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(71) Applicant(s)
Scantech International Pty Ltd

(72) Inventor(s)
Christie, Gavin Leith;Edwards, Michael Francis;Harris, Andrew Roland;Deans, Nick John;Smith, Kenneth Graham

(74) Agent / Attorney
Davies Collison Cave, Level 15 1 Nicholson Street, MELBOURNE, VIC, 3000

(56) Related Art
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(71) Applicant *(for all designated States except US)*: **SCANTECH INTERNATIONAL PTY LTD** [AU/AU]; -, 143 Mooringe Avenue, Camden Park, South Australia 5038 (AU).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **HARRIS, Andrew, Roland** [AU/AU]; -, 24 Gawler Street, Seaview Downs, South Australia 5049 (AU). **EDWARDS, Michael, Francis** [AU/AU]; 119 Allinga Avenue, Glenunga, South Australia 5064 (AU). **SMITH, Kenneth, Graham** [AU/AU]; 6 Joslin Street, Wayville, South Australia 5034 (AU). **CHRISTIE, Gavin, Leith** [AU/AU]; P.O. Box 1251, Golden Grove, South Australia 5125 (AU). **DEANS, Nick, John** [GB/AU]; 6 Headland Crescent, Woodcroft, South Australia 5162 (AU).

(74) Agent: **HENSHAW, Damon**; Davies Collison Cave, 1 Nicholson Street, Melbourne, VIC 3000 (AU).

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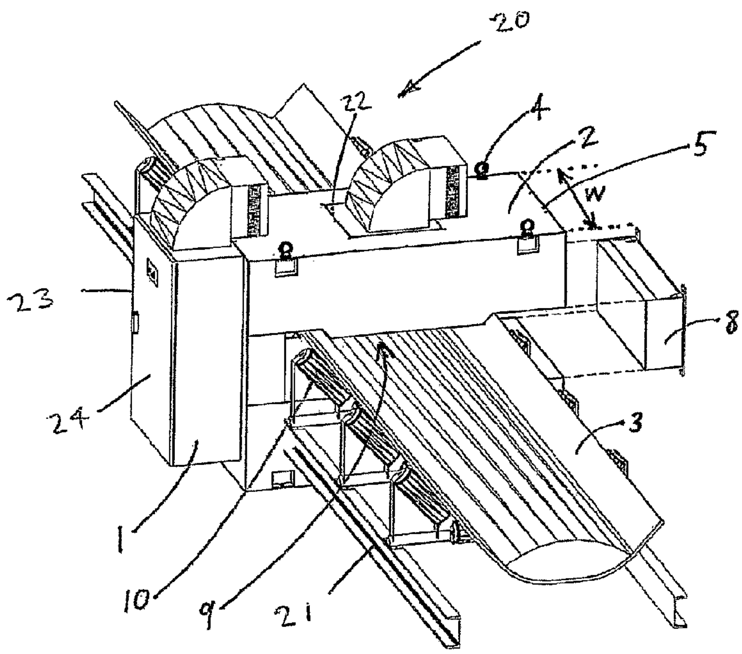
[Continued on next page]

(54) Title: ON-BELT ANALYSER SYSTEM



(57) **Abstract:** An analyser system (20) including an on-belt analyser having a housing (2) adapted to be positioned across a path of a conveyor belt (3) which carries material to be analysed, wherein the housing defines a tunnel (9) dimensioned to allow the belt to travel therethrough in suspended relation in order to allow analysis of the material without the belt contacting the analyser (1).

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ON-BELT ANALYSER SYSTEM

Related Applications

This application claims priority from Australian Provisional Patent Application No. 2005900951 and United States Provisional Patent Application No. 60/658195, the contents of which are incorporated herein by reference.

Technical Field

This invention relates to a bulk material analyser configured to analyse bulk material in the form of coal, minerals, cement raw materials, or the like.

Background

One form of on-belt analyser, which utilises a thermal neutron capture and gamma ray production technique known as PGNAA (Prompt Gamma Neutron Activation Analysis), is employed to analyse the composition of material such as coal or other mineral product transported on a conveyor belt. The analyser has a C-shaped housing provided with lifting points to allow the analyser to be appropriately positioned across a path of the belt. The weight of the analyser is quite substantial, in the order of 6500 to 9000 kg and the lifting points are necessarily provided at a base of the analyser due to structural load-bearing limitations of the housing. Once positioned, removable side shielding is fitted to close the open side of the C-shaped housing, to thereby define a tunnel in the order of 2 meters long, through which the belt passes. Tunnel slider panels support the belt as it passes through the analyser.

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Installation and operating costs of the analyser are relatively high given the analyser generally needs to be installed in a shed or the like for protection from the elements and various component parts such as the slider panels are subject to wear during operation. Also, in order to install the analyser substantial parts of the conveyor belt support structure, such as frame work and stringer or idler wheels, need to be removed. The remaining structure, at either side of the analyser, then needs to be configured in order to ensure an appropriate profile is applied to the conveyor belt, as it enters the analyser, compatible with the shape of the tunnel and the slider panels.

It is desired, therefore, to provide a bulk material analyser that alleviates one or more difficulties of the prior art, or that at least provides a useful alternative.

<u>Summary</u>

In accordance with the present invention, there is provided a bulk material analyser configured to analyse bulk material in the form of coal, minerals, cement raw materials, or the like, including:

a housing defining an enclosed tunnel for receiving a conveyor belt carrying a bulk material to be analysed;

a neutron source disposed below the conveyor belt to emit neutrons into the material in the tunnel for interaction with the material disposed therein; and

a gamma ray detector disposed above the conveyor belt to detect gamma rays emitted from the material in response to the neutron interaction;

wherein the conveyor belt is unsupported by the analyser within the tunnel.

The present invention also provides a bulk material analyser configured to analyse bulk material in the form of coal, minerals, cement raw materials, or the like, including a neutron source, a gamma ray detector, and a housing adapted to be positioned across a path of a conveyor belt which carries bulk material to be analysed, wherein the housing defines an enclosed tunnel dimensioned to allow the belt to pass above the neutron source, below the gamma ray detector, and through the tunnel without being supported within the tunnel.

The present invention also provides a bulk material analyser configured to analyse bulk material in the form of coal, minerals, cement raw materials, or the like, including a neutron source, a detector, and a housing adapted to be positioned across a path of a conveyor belt which carries bulk material to be analysed, wherein the housing defines an enclosed tunnel dimensioned to allow the belt to pass above the neutron source, below the gamma ray detector and through the tunnel without being supported within the tunnel so that the portion of the belt within the tunnel can be suspended between support idlers external of the tunnel.

The present invention also provides a bulk material analyser configured to analyse bulk material in the form of coal, minerals, cement raw materials, or the like, including:

a housing defining an enclosed tunnel for receiving a conveyor belt carrying a bulk material to be analysed;

a neutron source to emit neutrons into an interaction region within the enclosed tunnel for interaction with a bulk material disposed therein; and

a gamma ray detector disposed above the interaction region to detect gamma rays emitted from the material in response to the neutron interaction;

wherein the neutron source is disposed below the interaction region and a conveyor belt carrying the material is unsupported in the interaction region so as not to be subject to wear in the interaction region.

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Some embodiments relate to an analyser with a C-shaped housing which allows the housing to be retro-fitted across a bulk material conveyor belt, wherein the housing defines a tunnel dimensioned to allow the belt to travel therethrough in freely suspended relation in order to allow analysis of material carried on the belt, without the belt being supported by the housing in the tunnel.

Some embodiments relate to an analyser system including a PGNAA analyser having a housing adapted to be positioned across a path of a conveyor belt which carries material to be analysed, wherein the housing defines a tunnel dimensioned to allow the belt to pass through the tunnel without being supported by tunnel slider panels.

Some embodiments relate to an analyser system including a PGNAA analyser having a housing adapted to be positioned across a path of a conveyor belt which carries material to be analysed, wherein the conveyor belt forms part of a conveyor assembly and the housing defines a tunnel dimensioned to allow the analyser to be positioned between existing belt-supporting structure of the conveyor assembly

Some embodiments relate to an analyser with a housing adapted to be positioned across a path of a conveyor belt and a canopy for protecting the housing.

Preferably, the canopy is fitted to lifting points located on an upper arm of the housing.

Preferably, the housing defines a tunnel through which the conveyor belt passes and has extension panels fitted thereto to provide protection adjacent the analyser and external of the tunnel, from radiation emissions generated from a radiation source within the analyser.

Brief Description of the Drawings

Embodiments of the present invention are herein described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of an analyser in accordance with an embodiment of the present invention;
Figure 2 is a perspective view of the analyser of Figure 1, fitted with extension panels, automatic source drive shield, and canopy;
Figure 3 is a cross-sectional view of the analyser; and
Figure 4 is a diagrammatic end view of the analyser with a canopy.

Detailed Description

An analyser system 20 is shown in Figure 1 as including an analyser 1 and a conveyor assembly 21. The analyser 1 has a C-shaped housing 2 arranged to be positioned across a path of a conveyor belt 3 of the assembly 21. The analyser 1 is designed so as to weigh only in the order of 2000 kg which is light enough for the housing 2 to maintain structural integrity even if lifted from lifting points 4 provided by eye-bolts, which are provided on an upper arm 5 of the analyser 1. For that purpose, the analyser 1 is preferably formed of a steel framed enclosure filled with cast neutron shielding (CNS). The CNS is a dense suspension of 60% high-density polyethylene beads cemented together with a mixture of 20% borax and 20% polyester resin-plus catalyst. This material provides most of the shielding required since it is effective in slowing down and absorbing neutrons. The material is also waterproof, non-corrosive and intrinsically fire resistant.

Once the analyser 1 is positioned in the manner shown, side shield 8 is fastened in place so that the analyser defines a tunnel 9 through which the belt 3 passes. A width dimension "w" of the analyser is preferably in the order of 1 metre to allow the analyser to be positioned between existing supporting structure, such as idlers 10, of the conveyor assembly 21, which are conventionally spaced at between 1.2 and 1.5 metres apart.

In some circumstances, it may be necessary to provide additional shielding for radiation protection and, in that case, a further side shield 6 may be provided and extension panels 11 may be fitted either side of the tunnel, as shown in Figure 2. The extension panels are preferably formed of UV stabilised polyethylene or like material, which is suitable for absorbing radiation from, for example, a Cf-252 source. The panels 11 may be dimensioned so as to provide protection for an additional length "L" of, say, 1 metre either side of the analyser 1.

Figure 2 also shows the system 20 as including an optional microwave moisture content analyser 7 positioned above the belt 3.

Referring now to Figure 3, a cross-section of the analyser 1 is shown in detail with the side shielding 8 attached to the housing 2, so as to define the tunnel 9. A radiation source 12 is provided in a base 13 of the tunnel and detectors 14 are appropriately located above the tunnel 9. The tunnel 9 is positioned and dimensioned so as to receive the conveyor belt 3 in an elevated position relative to the base 13 of the tunnel 9. The clearance is preferably in the order of 30 mm to allow for a slight droop in the belt 3 between its supporting idlers 10. Previously, it was considered critical to minimise the distance between the Cf-252 source and material to be analysed in order to maximise absorption of neutrons in the material. Accordingly, the prior-art analyser was designed to have contact between the belt and the analyser using 25 mm thick slider panels. The geometry of the analyser illustrated in Figure 3, however, has been investigated using a program called MCNP (Monte Carlo N-particle) and it has been found that replacing the slider panels with air made little difference. Accordingly, a clearance is provided between the belt 3 and the base 13 of the tunnel 9, which allows the previous slider panels to be dispensed with, thereby reducing construction and maintenance costs. The tunnel 9 is shaped to accommodate conveyor belts 3 from 600 mm to 1400 mm wide with trough angles from 30° to 45° with no modification to belt 3 or tunnel 9. As a result of the relative clearance, an additional advantage is realised in that belt clips and staples (not shown) can not damage analyser 1.

Turning now to Figure 4, the analyser 1 is shown with a canopy 15 supported on struts 16 fixed to the lifting points 4. The canopy 15 is preferably formed of 3 mm thick steel or fibreglass and stands approximately 400 mm above the analyser 1, leaving an approximate clearing of 50 mm above the 350 mm high air conditioners 17. The canopy 15 provides protection to the top 18 of the analyser 1 from direct sunlight, rain and snow. The canopy 15 should also minimise dust build-up on and around the air conditioner 17. Provision of the canopy 15 additionally allows the analyser to be installed in an external environment at any desired location along the length of the conveyor belt 3, as compared to the prior art analyser, which needed to be installed within a shed. As such, the analyser 1 provides for further reduction in installation costs.

In addition to the above, the prior-art analyser used proprietary analogue electronics and NaI (sodium iodide crystal) detectors. The present analyser 1, on the other hand, uses off-the-shelf digital multi-channel analysers and bismuth germinate crystal (BGO) detectors.

The digital multi-channel analysers provide more consistent, linear, stable spectra and are more reliable as compared to the previous analyser electronics, for which components are becoming obsolete. The BGO detectors capture more gamma rays and have better photo-peak fraction due to higher crystal density, have better peak to background ratio (i.e. better signal-to-noise ratio) and better linearity. The detectors 14 and associated multi-channel analyser electronics are preferably located within a single common air-conditioned, temperature-controlled detector enclosure 22 to simplify operational and construction requirements. The remaining electronics such as an analyser computer and other electronics modules are likewise located within a single air-conditioned, temperature-controlled electronics cabinet 23, which has a sealed and locked door 24.

As such, the above-described analyser 1 provides a number of advantages over the prior-art analyser, which result from internal componentry, reduced weight and dimensions, as well as the provision of a canopy and the clearance between the analyser and a conveyor belt passing through the analyser tunnel. As may be appreciated then, the analyser may be installed on an existing conveyor assembly with minimal modification or removal of steel work of the belt support structure since the analyser is of a width sufficient to fit between pre-existing idlers and does not contact the belt so the supporting structure does not need to be configured in any particular fashion necessary to form a specific belt profile suitable for the tunnel, as compared to the prior-art analyser arrangement.

Further and more particular details of a preferred form of analyser are provided in Applicant's publications "On Belt Analyser Operation & Maintenance Manual" Version 1.3, September 2005; "On Belt Analyser-5 Health & Safety Review" Version 1.6, February 2006; and "On Belt Analyser Installation Manual" Version 7.3, October 2005, the contents of which are incorporated herein by reference.

The invention has been described, by way of non-limiting example only, and many modifications and variations may be made thereto, without departing from the scope of the invention.

Throughout this specification and claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgment or admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A bulk material analyser configured to analyse bulk material in the form of coal, minerals, cement raw materials, or the like, including:

a housing defining an enclosed tunnel for receiving a conveyor belt carrying a bulk material to be analysed;

a neutron source disposed below the conveyor belt to emit neutrons into the material in the tunnel for interaction with the material disposed therein; and

a gamma ray detector disposed above the conveyor belt to detect gamma rays emitted from the material in response to the neutron interaction;

wherein the conveyor belt is unsupported by the analyser within the tunnel.

2. The analyser of claim 1, wherein the belt travels through the tunnel in freely suspended relation so that the belt is not subject to wear within the tunnel.

3. A bulk material analyser configured to analyse bulk material in the form of coal, minerals, cement raw materials, or the like, including a neutron source, a gamma ray detector, and a housing adapted to be positioned across a path of a conveyor belt which carries bulk material to be analysed, wherein the housing defines an enclosed tunnel dimensioned to allow the belt to pass above the neutron source, below the gamma ray detector, and through the tunnel without being supported within the tunnel.

4. A bulk material analyser configured to analyse bulk material in the form of coal, minerals, cement raw materials, or the like, including a neutron source, a detector, and a housing adapted to be positioned across a path of a conveyor belt which carries bulk material to be analysed, wherein the housing defines an enclosed tunnel dimensioned to allow the belt to pass above the neutron source, below the gamma ray detector and through the tunnel without being supported within the tunnel so that the portion of the belt within the tunnel can be suspended between support idlers external of the tunnel.

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5. The analyser of any one of claims 1 to 4, wherein the housing is adapted to be positioned across a path of an existing conveyor belt without disrupting the existing conveyor belt.

6. The analyser of any one of claims 1 to 5, wherein the housing includes a C-shaped portion and a removable side portion which allows the housing to be retro-fitted across a bulk material conveyor belt.

7. The analyser of any one of claims 1 to 6, wherein the tunnel is configured to receive a belt of between 600 mm and 1400 mm in width, with a trough angle of between 30° and 45° without requiring any modification to the belt profile.

8. The analyser of any one of claims 1 to 7, including a conveyor assembly with idlers arranged to support the belt at either side of the enclosed tunnel so as to suspend the belt in an elevated position relative to the base of the enclosed tunnel as the belt passes through the tunnel.

9. The analyser of claim 8, wherein the idlers are spaced at between 1.2 and 1.5 metres apart.

10. The analyser of any one of claims 1 to 9, wherein the width of the analyser, in a direction lengthwise of the conveyor belt, is in the order of 1 metre.

11. The analyser of any one of claims 1 to 10, arranged whereby a clearance in the order of 30 mm is provided between the belt and a base of the tunnel.

12. The analyser of any one of claims 1 to 11, wherein extension panels are fitted either side of the tunnel to provide protection adjacent the analyser and external of the tunnel, from radiation emissions generated by the neutron source within the analyser.

13. A bulk material analyser configured to analyse bulk material in the form of coal, minerals, cement raw materials, or the like, including:

a housing defining an enclosed tunnel for receiving a conveyor belt carrying a bulk material to be analysed;

a neutron source to emit neutrons into an interaction region within the enclosed tunnel for interaction with a bulk material disposed therein; and

a gamma ray detector disposed above the interaction region to detect gamma rays emitted from the material in response to the neutron interaction;

wherein the neutron source is disposed below the interaction region and a conveyor belt carrying the material is unsupported in the interaction region so as not to be subject to wear in the interaction region.

14. The analyser of any one of claims 1 to 13, including lifting points at an upper section of the housing.

15. The analyser of claim 14, wherein the lifting points are provided by eye-bolts.

16. The analyser of any one of claims 1 to 15, including a canopy for protecting the analyser.

17. The analyser of any one of claims 1 to 16, wherein the neutron source and detector are configured for analysis using Prompt Gamma Neutron Activation Analysis (PGNAA).

18. The analyser of any one of claims 1 to 17, including multi-channel analyser electronics, wherein the gamma-ray detector and the multi-channel analyser electronics are located within a common air-conditioned, temperature-controlled detector enclosure.

19. A bulk material analyser configured to analyse bulk material in the form of coal, minerals, cement raw materials, or the like, substantially as hereinbefore described with reference to the accompanying drawings.

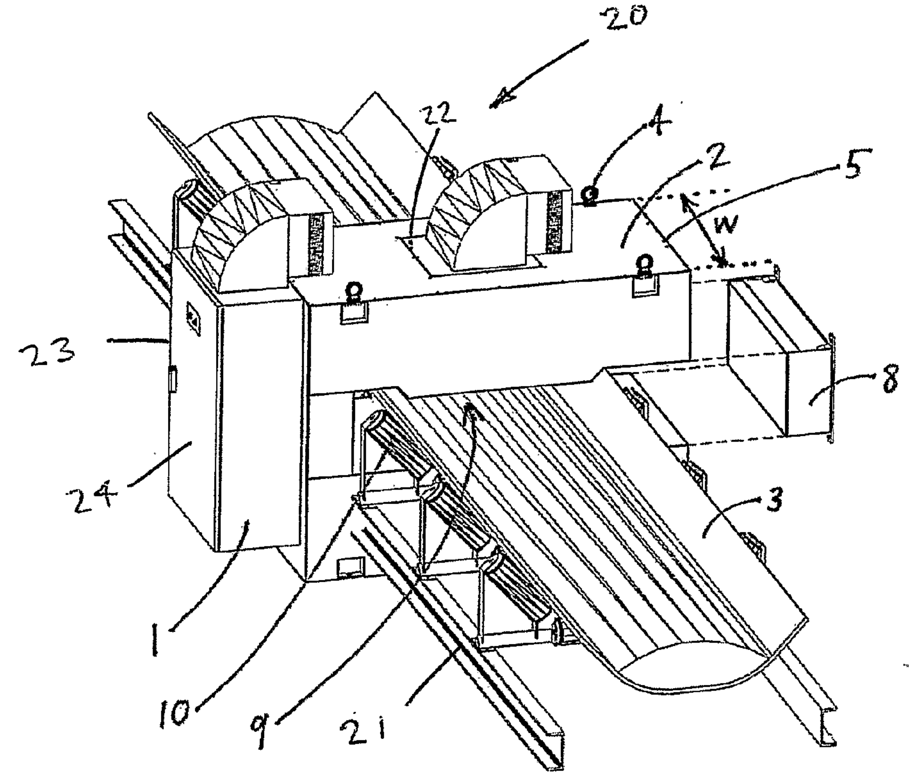

Figure 1

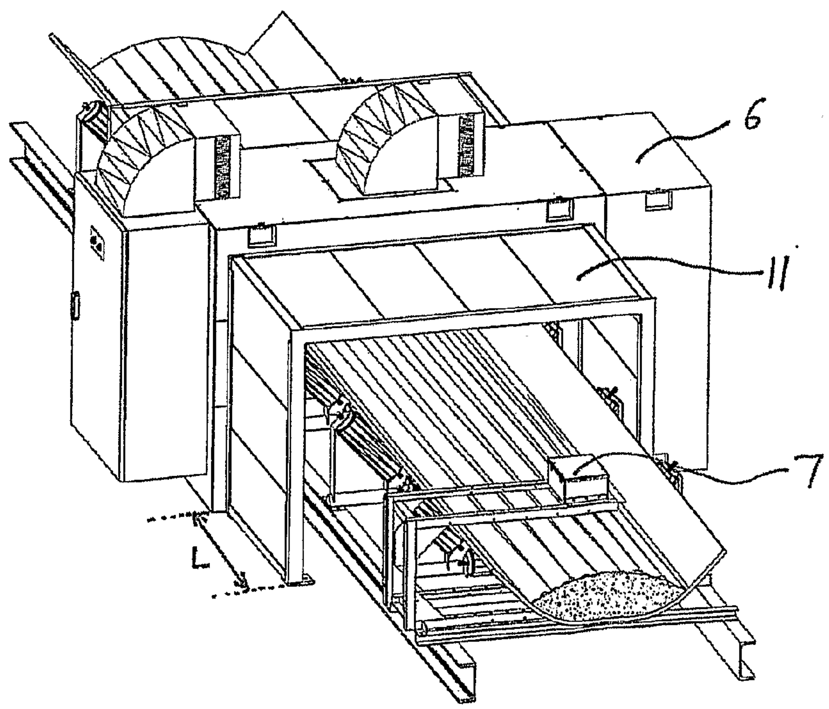

Figure 2

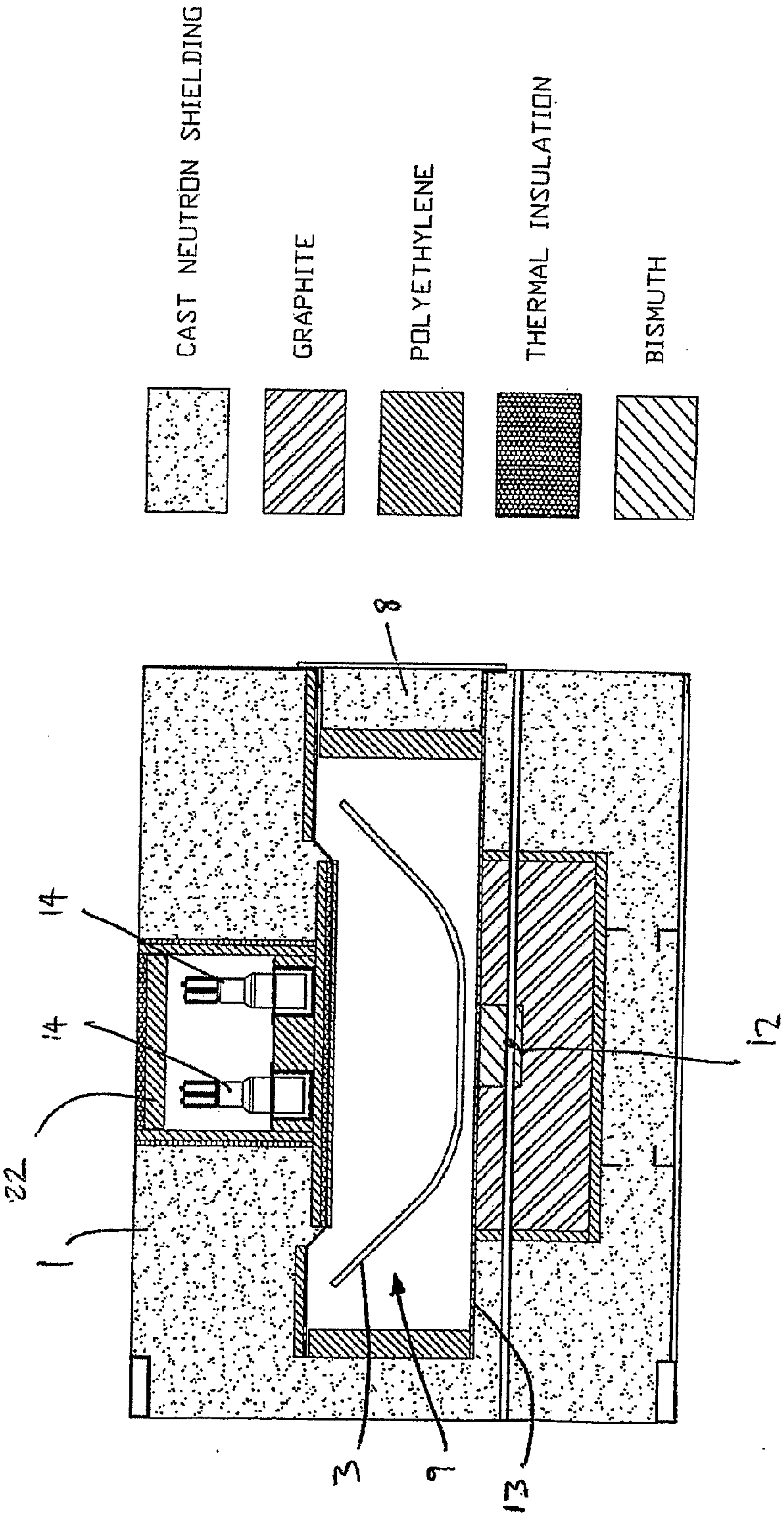
CAST NEUTRON SHIELDING
GRAPHITE
POLYETHYLENE
THERMAL INSULATION
BISMUTH
1
22
14
14
8
12
3
9
13

Figure 3

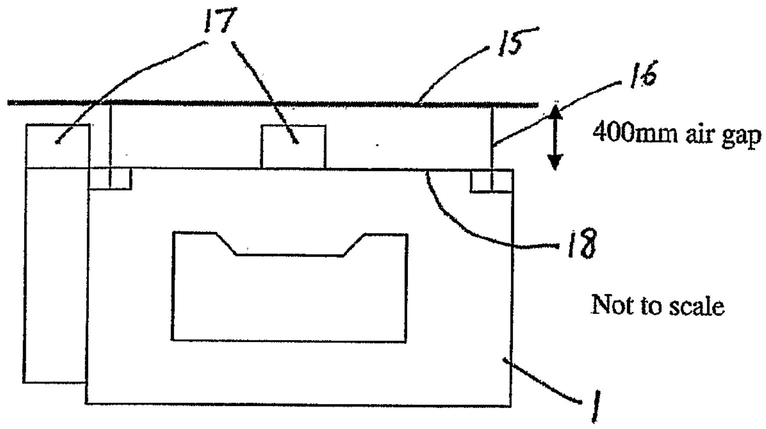

Figure 4