(CONVENTION. By one or more persons and/or a Company) Form 4

595512

3/

COMMONWEALTH OF AUSTRALIA

Patents Act 1952-1969

CONVENTION APPLICATION FOR A PATENT

LODGED AT SUB-OFFICE
2 3 APR 1986
Melbourne

(1) Here insert (in full) Name or Names of Applicant or Applicants, followed by Address (es).

SECTION 34(4)(a) DIRECTION SEE FOLIO 12
NAME DIRECTED UTDC Inc.

(2) Here insert Title of Invention.

hereby apply for the grant of a Patent for an invention entitled: (2)

REACTION RAIL

$225

(3) Here insert number(s) of basic application(s)

which is described in the accompanying complete specification. This application is a Convention application and is based on the application numbered (3)

479,933

(4) Here insert Name of basic Country or Countries, and basic date or dates

for a patent or similar protection made in (4) Canada

on 24th April 1985

APPLICATION ACCEPTED AND AMENDMENTS ALLOWED 31-1-90

~~My~~ Our address for service is Messrs. Edwd. Waters & Sons, Patent Attorneys, 50 Queen Street, Melbourne, Victoria, Australia.

DATED this 22nd day of April 1986.

(5) Signature (s) of Applicant (s) or Seal of Company and Signatures of its Officers as prescribed by its Articles of Association.

(5)

URBAN TRANSPORTATION DEVELOPMENT CORPORATION LTD.

by T. A. Barnes

T. A. Barnes

Reg'd. Patent Attorney

To:

(CONVENTION. Company.) Form 8

COMMONWEALTH OF AUSTRALIA

Patents Act 1952-1969

DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT OR PATENT OF ADDITION

(1) Here insert (in full) Name of Company.

In support of the Convention Application made by(1) URBAN TRANSPORTATION DEVELOPMENT CORPORATION LTD.

(hereinafter referred to as the applicant) for a Patent

(2) Here insert title of Invention.

for an invention entitled:(2) REACTION RAIL

(3) Here insert full Name and Address, of Company official authorized to make declaration.

I,(3) GARY M. CULLEN

of URBAN TRANSPORTATION DEVELOPMENT CORPORATION LTD., 2 St. Clair Avenue West, Toronto, Ontario, Canada, M4V 1L7

do solemnly and sincerely declare as follows:

1. I am authorised by the applicant for the patent to make this declaration on its behalf.

2. The basic application as defined by Section 141 of the Act was made in(4) Canada

(4) Here insert basic Country or Countries followed by date or dates and basic Applicant or Applicants.

on the 24th day of April 19 85, by URBAN TRANSPORTATION DEVELOPMENT CORPORATION LTD.

~~on the day of 19 , by~~

(5) Here insert (in full) Name and Address of Actual Inventor or Inventors.

3.(5) William C. Beattie, of Foxdenton, Bel-Air Park, Ballybarnes Co., Down, Ireland -and- W. John Ballantyne, of 804 Grouse Crescent, Kingston, Ontario, Canada, K7P 1A2

~~is~~/are the actual inventors of the invention and the facts upon which the applicant is entitled to make the application are as follow:

The applicant is the assignee of said actual inventors by an assignment dated: the 2nd and 13th of May, 1985

4. The basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application.

DECLARED at TORONTO

this 25th day of November 1988

(6) Signature. (6) [signature]

(12) PATENT ABRIDGMENT (11) Document No. AU-B-56541/86
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 595512

(54) Title
REACTION RAIL

International Patent Classification(s)
(51)[4] H02K 041/03

(21) Application No. : 56541/86 (22) Application Date : 23.04.86

(30) Priority Data

(31) Number	(32) Date	(33) Country
479933	24.04.85	CA CANADA

(43) Publication Date : 30.10.86

(44) Publication Date of Accepted Application : 05.04.90

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(56) Prior Art Documents
AU 46861/85 H02K 41/02 1/20 9/04

(57) Claim

1. A reaction rail assembly for forming a secondary of a linear induction motor that includes a linear induction motor primary mounted on a vehicle, the reaction rail comprising an elongate conductive member which is of generally uniform cross-section and is adapted to be secured to a track and which has a surface that, in use, faces a corresponding surface of a linear induction motor primary, and a core comprising a plurality of elongate bars of ferromagnetic material extending parallel to the conductive member, with adjacent bars being insulated from one another across the reaction rail so as to reduce eddy current losses and with each bar having a width and a height corresponding to one another, the core being located adjacent the conductive member so as, in use, to complete a magnetic circuit formed between the primary and the secondary of the linear induction motor.

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Form 10

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952-69

COMPLETE SPECIFICATION

(ORIGINAL)

Class Int. Class

LODGED AT SUB-OFFICE

2 3 APR 1986

Melbourne

Application Number: 56541/86.

Lodged:

Complete Specification Lodged:

Accepted:

Published:

Priority :

Related Art :

This document contains the amendments made under Section 49 and is correct for printing.

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GRIFFITH HACK & CO MELBOURNE

Complete Specification for the invention entitled:

AUSTRALIAN Reg 88(2) PATENT OFFICE

REACTION RAIL

The following statement is a full description of this invention, including the best method of performing it known to : us

FIELD OF THE INVENTION

This invention relates to a reaction rail. This invention more particularly relates to a reaction rail for a transit system, which utilizes tracked vehicles powered by linear induction motors (LIMs).

BACKGROUND OF THE INVENTION

One form of electrical drive for transit vehicles is the linear induction motor. Linear induction motors offer the advantage of mechanical simplicity, with consequent reduced maintenance requirements and greater reliability. Such a linear induction motor has a primary and a secondary, one of which is carried by the vehicle, and the other of which is provided in elongate form along the track.

For transit systems, it is common to provide the linear induction motor primary, which is supplied with the drive current, on the vehicle itself. The secondary is then provided along the track. The secondary is, in this case, a passive component of the system, which provides a low reluctance path for the magnetic field and a low resistivity facing material which enables the necessary induction currents to be generated. This enables the required thrust between the primary and the secondary to be generated.

It is to be appreciated that, since the secondary extends along the full length of the track, it is important that the secondary should be as cheap and economical as possible. Any construction that is excessively elaborate, will have a significant effect on the overall cost of a transit system. At the same time, the magnetic and electrical properties of the secondary should be as optimum as possible, otherwise the overall efficiency of the system will be impaired.

A common configuration for the primary and secondary of the linear induction motor is the so-called single-sided linear induction motor. In this case, both the primary and the secondary have just a single planar side or surface facing each other. As compared to, for example, double-sided systems where the primary might run in a slotted secondary, this has the advantage of relative simplicity. For a transit system using railway vehicles, the secondary is formed as a reaction rail extending longitudinally between the two rails of the track. At switches and the like, small gaps can be provided in the reaction rail. This has little effect on the overall efficiency on the system, whilst not affecting the layout of the tracks themselves.

A simple and cheap construction for such a reaction rail could utilize solid iron and solid aluminum. Thus, for example, one could have a continuously extruded aluminum top surface. Below this, a continuous length of iron, of appropriate magnetic properties, having the required cross-section would extend. The aluminum would provide the electrical path necessary for the currents induced by the magnetic field from the primary, whilst the iron would complete the magnetic circuit formed between the primary and the secondary. Such an arrangement has the disadvantage that unwanted eddy currents would be generated in the conductive iron impairing the effectiveness of the magnetic circuit. This factor results in a reduction in LIM performance.

As is known for rotary machines, the problem of eddy currents can be eliminated by the provision of laminated iron cores. In rotary machines, this is achieved by clamping together a large number of thin iron sheets, with thin layers of electrical insulation between. The direction of the laminations is such as to provide a relatively uninterrupted magnetic path in the required direction, whilst interrupting the paths along which eddy currents might arise. Such an arrangement can considerably reduce eddy currents.

However, for a reaction rail, which might be provided along many miles of track, such a construction is complex and costly. Theoretically, one could construct the iron core of a reaction rail from a large number of elongate strips, with insulation between, each strip being relatively thin and flexible. For a typical reaction rail, experience has shown that assembly of such an iron core requires care and special techniques. It is necessary to secure the laminations together by transverse bolts or the like.

Accordingly, it is desirable to provide a reaction rail construction, which has good electrical and magnetic properties, but which is relatively simple and economic to produce.

BRIEF SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a reaction rail assembly, for forming a secondary of a linear induction motor that includes a linear induction motor primary mounted on a vehicle. The reaction rail comprising an ~~An~~ elongate aluminum member, which is of generally uniform cross-section and is adapted to be secured to a track and which has a surface that, in use, faces a corresponding surface of a linear induction motor primary, and a ferromagnetic core comprising a plurality of elongate bars, extending parallel to the aluminum member, with adjacent bars being insulated from one another across the reaction rail so as to reduce eddy current losses and with each bar having a width and a height comparable to one another, the elongate bars being located adjacent the aluminum member, so as, in use, to complete a magnetic circuit formed between a primary and a secondary of the linear induction motor.

Preferably the height to width ratio of each bar of ferromagnetic material is less than four. Preferably each said bar of ferromagnetic material is square in cross-section. Conveniently the bars of ferromagnetic material are so dimensioned that the thrust reduction due to eddy current losses is less than 2% of the maximum theoretically obtainable thrust.

In accordance with a further aspect of the present invention provides a reaction rail assembly for forming a secondary of a linear induction motor that includes a linear induction motor primary mounted on a vehicle, the reaction rail comprising an elongate conductive member which is of generally uniform cross-section and is adapted to be secured to a track and which has a surface that, in use, faces a corresponding surface of a linear induction motor primary, and a core formed of ferromagnetic material and located adjacent the conductive member whereby, in use, the core completes a magnetic circuit formed between the primary and the secondary of the linear induction motor, the core comprising a plurality of elongate bars of ferromagnetic material located side by side across the core and extending parallel to the conductive member, with adjacent bars being generally insulated from one another across the reaction rail so as to reduce eddy current losses and with the bars of the core located adjacent the conductive member, wherein each bar has a thickness substantially greater than five millimetres and the thickness of the bars is selected so that the linear induction motor provides a desired thrust performance relative to the theoretical maximum thrust performance obtainable.

As a result of extensive testing, it has been discovered that a provision of numerous relatively narrow laminations in the ferromagnetic core are not necessary. As detailed below, it has been discovered that a relatively simple theory can be used to calculate the effective resistivity of the iron core as a function of lamination thickness. This calculation, combined with an analysis of the electromagnetic fields in a 2 dimensional longitudinal cross-section of the motor, show that under the type of operating conditions seen by this type of LIM, relatively thick bars can provide similar performance to configurations having "ideal" (zero conductivity) iron. In contrast to known constructions, this enables a cheap and simple construction to be used for the core, whilst maintaining the eddy current losses at an acceptable low level.

For example, to assemble the core, the individual bars could simply be welded together by a predetermined pattern of short weld beads, along their underside. There is no need to provide elaborate and complex mounting arrangements to maintain each bar in position, as is common for laminated constructions.

~~Our copending Canadian Patent Application~~ is concerned with a top cap ~~or~~ conductive member suitable ~~for use, in the reaction rail of the present invention~~. The conductive member, can be ~~is~~ formed with a profile such that, when assembled together with the core along a track, the conductive member or top cap is pre-stressed as as to be urged against the core. The purpose of this is to ensure that the conductive member is always located adjacent the core, and consequently undergoes little movement in use. This is important, as there is usually a relatively close spacing between the outer surface of the conductive member and the corresponding surface of a vehicle-born primary. It has been found with "flat profile" top cap extrusions that the mechancial forces at the lateral edges due to tightening of the hold-down bolts can cause the top-cap to bow upwards (away from the back-iron) at the centre. This situation leads to reduced mechanical clearance between the LIM primary and top cap surface. It also contributes to an increase in acoustic noise due to the effects of small, audible frequency mechanical vibrations which occur when the LIM primary passes. By prestressing the top cap during assembly, it should always firmly abut the iron core.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention and to show more clearly how it may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, which show a preferred embodiment of the present invention and in which:

Figure 1 shows a transverse section through a reaction rail assembly, along line 1-1 of Figure 2;

Figure 2 shows a cross-section of the reaction rail assembly of Figure 1, along the line II-II of Figure 1;

Figure 3 shows a cross-section of a conductive member forming part of the reaction rail of Figures 1 and 2, on a larger scale;

Figure 4 shows a side view of the reaction rail assembly of Figures 1 and 2 on a smaller scale;

Figure 5 shows a view from underneath of the core of the reaction rail assembly;

Figure 6 shows a plan view of a thrust rod on a larger scale;

Figure 7 shows a side view of the thrust rod of Figure 6;

Figure 8 shows a plan view of a key plate on a larger scale; and

Figure 9 shows a graph of the variation of thrust with the number of bars in the core.

Referring first to Figure 1, there is shown a reaction rail assembly generally denoted by the reference 1. The reaction rail assembly 1 is intended for mounting on the ties of a conventional railway track or on a concrete guideway (not shown). The reaction rail 1 has ties 4, on which the working components of the reaction rail assembly 1 are mounted. On the ties 4 are elongate iron bars 6 and an elongate aluminum member or top cap 8.

To secure the individual ties 4 to the ties of a conventional railway track, stud bolts 10 are provided. These are mounted at their lower ends (not shown) in the ties of a railway track. At their upper end, the stud bolts 10 each have two nuts 12. As detailed below, each tie 4 is formed from steel of hollow rectangular section, and includes a lower web 14.

In the lower web 14 there are formed two elongate slots 16. Here, on either side of the web 14, for each stud bolt 10, there are two washers 18, whose diameter is slightly less than the length of the slot 16. Thus, as shown, a web 14 is mounted at each end on a stud bolt 10 and held by the nuts 12 between a pair of washers 18. The provision of the two nuts 12 enables the vertical position of the tie 4 to be adjusted at either end to the required height. Consequently, it is possible to adjust the reaction rail 1, so that it has a uniform height both along its length and across its width, within the required tolerances.

The tie 4 includes an upper web 20, corresponding to the lower web 14, and two side webs 22, 24, forming the rectangular cross-section (see Figure 2). At either end of the upper web 20, there are two holes formed for bolts holding the aluminum member 8 in position as described in detail below.

Referring now to Figure 3, there is shown a cross-section through the aluminum member 8. This shows the aluminum member 8 as produced, and unstressed. The aluminum member 8 comprises a central section 80 of uniform thickness and extending almost the full width of the member 8. As shown, the central section 80 is curved so as to be slightly concave on its top surface. Along either edge of the aluminum member 8, there are two channel sections 82. Each channel section 82 has a T-shape cross-section slot 84. Sides 86 of each channel section 82 are parallel to one another, and are inclined, together with a T-shape slot 84, at an angle of 3° to the vertical. A top surface of a aluminum member 8 is denoted by the reference 88, and in use it faces a corresponding surface of a linear induction motor secondary carried by a vehicle (not shown).

Referring back to Figure 1, the reaction rail assembly 1 includes a ferromagnetic core 30.The core 30 is made up from 10 individual iron bars 32 of square-cross section. Figure 5 shows the assembly of the iron bars 32. Prior to assembling the iron bars 82, their abutting faces are primed with a non-conductive primer/varnish, for example Relvine 7901.

The iron bars 32 are then assembled together, so as to be level and free from gaps, with no twist on the length of the whole assembly. As denoted at 34 in Figure 5, short weld beads are provided on the underside in the pattern ~~shown. This pattern could be repeated, for example, nine times~~ along the length of the core 30. Also, welds 35 are formed at the ends of the bars 32. After welding, the ends of the iron bars 32 are ground flush. Then, after being cleaned suitably in known manner, the core 30 is provided with a suitable ~~protective coating, for example Copan Coal Tar Epoxy No. 10.~~

shown. The weld pattern comprises a first transverse row including a weld bead between each adjacent pair of bars. A second transverse row includes a weld bead for every other adjacent pair of bars, including the outside pair on either side of the core. A third transverse row includes a weld bead for every other adjacent pair of bars, with no weld bead for the two outer bars. This pattern could be repeated, for example, nine times along the length of the core 30. Also, welds 35 are formed at the ends of the bars 32. After welding, the ends of the iron bars 32 are ground flush. Then, after being cleaned suitably in known manner, the core 30 is provided with a suitable protective coating, for example Copan Coal Tar Epoxy No. 10.

As shown in Figures 1 and 4, the core assembly 30 is placed on top of the ties 4. Then, the aluminum member 8 is placed on top of the core 30. To secure the aluminum member 8 in position, carriage bolts 40 are used. Each carriage bolt 40 has a corresponding key plate 42 as shown in Figure 8. Each key plate 42 is elongate, and has a width indicated at 44, which is slightly less than the width of the top part of each T-shape slot 84. The length of each key plate 42 is greater than its width 44. In the centre of each key plate 42, in known manner, there is a square opening 46, corresponding to the similar square section portion of the shank of the carriage bolts 40. Prior to locating the aluminum member 8 on the ties 4, the carriage bolts 40 and associated key plates 42 are slid into position in the channel sections 82. As mentioned above, at each end of each tie 4, there are two openings for the carriage bolts 40. As shown in Figure 2, corresponding nuts 48 are secured to the carriage bolts 40, with washers 50 between the nuts 48 and the upper web 20. The co-operation between the key plates 42 and carriage bolts 40 prevents rotation of the carriage bolts 40 as the nuts 48 are tightened.

As the carriage bolts 40 are drawn down by the nuts 48, the aluminum member 8 is prestressed to the configuration shown in Figure 1. In this configuration, its central section 80 is maintained flat. As a result, the central section 80 maintains a constant force on the top of the core 30, and presses it against the ties 4.

The reaction rail 1 is the means by which the thrust applied to a vehicle is transferred to the track bed.

Consequently, it is necessary to provide for this thrust. For this purpose, at required intervals thrust rods 60 are provided (See Figure 6). Each thrust rod 60 is intended to extend between one of the stud bolts 10 and a tie of the conventional railway track. For this purpose, the thrust rod 60 includes a central sloped portion 62, a flat lower end portion 64 and an upper flat end portion 66. The lower flat end portion 64 includes a circular opening 68 for a bolt to secure it to a tie or concrete bed. The upper portion 66 includes a corresponding opening 69, which is elongate and intended to fit one of the stud bolts 10. The upper flat end portion 66 would be received below the web 14 and above the lower washer 18.

Turning to Figure 9, there is shown a graph, which shows the variation of thrust with the number of iron bars 32. In this graph, the vertical axis denotes the thrust, whilst the horizontal axis gives the number of iron bars. The curve shown is derived from a theoretical analysis, based upon the application of the following theory to a two-dimensional electromagnetic field analysis of the motor.

It is assumed that the current in the core follows rectangular paths. For each path, the length is equal to the core-pitch and the width is equal to the width of the corresponding bar, so that the overall width for the paths equals the width of the core 30. Further, it is assumed that sub-dividing the core into separate bars or elements forces the current paths to be contained within each bar, thereby increasing the total effective length of the current path. Also, it is assumed the depth of penetration of current into the iron is constant for a number of bars 32.

Now, for each bar 32, as viewed in plan, the resistance can be calculated from the following equation:

$$R\ BAR = K\,(2L + 2w)$$

K = Constant
L = Length (pole pitch)
w = Width of iron bar
R BAR = Effective resistance of iron bar

consequently, the resistance of the whole core 30 is given by:

$$R\ CORE = N \times R\ BAR = K(2NL + 2Nw)$$

or $$R\ CORE = 2K(NL+W)$$

R CORE = Resistance of whole core
N = Number of iron bars
W = Width of core

thus, the resistance of the core 30 to eddy currents depends on the width of the core 30, and the product of the number of bars 32 and the pole pitch. Consequently, for a small pole pitch, the width will be dominating, and there will have to be a large number of bars 32 to significantly increase the resistance. On the other hand, for a large pole pitch, the resistance will approximately vary in proportion to the number of bars 32.

Figure 9 shows a theoretical calculation of the variation in thrust for a typical LIM motor. The maximum obtainable thrust is 11.8 KN. This is achieved with a large number of bars 32, so that there is little or no eddy currrent loss. As the number of bars 32 is reduced, then the eddy current loss begins to effect the thrust. As shown, with

18 bars 32, the thrust is close to the theoretical maximum. For 9 bars 32, the thrust obtainable is still only 2% below the maximum. Whilst for five bars, the thrust is reduced by 4%. If one has one bar, ie. a solid iron core, then the thrust is reduced by 13%. Using this analysis, in this embodiment of the present invention, it was established that ten bars 32 would be sufficient. This has the advantage of producing a thrust loss of less than 2%, which is quite acceptable. Simultaneously, the construction employed is considerably simpler than that including a large number of narrow laminations. One has bars 32 of square cross-section, each of which is relatively sturdy and self-supporting. One needs simply weld the bars 32 together on their undersides at a number of locations, to form the core 30. (Strictly of course the welds will provide electrical interconnection between the bars 32, but in practice this effect is neglible).

It will thus be seen that the overall construction of the present invention provides for a reaction rail that is relatively simple. It has a small number of components, and can be assembled quickly and simply. Provision is made at various points for accomodating large tolerances. Thus, the thrust rods 60 include elongate openings 69, to accomodate longitudinal displacement relative to the studs 10. Similarly, to position the ties 4 accurately, the elongate slots 16 are provided, so that the transverse position of the ties 4 can be adjusted as required. The longitudinal position of the ties 4 does not matter. The nuts 12 enable the reaction rail 1 to be placed at exactly the required height, both along its length and across its width. The nuts 12 are tightened relatively tightly, to make a secure construction. The nuts 48 for the carriage bolts 40 are tightened to a relatively low torque, for example 10 ft-lbs. This permits longitudinal thermal expansion and contraction of the aluminum member 8, by sliding movement relative to the ties 4.

It is to be appreciated that whilst a preferred embodiment of the present invention has been described, many variations of the structure are possible. In particular, the arrangement of ties and bolts supporting the ties could be simplified. There may be installations in which a guide way is sufficiently accurately formed, to enable a reaction rail to be bolted directly to it, or via simple adjusting mechanisms, thus simplifying the design.

To complete the description of this described embodiment, the principal dimensions are given below.

The stud bolts 10 are 3/4" in diameter and 7-3/16" long. The washers 18 are 2" in diameter, 1/4" thick, and have an internal diameter of 13/16". The thrust rods 60 have a sloped central portion 62 that is approximately 16-7/8" long. The lower portion 64 is approximately 2" long, with a 7/8" of an inch diameter opening 68. The upper flat end portion 66 is 4-1/8" long, with a slot that is 2" long and 7/8" wide. The thrust rod 60 is 2" wide and 3/8" thick. The key plate 42 has a square opening of 7-1/16" side. The key plate 42 is 1-1/2" long and 7/8" wide, with its corners cut to an angle of 15° relative to the sides. The key plate 42 can be 1/8" thick.

The ties 4 of a rectangular section that is 6" wide and 4" deep, with a wall thickness of 1/4". These dimensions need not be exact. The slots 16 are 7/8" wide and 2-7/8" long. For the carriage bolts 40, there are four openings of 1/2" diameter. Additional means, such as a vent hole, can be provided, in the ties as required.

The carriage bolts 10 have a 3/8" diameter and are 1-1/4" long.

Each of the iron bars 32 forming the core 30 is 1'' square. For the aluminum member 8, forming a top cap of the reaction rail 9, the overall width is approximately 14", with a width between the channel sections 82 of 10-1/2", to accomodate the core 30. The central section 80 is approximately 3/16" thick, and in the unstressed condition, its centre is displaced downwards by 3/16" relative to the channel sections 82. Each channel section 82 is approximately 1-3/16" deep, and 1-11/16" wide. The T-shape slots 84 are approximately 7/8" deep, 7/16" wide at their necks and 1-1/16" wide at their upper portions.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A reaction rail assembly for forming a secondary of a linear induction motor that includes a linear induction motor primary mounted on a vehicle, the reaction rail comprising an elongate conductive member which is of generally uniform cross-section and is adapted to be secured to a track and which has a surface that, in use, faces a corresponding surface of a linear induction motor primary, and a core comprising a plurality of elongate bars of ferromagnetic material extending parallel to the conductive member, with adjacent bars being insulated from one another across the reaction rail so as to reduce eddy current losses and with each bar having a width and a height corresponding to one another, the core being located adjacent the conductive member so as, in use, to complete a magnetic circuit formed between the primary and the secondary of the linear induction motor.

2. A reaction rail assembly as claimed in claim 1, wherein the height to width ratio of each bar of ferromagnetic material is less than 4.

3. A reaction rail assembly as claimed in claim 1 or 2, wherein the bars of ferromagnetic material are so dimensioned that the thrust reduction due to eddy current losses is less than 2% of the maximum theoretically obtainable thrust.

4. A reaction rail assembly as claimed in claim 2, wherein each bar of ferromagnetic material has a square cross-section.

5. A reaction rail assembly for forming a secondary of a linear induction motor that includes a linear induction motor primary mounted on a vehicle, the reaction rail comprising an elongate conductive member which is of generally uniform cross-section and is adapted to be secured to a track and which has a surface that, in use, faces a corresponding surface of a linear induction motor primary, and a core formed of ferromagnetic material and located adjacent the conductive member whereby, in use, the core completes a magnetic circuit formed between the primary and the secondary of the linear induction motor, the core comprising a plurality of elongate bars of ferromagnetic material located side by side across the core and extending parallel to the conductive member, with adjacent bars being generally insulated from one another across the reaction rail so as to reduce eddy current losses and with the bars of the core located adjacent the conductive member, wherein each bar has a thickness substantially greater than five millimetres and the thickness of the bars is selected so that the linear induction motor provides a desired thrust performance relative to the theoretical maximum thrust performance obtainable.

6. A reaction rail as claimed in claim 5, wherein the thickness of the bars is that thickness which gives a thrust reduction due to eddy current losses which is less than 2 percent of the maximum theoretically obtainable thrust with no eddy current losses.

7. A reaction rail as claimed in claim 5, wherein the thickness of the bars is that thickness which gives a thrust reduction due to eddy current losses which is less than 4 percent of the maximum theoretically obtainable thrust with no eddy current losses.

8. A reaction rail as claimed in claim 5 or 6, wherein the core includes up to nine bars.

9. A reaction rail as claimed in claim 5 or 7, wherein the core includes up to five bars.

10. A reaction rail as claimed in claim 5, wherein the core includes up to 5 bars, and wherein the reaction rail gives a thrust reduction due to eddy current losses which is between 4 and 13 percent of the maximum theoretically obtainable thrust.

11. A reaction rail as claimed in claim 5, wherein the core includes up to ten bars.

12. A reaction rail as claimed in any one of claims 7 to 11, wherein each bar has a height, with the height being determined by flux penetration.

13. A reaction rail as claimed in any preceding claim, wherein the elongate bars are welded together by a repeated pattern of short weld beads along a bottom surface of the bars remote from the conductive member, and below the depth of substantial flux penetration, which repeated pattern comprises a plurality of rows of weld beads, each row extending transversely of the elongate bars and including a plurality of weld beads, and the rows being uniformly spaced from one another.

14. A reaction rail as claimed in claim 13, wherein the repeated pattern of short weld beads comprises a first transverse row including a short weld bead between each adjacent pair of elongate bars, a second transverse row of short weld beads comprising a weld bead for every other

adjacent pair of bars including the outside pairs on either side of the core and a third transverse row of weld beads which includes a weld bead for every other adjacent pair of bars with no weld bead for the two outer bars of the core.

15. A reaction rail as claimed in claim 14, wherein the core includes weld beads at the ends of the bars.

16. A reaction rail as claimed in any one of claims 13 to 15, wherein the adjacent elongate bars, apart from the weld beads, are electrically insulated by a layer of insulation, and the core is coated with a protective coating.

17. A reaction rail as claimed in any preceding claim, wherein the conductive member has a central section of uniform thickness and two slotted channel sections at either side, the channel sections including slots that open downwards.

18. A reaction rail as claimed in claim 17, wherein the central section of the conductive member is curved downwards, when unstressed, so that, in the complete assembly, the central section is prestressed and maintained pressed against the core.

19. A reaction rail as claimed in claim 17 or 18, wherein each of the channel sections further comprises a T-shape slot opening downwards, for receiving heads of bolts.

20. A reaction rail as claimed in claim 17 or 18, wherein the channel sections comprise T-shape slots which open downwards, and wherein carriage bolts and corresponding key plates are located in the T-shape slots, the key plates preventing rotation of the carriage bolts.

21. A reaction rail as claimed in any one of claims 17 to 20, wherein the reaction rail further comprises ties, on which the core is mounted and to which the conductive member is secured.

22. A reaction rail as claimed in any preceding claim, wherein the conductive member is formed of aluminum.

23. A reaction rail, as claimed in any one of claims 5 to 15, wherein the reaction rail further comprises a plurality of ties, each of which is of hollow rectangular construction and is secured along the track, with the elongate conductive member further comprising along either side, elongate channel sections, and bolts received in said channel sections and secured to the ties to secure the conductive member and the core in position.

24. A reaction rail as claimed in claim 23, wherein the conductive member comprises a central section extending between said channel sections, the central section being curved downwards when unstressed, so that, in the complete assembly, the central section is prestressed and maintained pressed again the core.

25. A reaction rail as claimed in claim 23 or 24, wherein the core comprises ten bars.

26. A reaction rail as claimed in any one of claims 23 to 25, wherein each tie further comprises two transverse, elongate slots in a lower web thereof, a pair of stud bolts and nuts, with the lower web of the respective tie secured to the stud bolts to permit vertical and transverse adjustment of that tie.

27. A reaction rail as claimed in any one of claims 23 to 26, wherein the reaction rail further comprises a plurality of thrust rods, connected to said ties, and for connection to ties of a conventional railway track.

DATED this 30th day of November, 1989.

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AUSTRALIA.

SKP:JZ (9.44)

23 406 56541

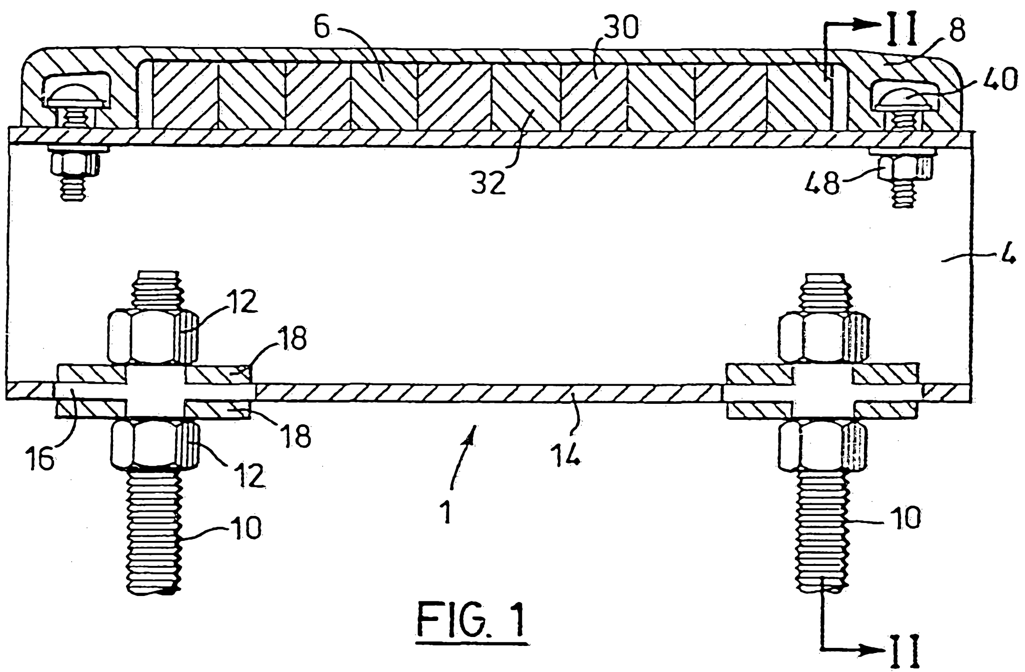

FIG. 1

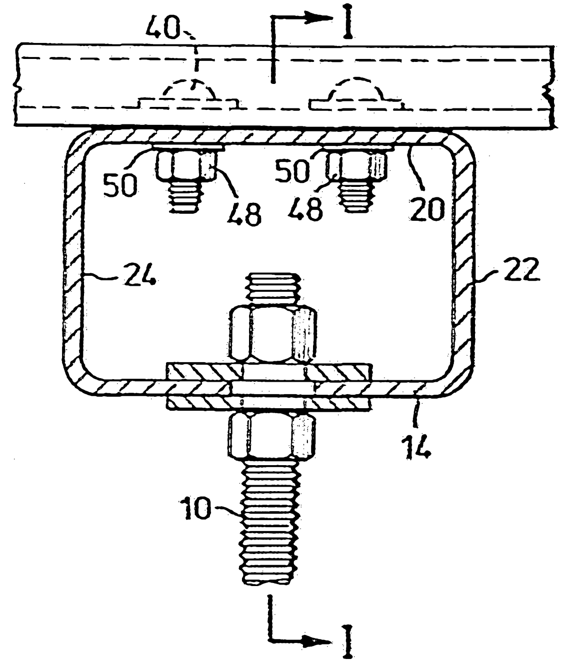

FIG. 2

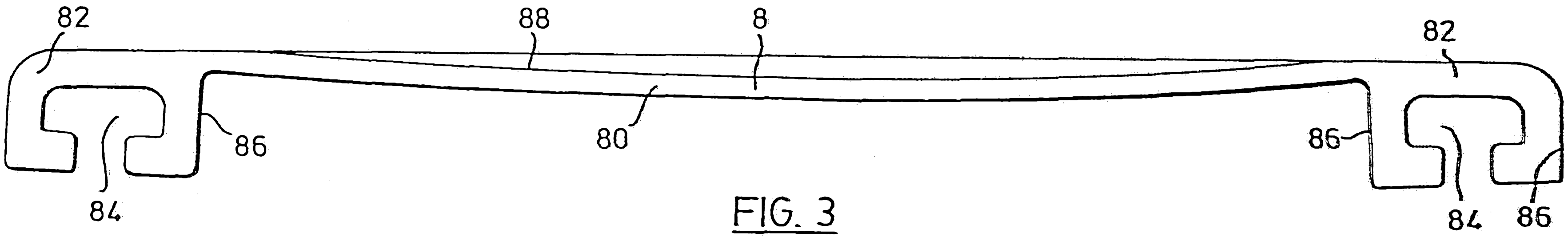

FIG. 3

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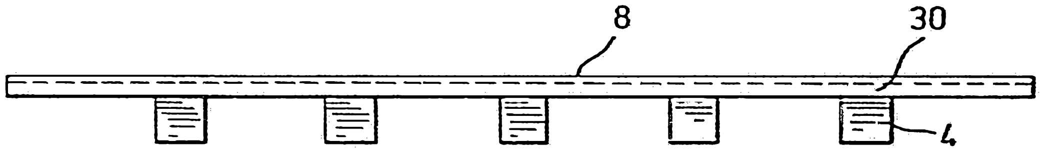

FIG. 4

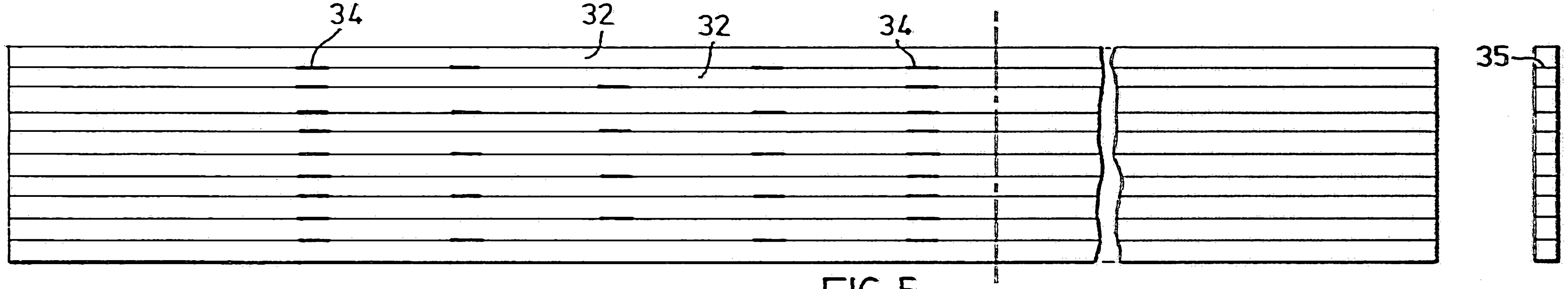

FIG. 5

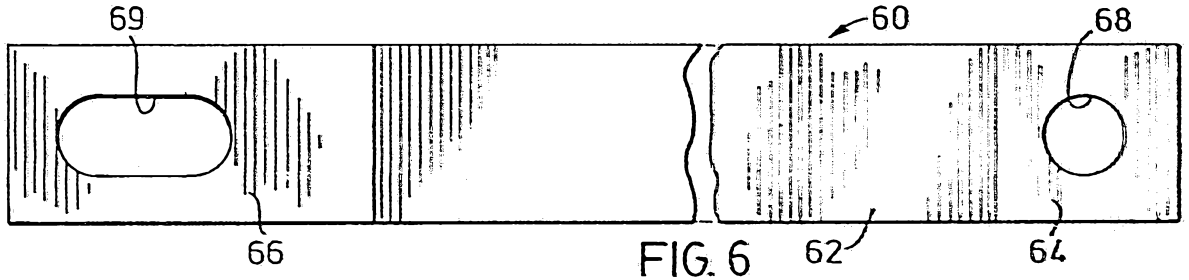

FIG. 6

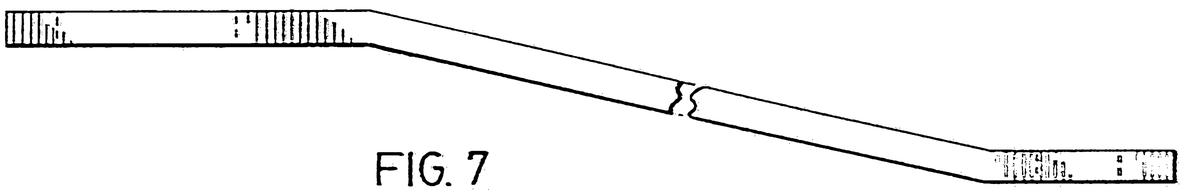

FIG. 7

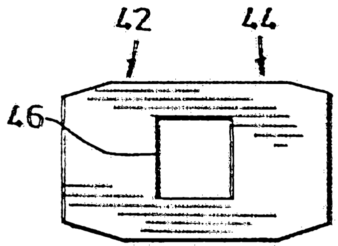

FIG. 8

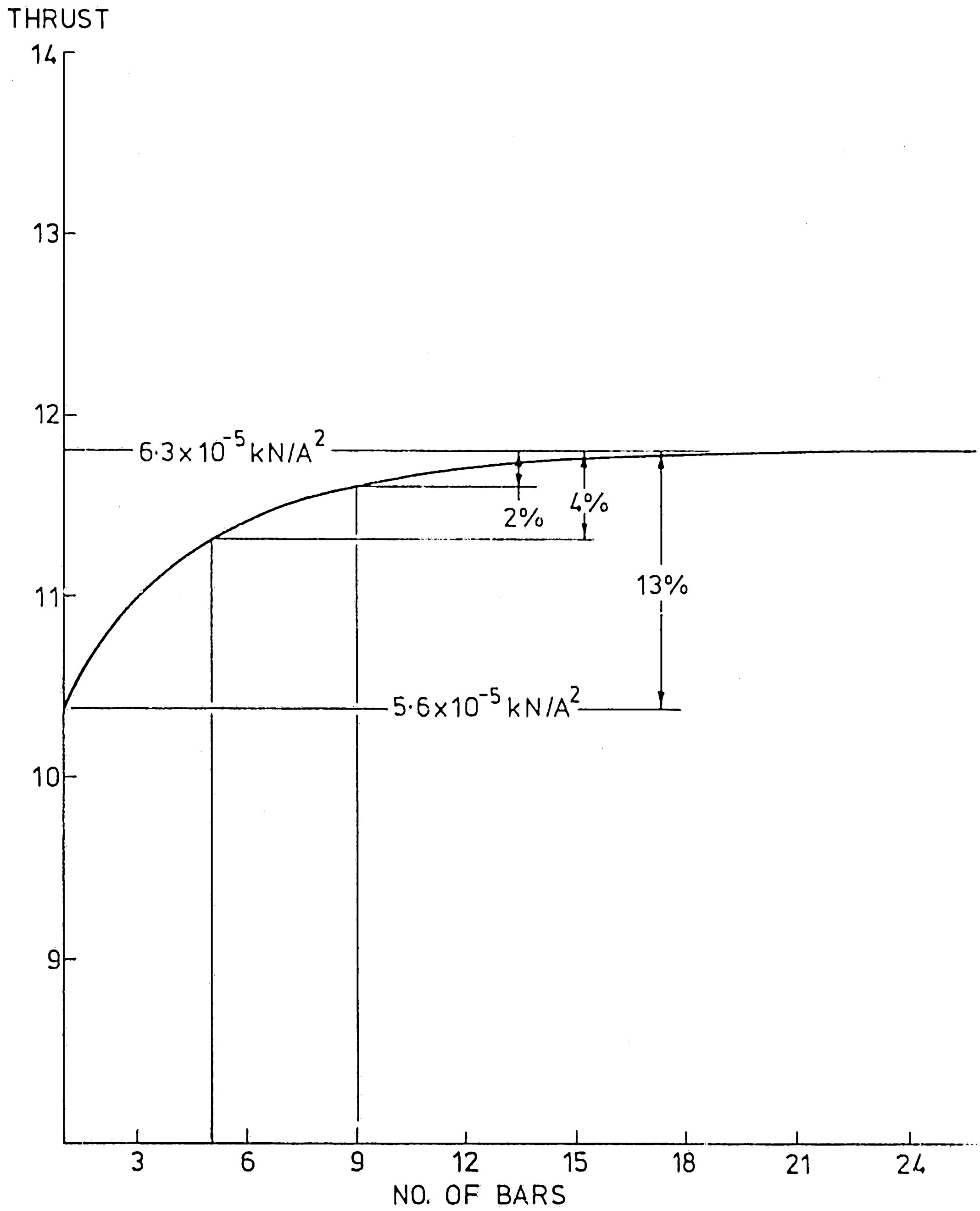
THRUST
14
13
12
11
10
9
6·3x10^{-5}kN/A^2
2%
4%
13%
5·6x10^{-5}kN/A^2
3
6
9
12
15
18
21
24
NO. OF BARS

FIG. 9