the rail. Two magnetic field generators constitute a magnetic module 4. The free ends of the magnetic field generators are arranged in a linear row and the magnetic fields being such that the magnetic field through one of said free ends has an opposite direction as compared to the magnetic fields through the other free ends.

[0022] Each magnetic field generator comprises a magnetic core 14 having said two free ends and is provided with magnetic coils 16 to which magnetic field generating energy is applied. The magnetic core may consist of laminated silicon sheets, e.g. so called transformer core sheet, or loose powder sintered magnetic material. The magnetic core is preferably U-shaped and has two legs and a joining part, wherein one magnetic coil is arranged on each of the legs. The legs for all magnetic field generators in the magnetic module are parallel.

The magnetic core may, alternatively, have any geometrical form provided that the magnetic core has two free ends in the same plane and that the magnetic core together with the ferromagnetic material to be heated forms a closed magnetic loop. Among possible geometrical forms may be mentioned a V-shaped core, an asymmetrical U-shaped core.

[0023] Alternatively, the magnetic core is divided in two separate rod-shaped legs, wherein at least one magnetic coil is arranged on each of the legs.

[0024] One factor that is important in order to achieve even heating is how the magnetic coils are arranged at the magnetic cores.

In order to generate a magnetic field in the magnetic core of the magnetic field generator one or many magnetic coils are arranged at the core. Advantageously two coils are used on each core. However, it is naturally possible to achieve the magnetic field in the magnetic core by many other structural arrangements of the coils, where both the number of used coils and also the location on the core may vary. For example, only one coil may be used on the core arranged e.g. on the lower part of the U-shaped core or on one of the legs, three or more coils may also be arranged at different locations on the core. The person skilled in the art appreciate that all different arrangements must be separately tuned, e.g. with regard to fed electrical energy.

[0025] According to one preferred embodiment of the present invention the magnetic modules are in direct contact to the metal part of ferromagnetic material to be heated.

[0026] According to a second preferred embodiment of the present invention there is an air-gap or a sheet made of a dielectrical material defining a predetermined distance between the magnetic modules and the metal part to be heated.

[0027] The thickness of the air-gap (or the dielectrical sheet) is determined in relation to the intended application of the heating device.

Generally, the square of the thickness of the air-gap influences the total thickness of the metal part (the thickness of the metal sheets) up to a maximum total thickness (air-gap and metal part) of 90 mm, given an air-gap of 9 mm.

[0028] In one implementation an air-gap of 1 or 2 mm was chosen in combination with a ferromagnetic material, e.g. iron, of 4 mm and a paramagnetic material (aluminium) of 2 mm. Other combinations are naturally possible.

[0029] One presumption for the present invention is that the metal part to be heated is a ferromagnetic material, e.g. iron, cast iron, magnetic stainless steel and all alloys that include iron.

[0030] According to a preferred second embodiment of the heating device the device further comprises a planar heating means 18 (figure 5) including a ferromagnetic material and constituting a heating surface adapted to face and be in contact with the rail to be heated, wherein said heating means is arranged in or close to a plane defined by said free ends. In one alternative embodiment the heating means comprises two planar sheets, a lower sheet facing the free ends of the magnetic field generators and an upper sheet on the opposite side adapted to face the rail. The upper sheet may be made of a ferromagnetic material , e.g. iron, and the lower sheet may be made from a paramagnetic material, e.g. aluminium.

[0031] The metal part in the form of a planar sheet may also comprise only a single sheet made from a ferromagnetic material.

[0032] The combination of ferromagnetic and paramagnetic materials for the sheets constituting the heating means may vary both regarding the choice of material and the thickness of the sheets.

By combining a paramagnetic material and a magnetic material the advantage is achieved that the paramagnetic material has a repelling effect, i.e. the H-field is symmetrically spread in the sheets that contribute to the even heating of the heating means. The combination of the paramagnetic and ferromagnetic materials also obtains a shield that prevents the electromagnetic field to be spread.

[0033] In one preferred embodiment the planar heating means, e.g. two metal sheets, are arranged in a plane defined by the free ends of the magnetic cores of the magnetic modules. The lower sheet is a 2 mm sheet of aluminium and the upper sheet is a 4 mm sheet of iron.

Preferably, the two sheets are floating with respect to each other, i.e. they are not fastened (fixed) to each other in order to avoid material stresses related to the different thermal expansions.

Alternatively, in some applications it would be advantageous to have the sheets fixed to each other by e.g. welding.

[0034] As discussed above an air-gap may be provided for between the free ends of the magnetic cores and the planar sheet means. In an alternative embodiment a dielectric sheet, e.g. silicone, may be arranged in the air gap with the purpose of obtaining a thermal insulation of the magnetic modules from the heat generated in the metal part.

[0035] The rail heating device may comprise N modules, where N = 1, 2, 3 or 4, arranged such that the free ends of the magnetic field generators of all modules are aligned. Of course, the number of used modules are dependent of the specific application. Naturally, a much higher number of modules may be used without departing from the present invention which is defined by the appended claims.

[0036] Another alternative embodiment is to arrange at least two magnetic modules beside each other so that the aligned free ends of the magnetic field generators for each module are parallel. This may be applicable if extra high heating capacity is required.

[0037] The rail heating device further comprises a rigid outer enclosure 12 adapted to protect the device from mechanical damages and environmental influences, e. g. snow or ice. The enclosure has preferably the shape of a U-shaped beam.

[0038] The outer enclosure is also provided with a fastening means (not shown) for attaching the device to the rail.

[0039] In figure 2 is also illustrated an energy feeding means 20 adapted to feed electrical energy to the coils of the module, control means 10 that controls the feeding means in accordance to input signals received from a control panel 22 where an operator may input various parameters related to the heating, e.g. desired target temperature, heating rate etc.

[0040] The device preferably comprises at least one temperature sensor arranged close to the plane of the free ends, wherein said sensor generates temperature signals that are applied to the control means and used to control the heating of the device. According to an advantageous embodiment a temperature sensor (not shown) is arranged beneath the ferromagnetic sheet. The temperature sensor generates a temperature signal to the control means in order to increase the accuracy in the control of the heating device. The temperature sensor is further discussed below.

Temperature sensors may alternatively be arranged between the ferromagnetic sheet and the paramagnetic sheet. Experiments performed by the inventor show that one sensor per magnetic module give an accurate temperature control. The sensor is preferably arranged in a central location of the magnetic module.

It would also be possible to use more sensors if the application requires an even more accurate temperature control.

The temperature sensor used in the present invention is preferably a thermo couple element sensor (e.g. type K), which is a passive sensor provided with two thin wires of different materials that generates a direct current in dependence of the temperature.

This type of sensors have a fast response time, e.g. in the order of 50 ms and are also be heat resistant up to at least 1000 degrees.

[0041] Figure 6 is an illustration of the electrical energy feeding of one magnetic module that is schematically shown from above to the right in the figure where the numbers 1-4 designate the four magnetic coils. Here, coil number 2 is connected to the reversed polarity compared to the three other.

[0042] Each magnetic module is provided with two connections f1 and f2, where f1 is connected to the input of three of the coils and f2 is connected to the output of these three coils. For the fourth of the coils in the magnetic module connection f2 is connected to the input and f1 to the output.

f1 and f2 are preferably connected to two phases in a three-phase system. In order to achieve a symmetrical load preferably 3, 6, 9 etc. magnetic modules are connected to the power source so that no phase shifting is induced resulting in the generation of reactive power.

[0043] Alternatively it is possible to use a one-phase system instead where one of the coils is connected to reversed polarity compared to the three other.

[0044] Alternatively each coil could be separately fed instead and in that case the correct polarity for each coil should be controlled by the control means.

[0045] The frequency of the electrical power generated by the power source and applied to the magnetic modules is preferably in the range of 50-60 Hz.

However, a much wider frequency range, e.g. 10-500 Hz, is naturally possible to use including the frequencies 16 2/3 Hz and 400 Hz.

[0046] Still another possibility is to use an even higher frequency, in the order of some kHz. One problem when using a higher frequency is the heat generated by the coils. By applying the magnetic field generating energy by using pulses of high frequency power the heating of the coils is easily reduced.

[0047] In a further embodiment of the present invention a so-called controlled disconnection of the magnetic modules is applied. This controlled disconnection is controlled by the control means and provides that the disconnection is made exactly at or close to a zero crossing of the magnetic field generating energy which results in that no magnetic reminiscence remains.

[0048] Figures 7-10 schematically illustrate by arrows the magnetic field deflections in a magnetic module that is fed with energy by using the circuitry illustrated in figure 6.

Figures 7 and 9 show a magnetic module from below and illustrate the magnetic fields in the plane of the free ends of the magnetic field generators.

In the figures, coil number two from above is fed with reversed polarity compared to the other coils, i.e. the free end that has an opposite directed magnetic field is one of the two inner free ends of a magnetic module. It is naturally also possible that the free end that has an opposite directed magnetic field is one of the two outer free ends of a magnetic module.

In figure 7 the situation at the phase position 90 degrees is illustrated showing the magnetic field core is directed inwards and downwards (see figure 8). The magnetic fields for the other cores are directed outwards and upwards (see figure 8). In figures 9 and 10 the situation at the phase position 270 degrees is illustrated where the directions of all magnetic fields are reversed as compared to figures 7 and 8.

[0049] The rail heating device according to the present invention is primarily intended for use in a railroad switcher where high capacity is of greatest importance. The energy is put directly on the surface and the surface is then heated to an appropriate temperature for melting snow/ice, e.g. in the range 5-50 °C.

[0050] The ferromagnetic sheet constituting surface facing that rail may advantageously be coated by some suitable coating material especially adapted for the special requirements in this application.

[0051] A control panel is provided including an information display showing the temperature etc., input means, e.g. knobs, for setting various parameters related to the heating, e.g. the heating rate and the target temperature.

[0052] In order to further explain how the advantageous even heating is accomplished by the present invention the following reasoning is given.

[0053] Thus, each magnetic module comprises two magnetic field generators and each magnetic field generator has two free ends (or poles), i.e. each magnetic module has four poles.

[0054] When feeding a magnetic module as described, e.g. in connection with figure 6, the coil of one leg of a magnetic field generator is fed by a reversed polarity as compared to the feeding of the other three coils of the magnetic module.

[0055] Thus, during each half period it is achieved three poles (e.g. North) having a magnetic field directed in the same direction and the fourth pole (South) having an opposite directed magnetic field. During the next half period the situation is the opposite, i.e. three S-poles and one N-pole.

[0056] The magnetic field of the single pole attracts one of the magnetic fields from one of the other three poles and as a result two remaining (left-over) magnetic fields having the same polarity are obtained.

[0057] These two remaining magnetic fields counteract which results in that the magnetic fields are spread in material to be heated, e.g. the ferromagnetic sheet or the rail. This in turn results in the even heating of the sheet/rail. The rapid spreading of the two remaining magnetic fields is related to that these fields are forced away from areas where the magnetic field between the established N- and S-pole exists.

[0058] Which of the three magnetic fields having the same direction that will attract the fourth opposite directed magnetic field depends on the distance between the free ends in such a way that the field is established between the free ends having the shortest distance between each other.

[0059] The above reasoning is naturally also more generally applicable, i.e. a number of "left-over" magnetic fields may be forced to generate heat in the same way. This is solely a matter of technical design.

[0060] Although the main application of the rail heating device according to the present invention is a number of close-related variants are possible. Among those may be mentioned heating of arrangements intended to work in tough weather conditions.

[0061] The present invention is not limited to the above-described preferred embodiments. Various alternatives, modifications and equivalents may be used. Therefore, the above embodiments should not be taken as limiting the scope of the invention, which is defined by the appending claims.

Claims

1. A rail heating device for heating rails of a railroad track comprising at least two magnetic field generators (1,2) each having two free ends (6) adapted to be arranged so that they are facing the rail to be heated, said magnetic field generators are controlled by a control means such that they are adapted to generate alternating magnetic fields, wherein the magnetic fields are converted into heat in the rail, **characterized in that** said free ends of the magnetic field generators are arranged in a linear row and that said magnetic fields being such that the magnetic field through one of said free ends has an opposite direction as compared to the magnetic fields through the other free ends.

2. Rail heating device according to claim 1, **characterized in that** the device further comprises a planar heating means (4,5) including a ferromagnetic material and constituting a heating surface adapted to face and be in contact with the rail to be heated, wherein said heating means is arranged in or close to a plane defined by said free ends.

3. Rail heating device according to claim 1, **characterized in that** the free ends are adapted to be in direct contact with the rail to be heated.

4. Rail heating device according to claim 1, **characterized in that** said two magnetic field generators constitute a magnetic module.

5. Rail heating device according to claim 4, **characterized in that** said free end that has an oppositely directed magnetic field is one of the two inner free ends of a magnetic module.

6. Rail heating device according to claim 1, **characterized in that** said magnetic field generator comprises a magnetic core having said two free ends and is provided with one or many magnetic coils to which magnetic field generating energy is applied.

7. Rail heating device according to claim 6, **characterized in that** said magnetic core is U-shaped and has two legs and a joining part, wherein one magnetic coil is arranged on each of the legs.

8. Rail heating device according to claim 6, **characterized in that** said magnetic core is divided in two separate rod-shaped legs, wherein at least one magnetic coil is arranged on each of the legs.

9. Rail heating device according to claim 4, **characterized in that** the legs for all magnetic field generators in the magnetic module are parallel.

10. Rail heating device according to claim 6, **characterized in that** the applied magnetic field generating energy is an alternating electrical power having a predetermined frequency, wherein the electrical power is applied with a reversed polarity to one of

the magnetic coils compared to the electrical power applied to the other three coils of the module.

11. Rail heating device according to claims 10, **characterized in that** said predetermined frequency is in the range of 50-60 Hz.

12. Rail heating device according to claim 4, **characterized in that** the device comprises N modules, where N = 1, 2, 3 or 4, wherein the free ends of the magnetic field generators of all the modules are aligned.

13. Rail heating device according to claim 4, **characterized in that** the device comprises 1-10 magnetic modules, wherein the free ends of the magnetic field generators of all the modules are aligned.

14. Rail heating device according to claim 2, **characterized in that** the device comprises at least two magnetic modules arranged beside each other so that the aligned free ends for each module are parallel.

15. Rail heating device according to claim 1, **characterized in that** said device comprises at least one temperature sensor arranged close to the plane of the free ends, wherein said sensor generates temperature signals that are applied to said control means and used to control the heating of the device.

16. Rail heating device according to claim 2, **characterized in that** said heating means comprises two planar sheets, a lower sheet facing the free ends of the magnetic field generators and an upper sheet on the opposite side adapted to face the rail.

17. Rail heating device according to claim 16, **characterized in that** said upper sheet is made of a ferromagnetic material and the lower sheet is made from a paramagnetic material.

18. Rail heating device according to claim 1, **characterized in that** the device further comprises a rigid outer enclosure adapted to protect the device from mechanical damages and environmental influences, e.g. snow or ice.

19. Rail heating device according to claim 18, **characterized in that** said enclosure is a U-shaped beam.

20. Rail heating device according to claim 18, **characterized in that** said outer enclosure is provided with a fastening means for attaching the device to the rail.

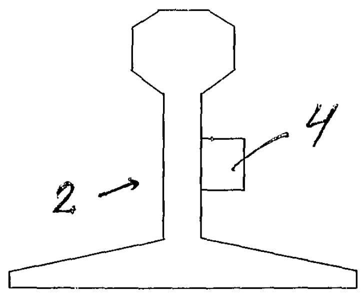

Fig. 1

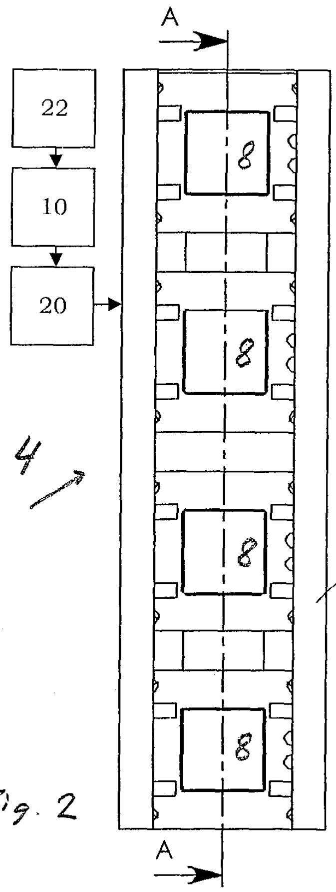

Fig. 2

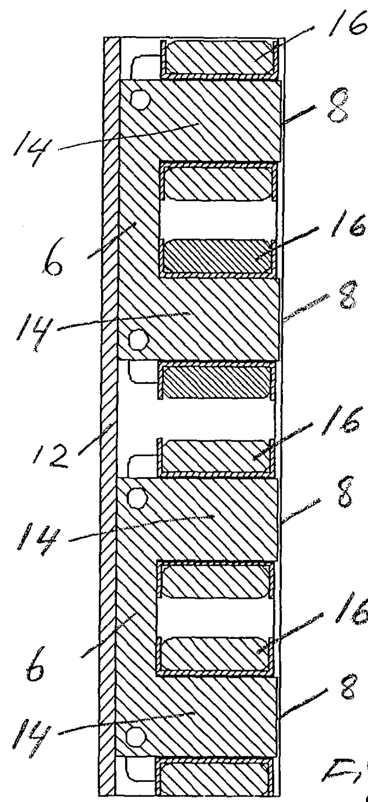

Fig. 3

A-A

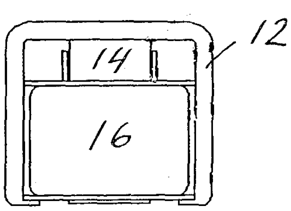

Fig. 4

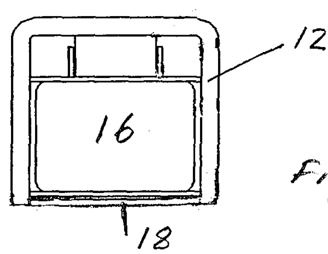

Fig. 5

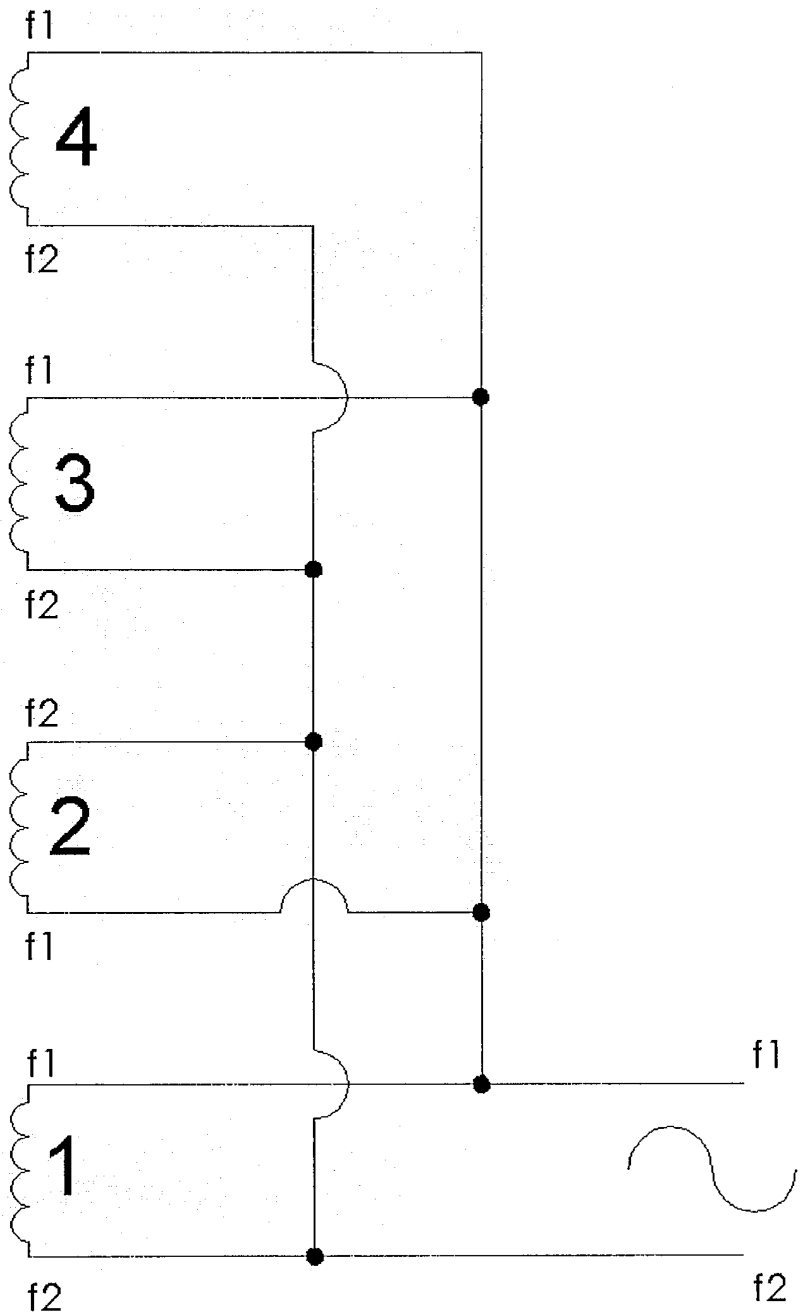

Fig. 6

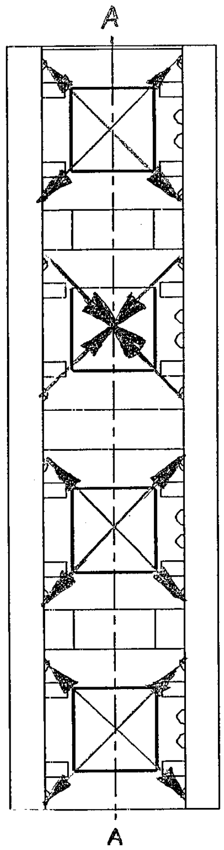

Fig. 7

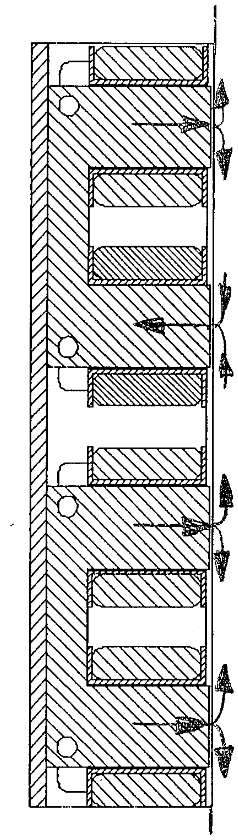

Fig. 8

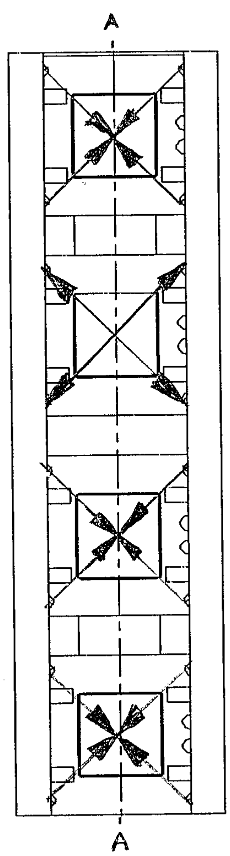

Fig. 9

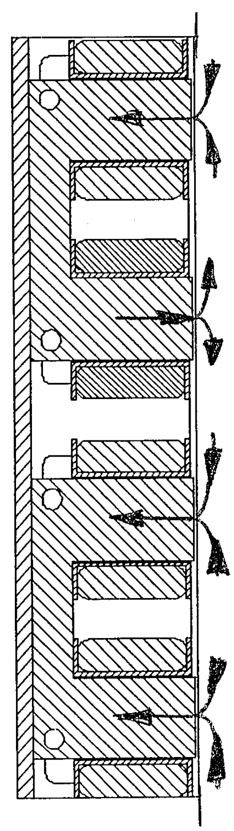

Fig. 10

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 10 1238

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
D,X	US 5 389 766 A (TAKAHASHI SEIICHI ET AL) 14 February 1995 (1995-02-14) * abstract; figures 1-4,7 * * column 1, line 42-61 - column 4, line 8-17 * * claim 1 * ---	1,3,6, 10,12, 14,15, 18,20	E01B7/24
A	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 02, 29 February 1996 (1996-02-29) & JP 07 288177 A (NIPPON KOEI CO LTD), 31 October 1995 (1995-10-31) * abstract * -----	1,2	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			E01B

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	25 August 2004	Fernandez, E

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 10 1238

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