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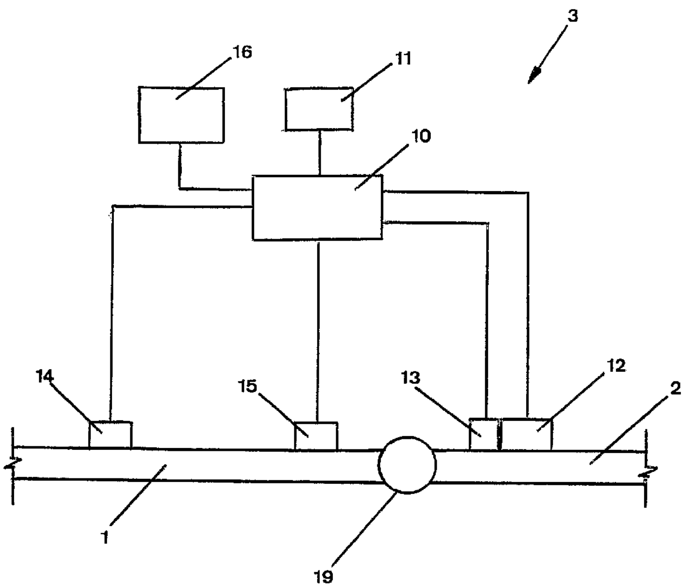
(54) Title: METHOD OF WELDING RAILWAY LINES



(57) **Abstract:** This invention relates to a welding process for welding adjoining ends of adjacent sections of railway line (1,2) in situ, the process including attaching a vibration apparatus (3) on the railway line and vibrating the line at a suitable low frequency of vibration and amplitude of vibration, such inputs being preset and/or adjustable during the process by a vibration control means(12) to measure the frequency and amplitude of vibration and being adapted to allow adjustments to the frequency of vibration and the amplitude of vibration; then welding the sections of railway line together during the period of vibration applied to the sections of railway line until the weld is complete; and continuing to vibrate the sections of railway line about the weld area (19) for a period of time sufficient to allow heat to dissipate from the weld area.

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METHOD OF WELDING RAILWAY LINES

TECHNICAL FIELD

This invention relates to joining railway lines. More particularly, but not exclusively, the present invention relates to a method of welding railway lines.

BACKGROUND ART

Modern railway lines are generally made of a high carbon steel as it is considered to be a suitably durable material. As some railway lines endure harsh weather environments along with heavy axle train and carriage loadings, even these high carbon steel lines suffer the risk of cracking and buckling and joint failures from time to time. The consequences of a track failure can lead to catastrophic derailments leading to loss of life and damage to property. Therefore, the integrity of railway lines is paramount to achieving the safe carriage of persons and property across countries.

The repairing of cracks and defective or failed joints in railway lines is a major problem for railway companies. One method of repairing a failed line is to cut out a section of line on either side of the defective area, thus requiring welding two joints when inserting the replacement section of railway line into the track. This type of repair work is time consuming and can result in potentially weak and defective weld joints if the work not carried out properly.

One trend with railway lines is with welding or joining sections of railway track to form a continuous welded line. However, it has been evident that these joins can suffer from fatigue and even, in some instances, premature failure by cracking through the weld joint. It has been a challenge to maintain the integrity of railway lines in recent years, particularly when lines are subjected to various stresses and strains imposed from trains having a heavy axle loading. The techniques for joining and rejoining sections of railway line have come under intense focus and pressure in recent years as a result of rail failures, and concerns over the reliability of tracks are effecting the safe operation of virtually every railway in the world.

The basic process of welding sections of a railway line to form a continuous welded line is known. Common types of welding processes employed are flash butt and thermite type welding processes. However, flash butt welding relies heavily on a high quality weld to become effective and reliable, and even then the life of such a weld joint is limited, particularly when subject to heavy axle loadings. Another type of weld is made by the aluminothermic or thermite reaction process. Thermite type weld joints result in a lower strength weld compared with other methods and as such are banned by some railway companies due to a perceived higher risk of weld failure. These failures can be caused by sub standard welding and due to the fact the such welds can be difficult to check for integrity and thus it is not uncommon for such welds to be defective.

It is a non-limiting object of the invention to provide a welding process for joining or repairing a railway line which overcomes at least some of the abovementioned problems, or which at least provides the public with a useful choice.

SUMMARY OF THE INVENTION

According to a non-limiting broad aspect of the invention there is provided a welding process for joining sections of railway line in situ, the process including the preliminary step i. of positioning an end of each adjoining section of railway line in a suitably close alignment end to end, the steps of the process including:

A. configuring and attaching a vibration apparatus on the railway line such that the vibration means is attachable to the line, and vibrating the line at a suitably low frequency of vibration and amplitude of vibration, such inputs being preset and/or adjustable during the process by a vibration control means adapted to measure the frequency and amplitude of vibration and being adapted to allow adjustments to the frequency of vibration and the amplitude of vibration;

B. welding the sections of railway line together during the period of vibration applied to the sections of railway line until the weld is complete; and

C. continuing to apply vibration to the sections of railway line about the weld area for a period of time sufficient to allow heat to dissipate from the weld area.

Preferably in step C. the vibration apparatus continues to apply vibration to the weld area for a period of between 5 to 20 minutes after welding is completed.

Desirably in step A. the vibration apparatus includes a vibration means being a motor having eccentric weights applied to the shaft of the motor, the motor being clamped to a section of railway line adjacent the weld area, and wherein the frequency of vibration is measured by a tachometer means being releasably attachable to the railway line, and the amplitude of vibration is measured by an accelerometer means being releasably attachable to the railway line, the tachometer means and the accelerometer means being adapted to provide feedback signals to the vibration control means.

Desirably in step A. the frequency of vibration applied by the vibration apparatus is between about 50 and 200 Hertz. More preferably the frequency of vibration is between about 70 and 80 Hertz and the amplitude of vibration is substantially about 1 millimetre per second.

Preferably in step B. welding is performed using a metal inert gas welding process, and wherein an inert shielding gas is applied to the welding area during welding along with a wire feed unit being adapted to continuously supply a wire electrode filler material into the weld area.

Desirably the shielding gas is a blend of argon and carbon dioxide. Advantageously the shielding gas is a blend of substantially about 55% by weight of argon and substantially about 45% by weight of carbon dioxide.

Desirably the wire electrode is 2.4 millimetres in diameter.

Preferably in preliminary step i., the sections of railway line are prepared by making V shaped cuts in at least one of the edges of an end of the adjoining sections of railway line.

Desirably in preliminary step i. the V shaped cuts in the edge of each end of the adjoining sections of railway line are at an angle of between 15 and 165 degrees. More preferably in preliminary step i. the V shaped cuts made in the head of the each edge of the adjoining sections are raked back from square to increase the strength of the weld joint.

Optionally the V shaped cuts made in the head and the foot of the each edge of the adjoining sections are raked back at any sufficient angle from square to increase the strength of the weld joint.

According to a further aspect of the invention there is provided a welding process for joining sections of railway line in situ end to end, the process including the preliminary step i. of positioning an end of each adjoining section of railway line in a suitably close alignment end on end, the sections of railway line being prepared by making V shaped cuts in at least one adjoining edge of the adjoining ends of the sections of railway line, the V shaped cuts being made in the top surface of the head, and along one side of the stem of the line, and in both sides of the foot of the line, the steps of the process including:

a.) configuring and attaching a vibration apparatus on the railway line such that the vibration means is attachable to the line, and vibrating the line at a suitably low frequency of vibration and amplitude of vibration, such inputs being preset and/or adjustable during the process by a vibration control means adapted to measure the frequency and amplitude of vibration and being adapted to allow adjustments to the frequency of vibration and the amplitude of vibration;

b.) welding the sections of railway line together during the period of vibration applied to the sections of railway line until the weld is complete; and c.) continuing to apply vibration to the sections of railway line about the weld area for a period of time sufficient to allow heat to dissipate from the weld area.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will now be illustrated, by way of example only, with reference to the accompanying drawings in which:

Figure 1: Shows a schematic diagram of vibration equipment configured for use on sections of railway line;

Figure 2: Shows a schematic diagram of welding equipment configured for use on sections of railway line;

Figure 3: Shows a cross sectional profile through a typical railway line;

Figure 4: Shows a side view of sections of railway line prepared for welding;

Figure 5: Shows a plan view of sections of railway line prepared for welding; and

Figure 6: Shows a cut away perspective view of a weld area as prepared in a railway line.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to figure 1, a vibration apparatus and system, generally referred to as 3, for vibrating a railway line according to a preferred embodiment of the invention, is illustrated.

It is seen that the vibration can assist in the control the movement of carbon in the steel structure during the welding process, and this action is considered to be a very desirable attribute of the welding process of the invention. The welding process of the invention involves any suitable form of welding and more preferably involves gas metal arc welding, commonly referred to as MIG (metal inert gas) welding. Advantageously MIG welding equipment is utilised and adapted to create a suitable weld joint between sections of railway lines end on end or on sections of railway line prepared in a way to enhance the quality of the weld. The use of this form of welding is described in more detail with reference to figures 2 to 4 below.

In figure 1, the two ends of the railway line 1,2 are prepared and aligned and are desirably retained or held *in situ.* The weld area joining the ends of the sections of line 1,2 is generally indicated within a circle 19. Preferably the ends to be joined are cut and shaped with a gas torch or otherwise to form a square cut, or more preferably a V shape or other such angled cut, as desired. It has been found that a V shape formation of the ends of the line 1,2 can increase the strength and therefore the quality of the weld joint. Other non square formations may be applied, and one desirable arrangement of V shaped angles and notches is shown in more detail with reference to figures 4 to 6.

The invention includes a controlled means of vibrating the railway lines 1, 2 in the form of suitable vibration apparatus or equipment 3 is set up on the railway line 1,2 to supply a constant and suitable vibration of the sections of railway line 1, 2. The ends of the railway line 1,2 are desirably retained in their clipped and fixed and aligned positions on respective railway line sleepers. The vibration apparatus 3 desirably includes a controlled source of vibration by way of a vibration apparatus preferably including a control means 10 in the form of a computer means including a microprocessor suitably programmed to control the operation of the vibration equipment. A suitable display means 11 associated with the control means 10 is desirably utilised to enable an operator to read measurements and to ensure a suitable frequency and duration of vibration is applied to the sections of railway line 1,2 during the welding process.

The control means 10 can function to control each step of the vibration process. The control means 10 can desirably be powered by any power supply means 16 and when used remotely may be powered by any suitable and durable battery means (not shown) or generator means for remote testing on railway lines away when operating remotely from an available mains electrical power source, thus enabling the vibration apparatus to be used for portable applications.

The vibration apparatus includes a vibration means 12 being mountable by any known and suitable securing means, such as for example a clamp, to an appropriate position on the sections of railway line 1 or 2, and more preferably to the head of the line. Desirably the vibration means is in the form of a shaker or exciter 12 including a motor adapted with a vibration inducement means preferably in the form of eccentric weights mounted to the motor shaft that apply a vibration force on the head of a section of line 1, 2. Such force is adjustable such that the frequency of vibration can be changed as required. The vibration means 12 is advantageously controlled by a user controlling and adjusting the speed of the motor 12. The motor 12 can therefore be controlled by operating a speed control adjustment means from the control means 10.

The motor speed of the vibration means can be sensed using any known form of motor speed measuring means and in this embodiment is in the form of a tachometer 13 that is mounted to the shaft of the motor 12. The tachometer 13 measures the shaft speed and the measured signal outputs are fed to the control means 10.

The amplitude of vibration induced on a section of railway line 1 can be sensed and measured using a signal measuring means in the form of a transducer means, desirably an accelerometer 14. The accelerometer 14 generates an electrical signal in response to the vibration acceleration of the railway line as induced by the vibration means 12, and provides a signal that is fed to the control means 10. The control means 10 is configured and arranged to convert the signals into a measurement of frequency of vibration for display on the display means 11. Typically the amplitude of vibration is preferably about 1 millimetre per second although it is envisaged that the vibrating apparatus 3 will be adapted to provide any desirable amplitude of vibration outside this stated value.

A temperature measurement means 15 is preferably used to measure the temperature of the line 1,2 during operation. The temperature measurement means 15 is desirably in the form of a pyrometer and provides measurement signals to the control means 10 that allows the temperature of the line to be tagged against other recorded data at the time of operation of the vibration apparatus 3.

The display means 11 can be provided to display the plotted measurements of velocity amplitude (for example, in mm/second) against the frequency of vibration and any other desirable characteristics of the data obtained during operation of the vibration apparatus 3 during the welding operation and after.

The vibration apparatus 3 is configured and arranged to allow a user to apply a constant vibration to sections of the railway line 1 and/or 2 at any suitable frequency of vibration that may be substantially between about 50 to 200 Hertz (Hz). More preferably the frequency set is between about 70 and 80 Hz.

It is envisaged in one application of the invention that the vibration apparatus 3 will be operated at the start of the welding operation, and will continue for a suitable time period after welding is complete, and is desirably applied for a period of between 5 to 20 minutes after welding. Other periods of time are envisaged within the scope of the invention, the time periods being partially dependent on the time taken for heat to be dissipated from the newly welded area.

Referring to figure 2, a typical set up for welding sections of sections of railway lines 1,2 according to a preferred embodiment of the invention, is illustrated.

The welding process involves use of an arrangement of known and readily available equipment. Preferably the welding equipment is configured for a metal inert gas welding process. The equipment desirably includes a welding gun torch unit 20 configured and arranged to feed a consumable wire or electrode 21 through the gun unit 20 and into the weld area from a wire feed unit 22. The gun unit 20 is also provided with a nozzle adapted for supplying a shielded gas to the weld site. Desirably the wire electrode 21 is of a sufficiently large diameter to allow a consumable electrode or weld filler material to be continuously introduced and fed into the weld pool and weld site during a welding operation, as required.

The wire electrode 21 may be of any suitable diameter, and is preferably between 1 to 2.4 millimetres or more. More preferably a 2.4 mm diameter wire electrode is used. The wire 21 may contains a deoxidising metal such as manganese, silicon or aluminium or the like sufficient to reduce the risk of oxygen porosity in the weld area, and titanium and/or zirconium or the like to reduce the risk of nitrogen porosity. Preferably the wire 21 is a rutile-coated austenitic-ferritic weld metal that exhibits a high resistance to cracking. One suitable and available type of electrode is commonly known as RSP that embodies the desirable properties described above. It is envisaged that different wire electrodes may be applied to different regions of the sections of line 1,2 and it may well be that the weld material for the head of the line produces a harder weld than in the stem or foot areas.

A suitable power supply 24 is provided to preferably supply a positively charged electrode 21 to the weld area. A negatively charged clamp lead 25 from the power supply is clamped to the railway line that may be a short distance from the weld area. The voltage supplied is constant, and preferably a direct current charges the electrode 21 in any suitable range, such range being advantageously being at least 40 Amps, and more desirably is between substantially about 100 and 500 Amps but may be higher. The power supply 24 is provided in any available form, and it is envisaged that for applications that are remote from mains power supply can be powered by a diesel generator or other such generator. The power generator 24 is desirably adapted for carriage on a dolly or motorised carriage that can quickly travel along railway tracks, as required

A supply of suitable shielding gas 27 to the weld area from a gas supply unit 23 is supplied via a suitable hose 26. The gas is considered to be desirable for protecting the weld area from oxygen and nitrogen that can cause defects along with weld embrittlement and porosity. The gas is preferably a mixture or blend of at least two or three gases, and is desirably a combination, for example, of various inert gases of varying percentages by weight.

In one application, the blend of shielded gas is a mixture of carbon dioxide and argon and at least one other inert gas such as helium. A typical blend of shielding gas may be up to about 95% argon or an argon blend that may include 10 to 30% or more helium, and at least 10 to 40% carbon dioxide. Other desirable blends are envisaged with a higher percentage of argon being blended with a lower percentage of carbon dioxide. In another application about 90% argon gas is mixed with 10% carbon dioxide.

In another typical application, for example, the estimated feed rate of gas to the weld site during the welding operation may be between about 10 to 16 litres per minute of argon gas and between 10 to 16 litres per minute of carbon dioxide.

Referring to figure 3, a cross sectional view through a typical railway line 1, is illustrated.

The cross sectional view illustrates a typical simplified profile of a railway line 1 that illustrates three distinct regions. The head 30 is the main region upon which train wheels bear against, and which is supported in an elevated position by the stem 31 and the foot 32 of the line 1. Given that the stem 31 has a relatively narrow waist, and the foot has a wide and relatively flat profile, it is seen that one preferred method of preparing sections of line for welding involves different sized weld areas to join the line.

Referring now to figures 4 to 6, a weld area 19 prepared in sections of railway line 1,2, is illustrated.

It will be seen that the adjoining ends of the sections of railway line 1,2 may be prepared as a standard square cut and placed together. However, further desirable preparatory steps are envisaged within the scope of the invention.

The method of the invention advantageously includes the preliminary step i. of preparing the sections of railway line 1,2 for welding. The sections of railway line 1, 2 are prepared for joining with desirably V-type cuts made by a gas torch or other such suitable tool in the areas or regions of the railway head 30, the stem 31 and the foot 32. As seen in the figures, an angled and optionally racked back V shape weld area 34 is formed in the head, thus allowing suitable weld filler material to be fed into the weld area in a way that builds up layers in the V-cut to join the sections of line 1,2. The V-shape is also desirably angled back from a square cut in the head 30 of the rail. The V shape angle as shown in figure 5 is about 110 degrees on the head 30, although it will be appreciated that more acute angles, or any angle between 100 and 170 degrees could be applied.

This arrangement of the sections of line 1,2 may advantageously provide a more robust and durable weld, which, when coupled with the method of welding a railway line in accordance with an aspect of the invention, increases the likelihood of achieving a successful weld of the railway line using the method of the invention.

The angle of the V shape in each area or region of the line 1,2 made in the rail is any desirable angle and is preferably between about 20 to 30 degrees although any workable angle between substantially about 15 and 165 degrees in a V shape or similar may be applied. It is generally seen that, within reason, the greater the angle and size of the V shape, the larger the weld area requiring a greater amount of weld filler material to rebuild the weld area. This can result in obtaining a weld joint with a greater strength over a much smaller weld joint.

As the stem 31 of the railway line has a narrow waist, the weld area 35 may desirably be formed as a V or notch cut along the join between the two sections of line 1,2. As the waist is narrow or relatively thin along the stem 31, it is envisaged that the V shaped notch is cut on one side of the stem 31 and therefore it is seen that the weld area for the section of the stem 31 is on one side.

The V shape or notch cut is preferably made in the base or foot 32 of the rail. Furthermore, it is desirable to make a V shaped notch in a raked and/or angled alignment between the sections 1,2 as opposed to a square cut between the sections 1,2.

Other shapes can be applied such as a U shape. However, the V shape illustrated is preferred as it is, in part, an easier and quicker shape to form with a metal cutting tool such as a gas cutting torch.

One non-limiting example of the method or process of welding a railway line in accordance with the invention is as follows:

Example A

In step a. of the process, the vibration apparatus 2 is set up on a railway line with the vibration means in the form of a motor 12 and associated eccentric weights setting up a repeating vibration on the railway line. The tachometer 13 is coupled to the line along with the accelerometer 14 and desirably a temperature measurement means 15. This apparatus on the railway line is run by the control means 10, desirably including instrumentation means, such that the vibrating operation is undertaken in a controlled manner.

Preferably MIG welding apparatus and its associated process is applied during this welding process in step b. of the method of the invention. A suitable welding gas torch 20 is applied to the weld area 19 to make a V formation between ends of the section of railway line 1,2 to be joined to obtain a greater quality weld. It may well be that the sections of line 1,2 do not require any preheating.

The vibration apparatus is started and the control means 10 operates to apply a constant vibration of substantially between about 70 to 80 Hz with an amplitude of vibration of substantially about 1 millimetre per second to the sections of railway line 1,2 to be joined by welding.

Then wire filler material is fed into the weld site during vibration along with a blend of shielding gas. A wire electrode 21 having a diameter of 2.4mm with an applied amperage of substantially about 250 Amps is then fed into the prepared weld area 19 until the weld area is build up sufficiently. This may be achieved in beads and layers and wherein more filler material is required in the weld area 34 of the head 30 than other weld areas.

It is seen that the vibration allows for a good feed rate for wire being applied. It is seen that the weld filler used in the process is compatible with the high carbon steel material to enable a strong weld to result. The electrode in this example is a commonly available RSP electrode known as a rutile-coated austenitic-ferritic weld metal that offers a high resistance to cracking.

The welding operation should take up to about 15 minutes depending on the amount of filler material required. Once the weld is finished, in accordance with step c. of the process of the invention, the vibration apparatus 3 continues to operate for a further period of time of substantially between about 5 to 15 minutes or more until heat has dissipated from the weld area, as required.

It is expected that time periods may apply depending on the size of the weld and the particular application. Such action brings about a stress relieving action on the line and the weld joint created, and such action can improve the strength and elasticity of the weld joint. The application of vibration during and after welding can also serve to dissipate heat from the joint and may well decrease the risk of an initial weld failure in the joint due to cracking and the like as can occur from the standard process of welding of railway lines using a MIG welder by an average welder.

It is considered that the vibration may well be changing the thermodynamic properties of the sections of line 1, 2. The application of vibration may also be increasing the conductivity of the sections of line 1,2 and be improving the effective heat dissipation during the welding process.

Wherein the aforegoing reference has been made to integers or components having known equivalents, then such equivalents are herein incorporated as if individually set forth. Accordingly, it will be appreciated that changes may be made to the above described embodiments of the invention without departing from the principles taught herein.

It is to be understood that the above description is intended to be illustrative, and not restrictive. Additional advantages of the present invention will become apparent for those skilled in the art after considering the principles in particular form as discussed and illustrated. Thus, it will be understood that the invention is not limited to the particular embodiments described or illustrated, but is intended to cover all alterations or modifications which are within the scope of the appended claims.

CLAIMS:

1 A welding process for joining sections of railway line in situ, the process including the preliminary step i. of positioning an end of each adjoining section of railway line in a suitably close alignment end to end, the steps of the process including:

a. configuring and attaching a vibration apparatus on the railway line such that the vibration means is attachable to the line, and vibrating the line at a suitably low frequency of vibration and amplitude of vibration, such inputs being preset and/or adjustable during the process by a vibration control means adapted to measure the frequency and amplitude of vibration and being adapted to allow adjustments to the frequency of vibration and the amplitude of vibration;

b. welding the sections of railway line together during the period of vibration applied to the sections of railway line until the weld is complete; and

c. continuing to apply vibration to the sections of railway line about the weld area for a period of time sufficient to allow heat to dissipate from the weld area.

2. A welding process according to claim 1 wherein in step c. the vibration apparatus continues to apply vibration to the weld area for a period of between 5 to 20 minutes after welding is completed.

3. A welding process according to claim 1 wherein in step a. the vibration apparatus includes a vibration means being a motor having eccentric weights applied to the shaft of the motor, the motor being clamped to a section of railway line adjacent the weld area, and wherein the frequency of vibration is measured by a tachometer means being releasably attachable to the railway line, and the amplitude of vibration is measured by an accelerometer means being releasably attachable to the railway line, the tachometer means and the accelerometer means being adapted to provide feedback signals to the vibration control means.

4. A welding process according to claim 1 wherein in step a. the frequency of vibration is between about 50 and 200 Hertz.

5. A welding process according to claim 1 wherein in step a. the frequency of vibration is between about 70 and 80 Hertz and the amplitude of vibration is substantially about 1 millimetre per second.

6. A welding process according to claim 1 wherein in step b. welding is performed using a metal inert gas welding process, and wherein an inert shielding gas is applied to the welding area during welding along with a wire feed unit being adapted to continuously supply a wire electrode filler material into the weld area.

7. A welding process according to claim 6 wherein the shielding gas is a blend of argon and carbon dioxide.

8. A welding process according to claim 7 wherein the shielding gas is a blend of substantially about 55% by weight of argon and substantially about 45% by weight of carbon dioxide.

9. A welding process according to claim 6 wherein the wire electrode is 2.4 millimetres in diameter.

10. A welding process according to claim 1 wherein in preliminary step i. the sections of railway line are prepared by making V shaped cuts in the edge of each end of the adjoining sections of railway line.

11. A welding process according to claim 1 wherein in preliminary step i. the V shaped cuts in the edge of each end of the adjoining sections of railway line are at an angle of between 15 and 165 degrees.

12. A welding process according to claim 11 wherein in preliminary step i. the V shaped cuts made in the head of each edge of the adjoining sections are raked back from square to increase the strength of the weld joint.

13. A welding process according to claim 1 wherein in preliminary step i. the V shaped cuts made in the head and the foot of the each edge of the adjoining sections are raked back at any sufficient angle from square to increase the strength of the weld joint.

14. A welding process for joining sections of railway line in situ, the process including the preliminary step i. of positioning an end of each adjoining section of railway line in a suitably close alignment end on end, the sections of railway line being prepared by making V shaped cuts in at least one adjoining edge of the adjoining ends of the sections of railway line, the V shaped cuts being made in the top surface of the head, and along one side of the stem of the line, and in both sides of the foot of the line, the steps of the process including:

a. configuring and attaching a vibration apparatus on the railway line such that the vibration means is attachable to the line, and vibrating the line at a suitably low frequency of vibration and amplitude of vibration, such inputs being preset and/or adjustable during the process by a vibration control means adapted to measure the frequency and amplitude of vibration and being adapted to allow adjustments to the frequency of vibration and the amplitude of vibration;
b. welding the sections of railway line together during the period of vibration applied to the sections of railway line until the weld is complete; and
c. continuing to apply vibration to the sections of railway line about the weld area for a period of time sufficient to allow heat to dissipate from the weld area.

15. A weld joint in a railway line prepared and made by the welding process as claimed in any one of claims 1 to 14.

16. A welding process in accordance with either claim 1 or claim 14 substantially as herein described.

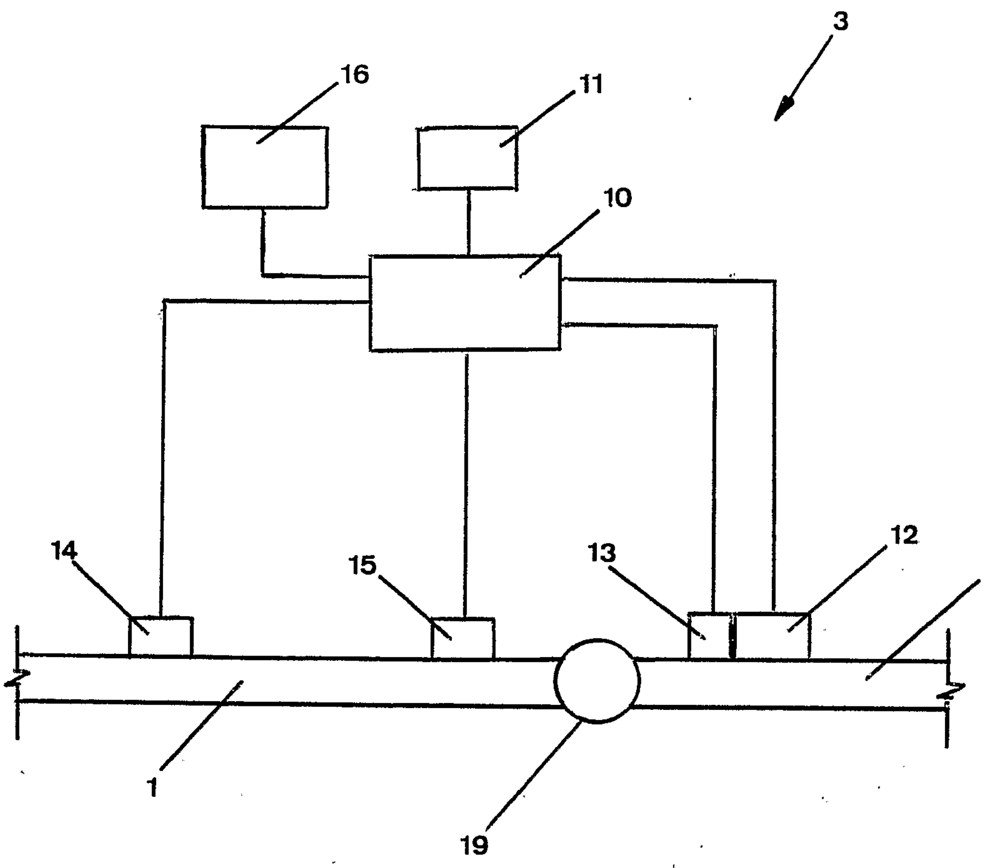

Figure 1

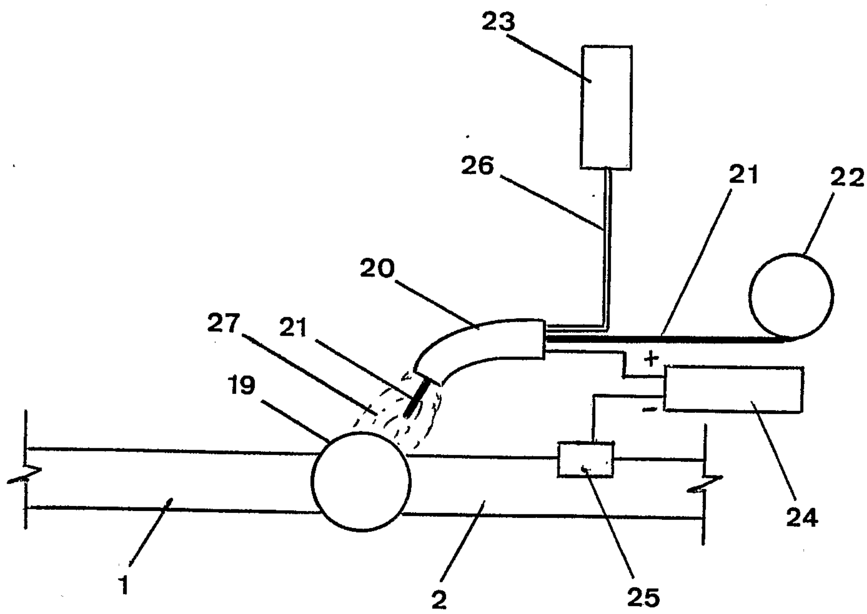

Figure 2

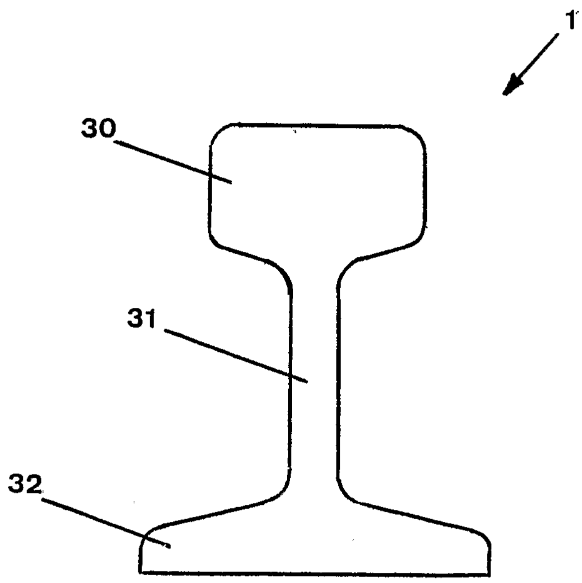

Figure 3

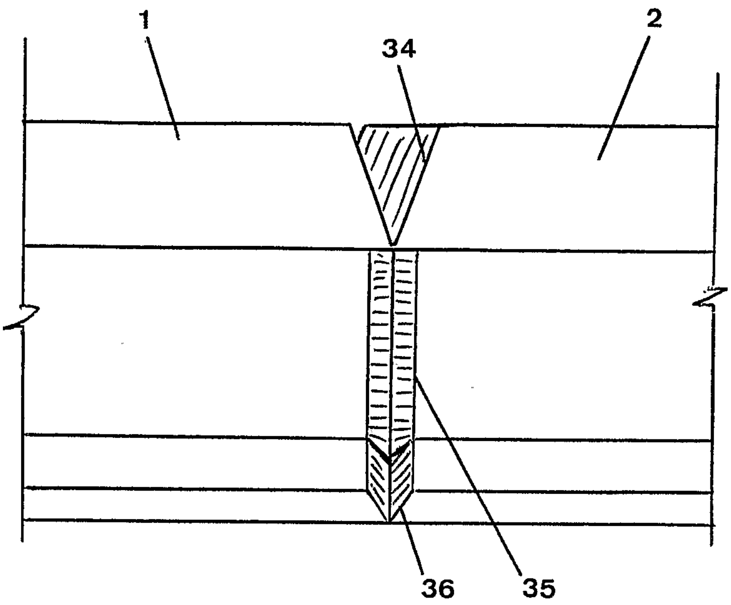

Figure 4

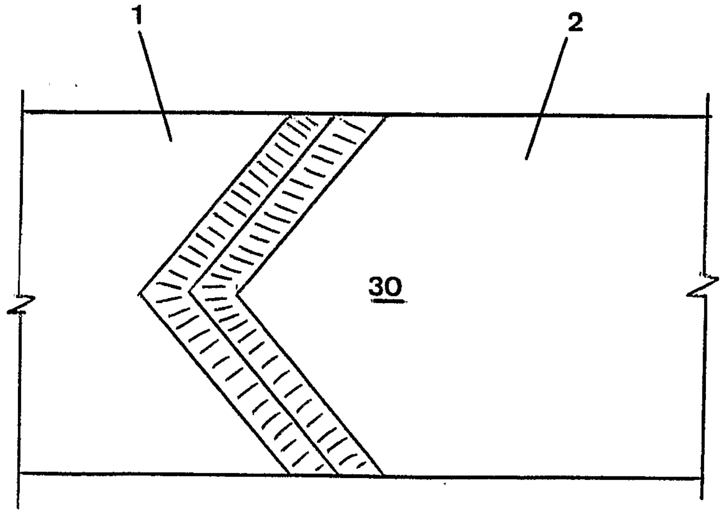

Figure 5

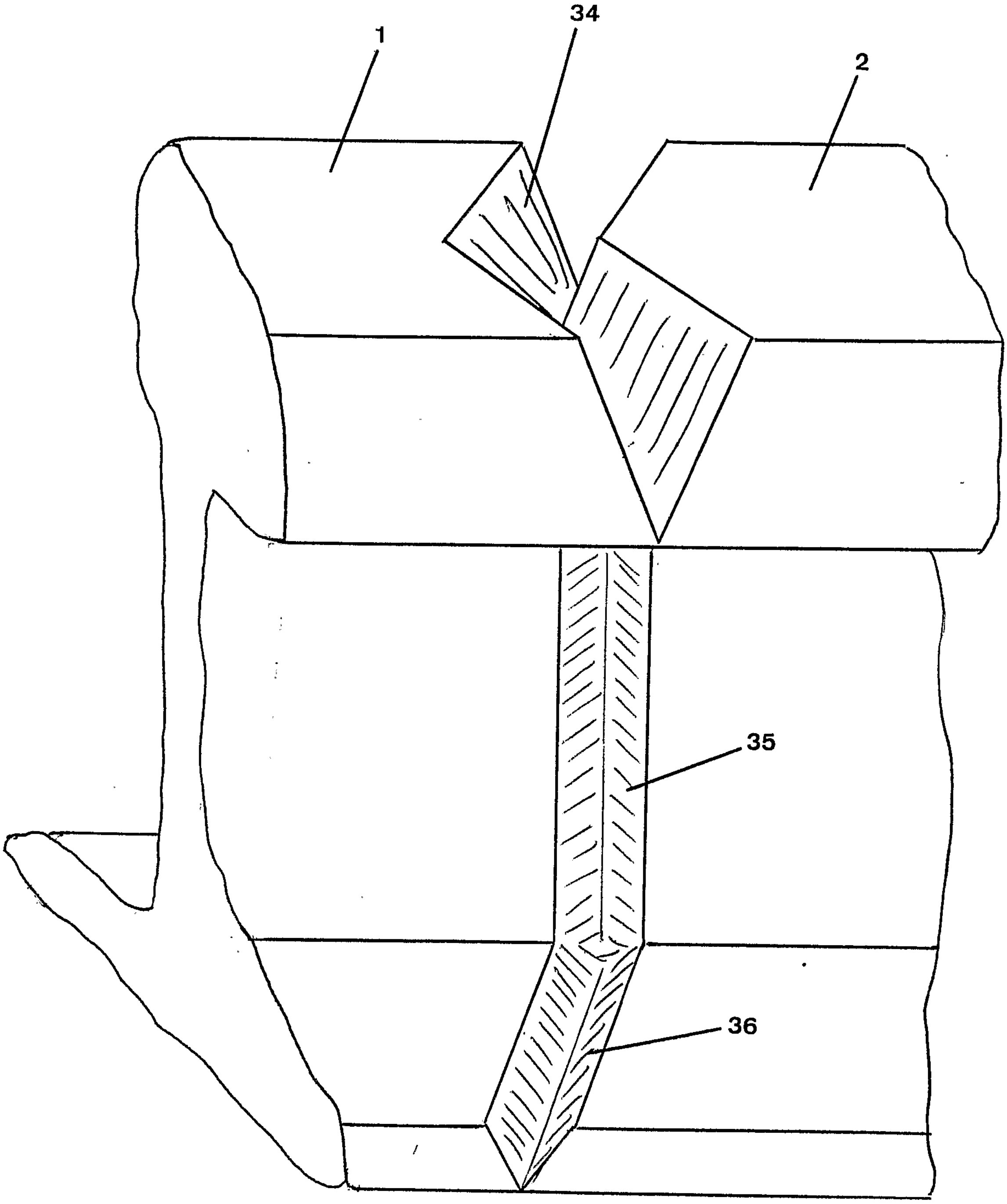

Figure 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ2006/000044

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

B23K 37/00 (2006.01) ***B23K 9/00*** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI & keywords (rail, weld, vibrate and similar terms); USPTO & keywords (railway, stress, track, weld, vibrate, heat and similar terms); Espacenet & keywords (rail, weld, vibrate and similar terms); GOOGLE & keywords (weld, railway, vibrate, line, dissipate, stress)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3999276 A (BROWN et al) 28 December 1976 See abstract and column 2	1-16
A	US 5252152 A (SEROR) 12 October 1993 See abstract	
A	Derwent Abstract Accession No. 2000-001680/01, Class Q41, FR 2778418 A1 (POUGET) 12 November 1999 See English abstract	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 May 2006	25 MAY 2006

Name and mailing address of the ISA/AU	Authorized officer
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	**STEPHEN CLARK** Telephone No : (02) 6283 2781

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3905300 A (STEWART) 16 September 1975 See abstract	

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member	
US	3999276	NONE	
US	5252152	NONE	
FR	2778418	NONE	
US	3905300	CA	1039111

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX