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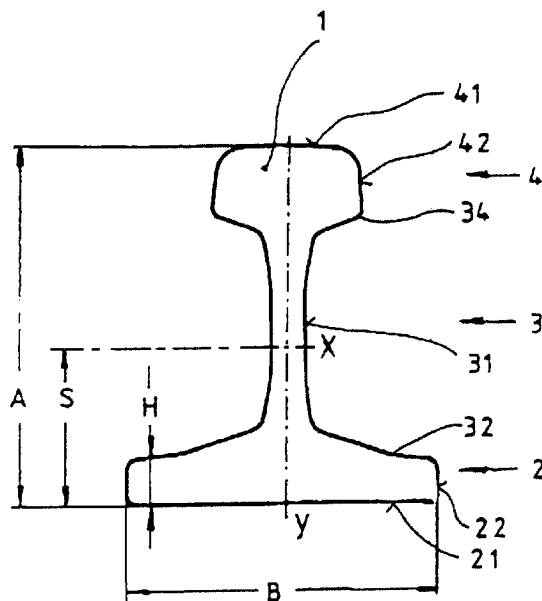
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(54) RAIL A FAIBLE NIVEAU DE RADIATION SONORE

(54) REDUCED RADIATED-NOISE RAIL



(57) The invention relates to a profiled rail (1), especially for a railway track, with a reduced total radiated noise level when in use. In order to reduce the noise radiation level, at least one web side surface (31) is substantially concavely rounded without any salient points in the lower region (31') between the transition edge (32) on the side of the rail pattern (3) and the centre of gravity axis (X) in the rail cross-section and/or the height (H) of the pattern is increased by comparison with a normally profiled rail having a corresponding total rail height A.



**PCT**  
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**(54) Title:** REDUCED RADIATED-NOISE RAIL

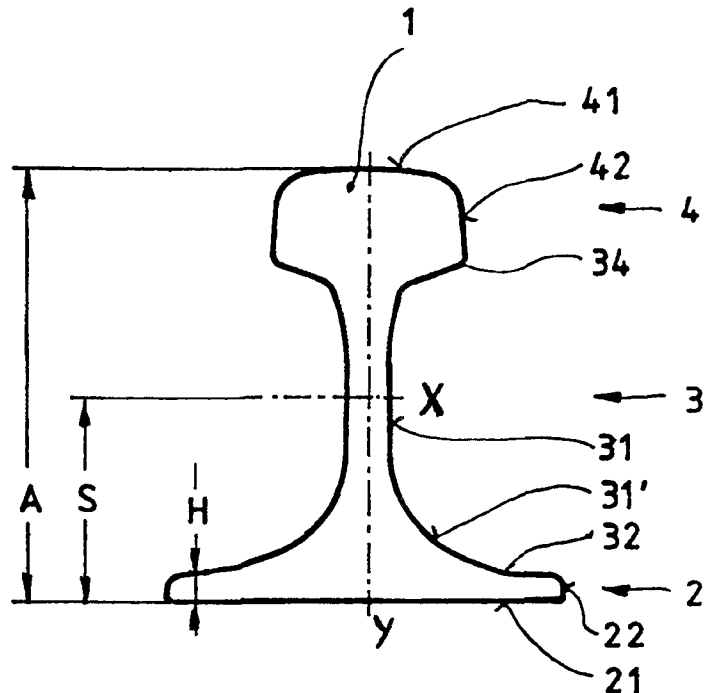
**(54) Bezeichnung:** SCHIENE MIT GERINGEREM ABGESTRAHLTEN LUFTSCHALLPEGEL

**(57) Abstract**

The invention relates to a profiled rail (1), especially for a railway track, with a reduced total radiated noise level when in use. In order to reduce the noise radiation level, at least one web side surface (31) is substantially concavely rounded without any salient points in the lower region (31') between the transition edge (32) on the side of the rail pattern (3) and the centre of gravity axis (X) in the rail cross-section and/or the height (H) of the pattern is increased by comparison with a normally profiled rail having a corresponding total rail height A.

**(57) Zusammenfassung**

Die Erfindung betrifft eine profilierte Fahrschiene (1), insbesondere eine Eisenbahnschiene, mit einem beim Befahren geringeren abgestrahlten Luftschallgesamtpegel. Zur Verringerung der Schallabstrahlung ist vorgesehen, mindestens eine Stegseitenfläche (31) zumindest im unteren Bereich (31') zwischen fußseitiger Übergangskante (32) am Schienenfuß (3) und der Schwerpunktachse (X) im Querschnitt der Schiene im wesentlichen knickpunktfrei konkav gerundet auszubilden und/oder die Schienenfußhöhe (H) im Vergleich mit einer entsprechenden Schienengesamthöhe A aufweisenden Normalprofilschiene zu vergrößern.



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## Rail with Reduced Radiated Noise Level

The invention relates to a profiled rail, especially a railway rail, having a reduced total radiated noise level when in use, and comprising a foot section with a bottom surface, a web section, and a head section with a tread surface, and having a rail height and preferably also a rail head width, and in particular a moment of inertia and a section modulus about the axis of the centre of gravity, corresponding substantially to those of standard, normally profiled rails having the same load-bearing capacity.

Running rails are profiled, rolled steel bars which are used to build trackways, especially railroad tracks, on which loads can be economically transported. On these tracks, metallic wheels, made preferably from steel or having a steel tire, run on the tread surface of a section of the rail referred to as the rail head. The foot of the rail, which is located opposite to and joined to the head by means of a web, is connected with its bottom surface to a base structure.

In the course of development of railway systems, functionally optimized cross-sectional profiles of rails were appropriately standardized for various loads and applications. In Europe, a frequently used standard profile for railroad rails bears the designation UIC 60; the rail weighs approx. 60 kg/m and tight dimensional tolerances of, for example,  $\pm 0.6$  mm for the rail height and  $\pm 0.5$  mm for the width of the rail head, are specified. Tight tolerances in the rail profile are important, especially for the purpose of building a geometrically accurate track intended to permit the speed of trains to be increased without any loss in ride comfort and without any major dynamic loads occurring. In order to reduce wear, rails having heads exhibiting increased hardness are already being manufactured and used.

Despite the highest possible dimensional accuracy, a tread or running surface of the best quality, and smoothness of the rails, as railway cars travel along the track vibrations, and thus radiated noise, occur. This airborne noise can attain high intensity, especially at high transportation

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speeds, and it can cause considerable environmental pollution. It has been found that the travel noise generated by trains is caused to a considerable extent by airborne noise radiated from the surface of the rail.

Attempts have already been made by sound-insulating surface sections of  
5 the rail to reduce the intensity of the radiated noise.

Applying a coating of vibration-damping material, as proposed in DE-A-4225581 or AT-AS 652/90, is only partially successful in achieving this goal; it is also expensive, prevents visual inspection of the rail in the track and, especially if reinforced polymers are used, it can itself be a source of  
10 environmental pollution. In addition, there have been several proposals, e.g. in DE-OS 4411833, to use elastic components in the fastening elements to reduce the transmission of vibrations to the base structure and thus to reduce the amount of airborne noise radiated from this source.

All the devices and arrangements so far proposed to reduce the airborne  
15 noise radiated from rails or track installations have in common the disadvantage that they are not very effective, and/or are very expensive, and are aimed essentially at reducing the transmission of vibrations from the rail.

It is the purpose therefore of the invention to reduce or shape the vibration  
20 of the rail, when it is travelled on by trains moving especially at high transportation speeds, so that the total level of radiated noise and the noise pollution of the environment are reduced. The goal of the invention is thus in particular to reduce the vibrations of the body or the rail itself, which vibrations are responsible for generating the airborne noise, and thereby, in  
25 a simple manner, to reduce the radiated noise and the environmental pollution.

Using a profiled rail of the kind mentioned at the beginning, this task or goal is accomplished in that at least one lateral web surface, at least in the lower

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area between the transition edge at the foot of the rail, namely the edge formed at the transition from the foot into the lateral web surface, on the one hand, and the axis of the centre of gravity, on the other hand, is concavely rounded and substantially free of any angularities in the cross  
5 section of the rail, and/or the height of the rail foot is larger compared with that of a standard profiled rail.

It has surprisingly been discovered that, contrary to what is assumed by experts in the field, it is not the web between the head and foot of the rail, vibrating like a membrane, that creates most of the radiated noise. Instead,  
10 the rail head and in particular the foot of the rail exhibit high solid-borne noise levels and thus contribute greatly to the level of the total sound pressure and in turn are chiefly responsible for the noise pollution of the environment. The reasons for the increased wave-like vibration in the longitudinal direction, i.e. the springiness, as a function of the frequency,  
15 for example, of one flange of a rail foot have not yet been scientifically fully explained. However, it is assumed that angularities in the surface profile or discontinuous changes in the thickness of the cross section may act as vibration nodes or theoretical clamping points causing or permitting increased vibrations to occur in sections of the rail profile, for example in a  
20 flange of the rail foot. In the manner according to the invention, increasing the height of the foot of the rail and/or in particular ensuring the transition, without angularities, from the foot into the lateral surface of the web brings about a change in the vibrations in the area of the rail foot; as a result, the amount of airborne noise radiated by the surfaces of the rail foot into the  
25 environment and possibly to a base structure which reflects this radiated noise, is reduced.

A further reduction in the radiated noise is achieved when the cross-sectional profile is designed symmetrically to the height axis, as a result of which the tendency for local vibration nodes to form in the profiled bar is  
30 further reduced.

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If, as further advantageously provided, the lower part and the upper part of the lateral surface of the rail web between the transition edge at the foot of the rail and the transition edge at the head of the rail, namely the edge which is formed when the lateral surface of the rail head merges into the upper surface of the web, are designed so as to be concavely rounded and substantially free of angularities in the cross section of the rail, the formation of vibrations, especially in sections of the rail profile which as a result radiate airborne noise, is further reduced.

It may be further advantageous from the point of view of manufacturing or rolling the rail, as well as for the purpose of minimizing the weight, but especially also in order to reduce airborne noise emission, if in the cross section of the rail the lateral surface of the rail web is made up of a circularly and/or an elliptically shaped lower and upper part and possesses preferably a straight middle or intermediate section, merging tangentially with the aforesaid parts, and through this middle section passes the axis of the centre of gravity. It may be favourable in this case if the minimum thickness of the rail web is the same as or greater than that of standard rails.

A particularly favourable embodiment, in which the rail possesses a high load-bearing capacity while at the same time radiating a low level of airborne noise is achieved if the distance between the axis of the centre of gravity and the bottom surface at the foot of the rail has a value between (0.5 and 0.38), preferably between (0.47 and 0.41) times the height (A) of the rail.

The vibration sensitivity of the outer sections of the flanks of the rail foot can be largely eliminated or minimized in a simple way if the foot is less wide and/or higher compared with the respective standard rail profile.

If, as advantageously provided, the hardness of the material in the head, and in particular in the tread area of the rail according to the invention, has

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been increased, as known in the art, it is possible to substantially reduce the resulting increase in the noise radiated by standard profiles if, in addition, the hardness of the material in the foot and in particular in the central area of the rail, which is arranged substantially symmetrically to the axis of the  
5 rail and contains the bottom surface, is also increased; in this way, a particularly stable embodiment possessing ideal functional properties is obtained.

In the following, the invention is explained in more detail based on methods of implementation and test results schematically illustrated in the drawings.

- 10 Figure 1 is a cross section through a standard UIC 60 rail.  
Figure 2 is a cross section through a rail reinforced according to the invention in the foot area.  
Figure 3 is the cross section through a rail having rounded lateral web faces, free of angularities, at the foot of the rail.  
15 Figure 4 is a rail cross section with fully rounded web surfaces.  
Figure 5 depicts the total level of solid-borne noise and the weights of rails as a function of the cross-sectional shape.

Figure 1 shows a cross-sectional view of a standard UIC 60 rail. The rail has an overall height A of 172 mm, a head height of 37.55 mm from the tread  
20 surface 41 to the edge 34 where the transition is made from the side 42 of the head 1 to a lateral surface 31 of the web, and a foot width B of 150 mm. The distance S of the axis X of the centre of gravity from the bottom surface 21 extending between side edges 22 at the foot 2 of the rail is 80.95 mm.

A standard UIC 60 rail of this type, having a weight or mass of 60.84 kg/m,  
25 was caused to vibrate by applying excitation in the form of impulses laterally or eccentrically at the tread surface 41, transverse to the longitudinal orientation, in a vertical and horizontal direction, and the maximum total level of solid-borne noise as well as the radiated sound power were determined. The values determined for a standard rail, as

shown in Fig. 5, bar B, represent base values for the UIC 60 which can be compared with the values obtained from rails according to the invention. Figure 2 depicts a rail according to the invention having a reinforced foot 2, or a larger foot thickness H, compared with a standard UIC 60 rail. As a result, while maintaining the same overall rail height A, the distance S between the axis (X) of the centre of gravity and the bottom surface 21 is reduced and, as is also apparent from Figure 5, bar 1, the weight of the rail is slightly increased. Compared with a standard rail, given the same excitation, this design leads to a reduction in the maximum total level of solid-borne noise and to a significant drop in the total level of airborne noise, as is also evident from Figure 5, bar 1.

Figure 3 shows a rail profile according to the invention in which the foot 2 has a height H corresponding to the standard UIC 60 profile, but in which the lower part 31' of the lateral surface 31 of the rail web 3, between the transition edge 32 at the foot and the intersection with the axis X of the centre of gravity, has a symmetrical, circularly rounded configuration free of angularities. Compared with the standard rail, when the same pulsating excitation was applied, this embodiment was found to have a much reduced total level of solid-borne noise and a total level of radiated sound power that was lower by approximately 1.05 dB, as shown diagrammatically in Figure 5, bar 2, while the mass of the rail (see lower part of Figure 5, bar 2) was only slightly increased.

Figure 4 shows another rail profile according to the invention which possesses fully rounded fishing spaces, or lateral web surfaces 31 free of angularities, extending from the transition edge 32 at the foot of the rail to the transition edge 34 at the head of the rail, and having a plane-parallel middle section of the web 3 in the area of the axis of the centre of gravity, said section merging tangentially into said surfaces. A continuous thickening of the web 3 towards the head 4 and the foot 2 of the rail increases the mass of the rail 1 per metre, as is evident from the lower part of Figure 5, bar 3. As also shown by bar 3 in the upper part of Figure 5, the maximum

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total level of solid-borne noise is reduced to a very small percentage compared with the standard UIC 60 profile, and also the total level of radiated sound power is reduced by about 3.0 dB.

- Compared with other standard rail profiles, rails embodying the
- 5 characteristics according to the invention also exhibited substantially lower total levels of radiated sound power.

## CLAIMS

1           1.       A railroad rail having a reduced radiated noise level when in  
2 use, and comprising a foot section (2) with a bottom surface (21), a web  
3 section (3), and a head section (4) with a tread surface (41), and having a  
4 rail height (A), with a rail head width, and a moment of inertia and a section  
5 modulus about a horizontal axis (X) passing through the centre of gravity as  
6 viewed in a transverse cross-section of the rail, whose values correspond  
7 substantially to those of standard profiled rails having identical load-bearing  
8 capacity, characterized in that said cross-section is formed symmetrically to  
9 a vertical height axis (Y) intersecting said horizontal axis (X) and said centre  
10 of gravity and, in a lower area (31') between a transition edge (32) at the  
11 foot, namely an edge forming a transition of the foot section (2) into a  
12 lateral web surface (31), and said horizontal axis (X), a concavely rounded  
13 lateral web surface (31) free of angularities is formed in the cross section of  
14 the rail.

1           2.       The rail of Claim 1, having a reduced radiated noise level when  
2 in use, and comprising the foot section (2) with the bottom surface (21),  
3 the web section (3), and the head section (4) with the tread surface (41),  
4 and having the rail height (A), with the rail head width and the moment of  
5 inertia and the section modulus about the axis of the centre of gravity  
6 whose values correspond substantially to those of standard profiled rails  
7 having the same load-bearing capacity, characterized in that the cross-  
8 sectional profile is formed symmetrically to the height axis (Y), and the  
9 height (H) of the foot of the rail is greater than that of the standard profiled  
10 rail.

1           3.       The rail of Claim 1 or 2, characterized in that the lower part  
2 (31') and the upper part (31'') of the lateral surface (31) of the rail web (3),  
3 between the transition edge (32) at the foot and the transition edge (34) at  
4 the head of the rail, namely the edge formed at the transition of the lateral  
5 surface (42) of the rail head (4) into the upper surface (31'') of the web, is

6 concavely rounded and free of angularities in the cross section of the rail (1).

1 4. The rail of one of Claims 1 to 3, characterized in that, in the cross  
2 section of the rail (1), the lateral surface (31) of the web is made up of a  
3 circularly or elliptically shaped lower part (31') and a circularly or elliptically  
4 shaped upper part (31'').

1 5. The rail of Claim 4 comprising a straight middle section which  
2 merges tangentially into said lower and upper parts and through which runs the  
3 axis (X) of the centre of gravity.

1 6. The rail of one of Claims 1 to 5, characterized in that the distance  
2 (S) between the axis (X) of the centre of gravity and the bottom surface (21)  
3 at the foot (2) of the rail has a value between 0.5 and 0.38 times the height  
4 (A) of the rail.

1 7. The rail of one of Claims 1 to 6, characterized in that the distance  
2 (S) between the axis (X) of the centre of gravity and the bottom surface (21)  
3 at the foot (2) of the rail has a value between 0.47 and 0.41 times the height  
4 (A) of the rail.

1 8. The rail of Claims 1 to 6, characterized in that the foot (2) of the  
2 rail (1) has a narrower width (B) and/or a greater height (H) than the respective  
3 standard rail profile.

1 9. The rail of one of Claims 1 to 8, characterized in that, in the head  
2 section (4), the material in an area of the rail (1) containing the tread surface  
3 (41) is harder than that of the web (3) or foot (2).

1 10. The rail of one of Claims 1 to 9, characterized in that in the foot  
2 (2), the material in the central area of the rail (1), located essentially  
3 symmetrical to the axis (Y) and containing the bottom surface (21), is harder  
4 than the material of the web.

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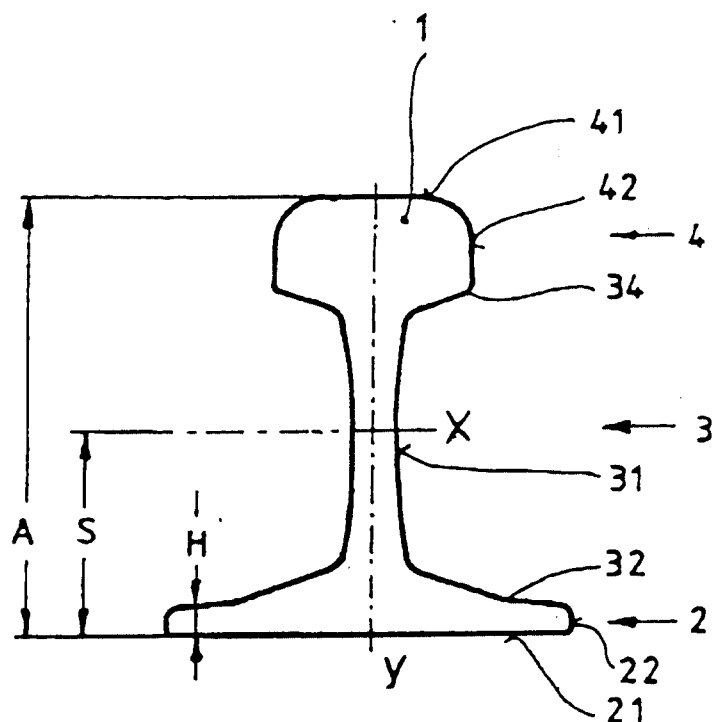


Fig. 1  
(Prior Art)

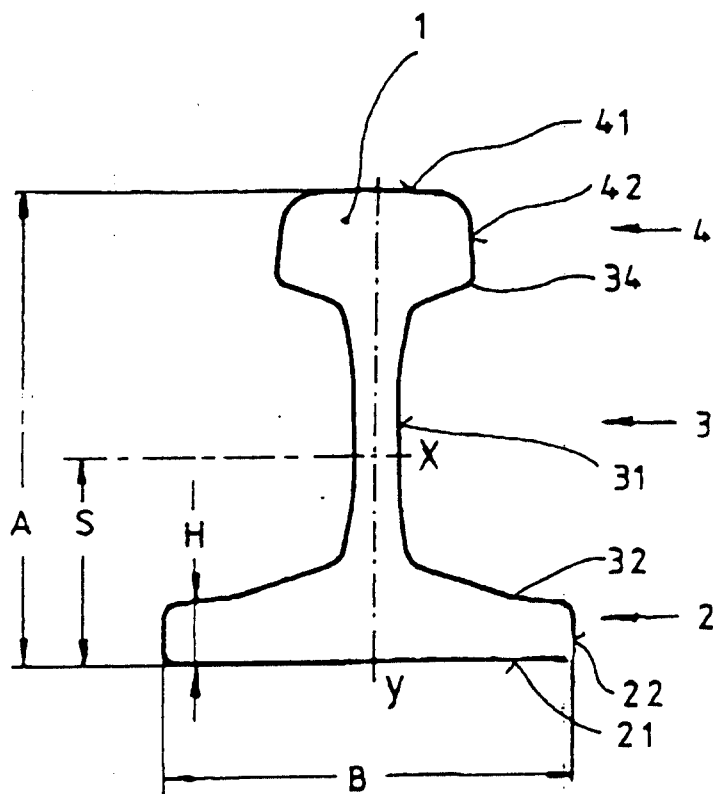


Fig. 2

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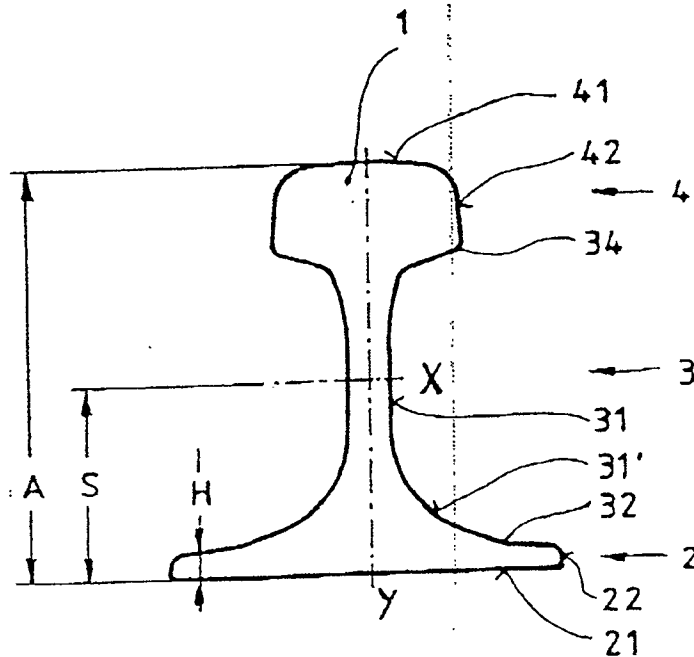


Fig. 3

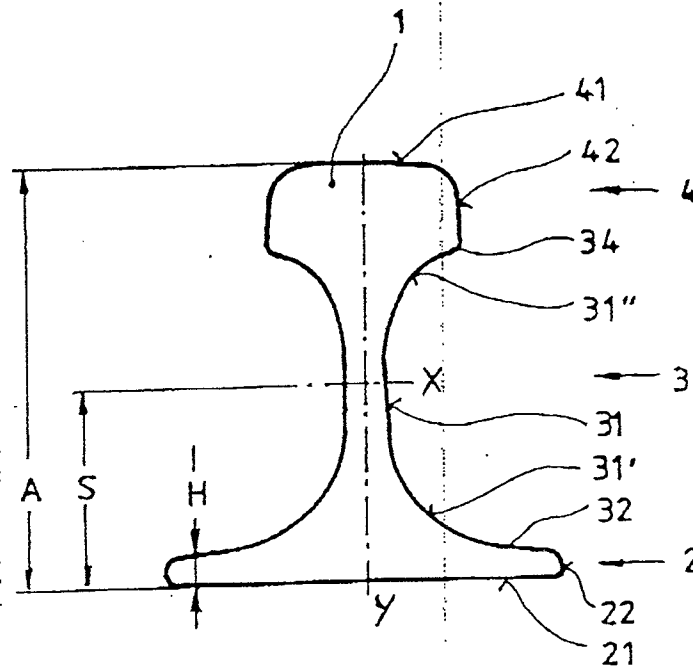


Fig. 4

ERSATZBLATT (REGEL 26)

- *Gowling, Strathy & Henderson*

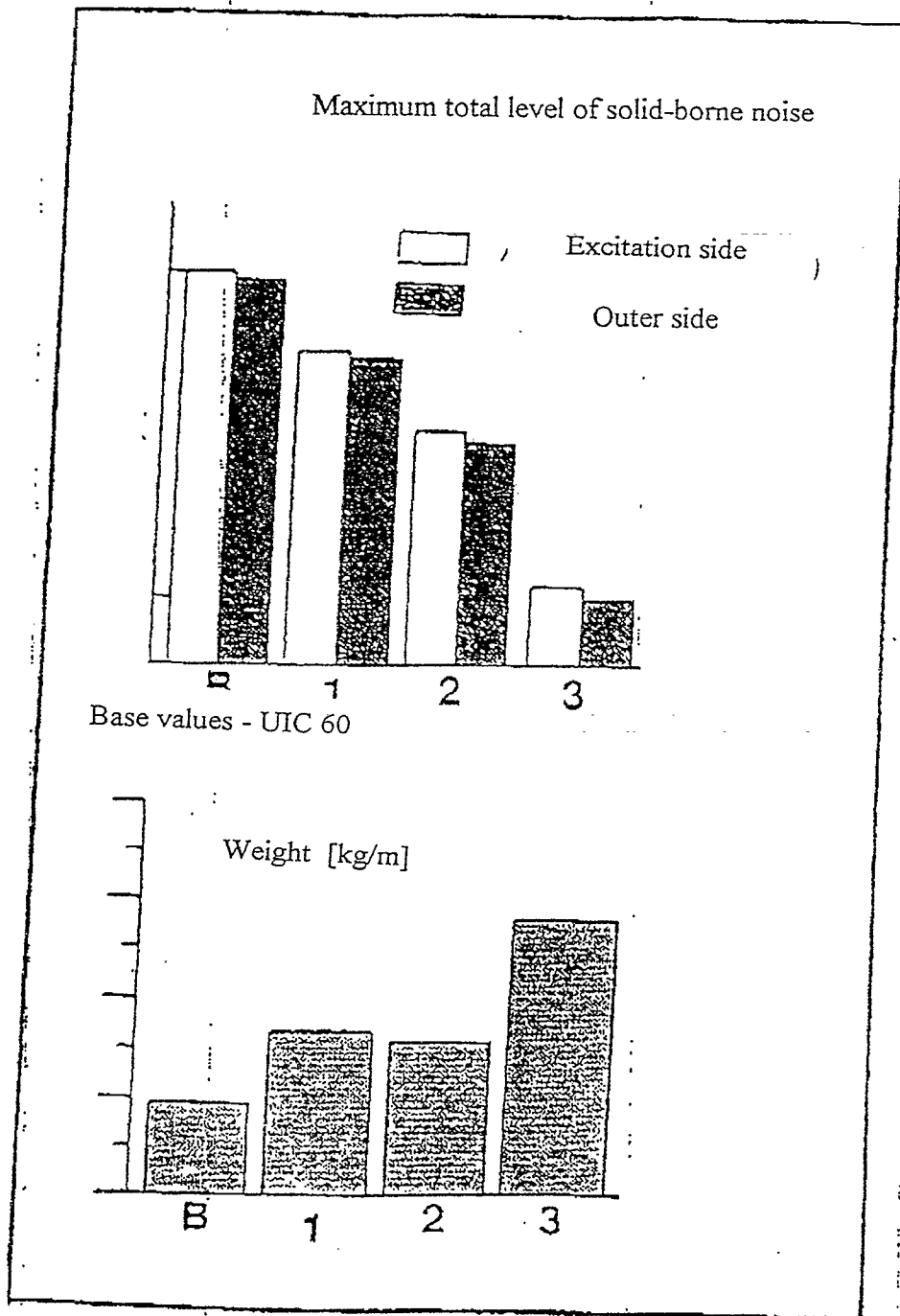


Fig. 5

