

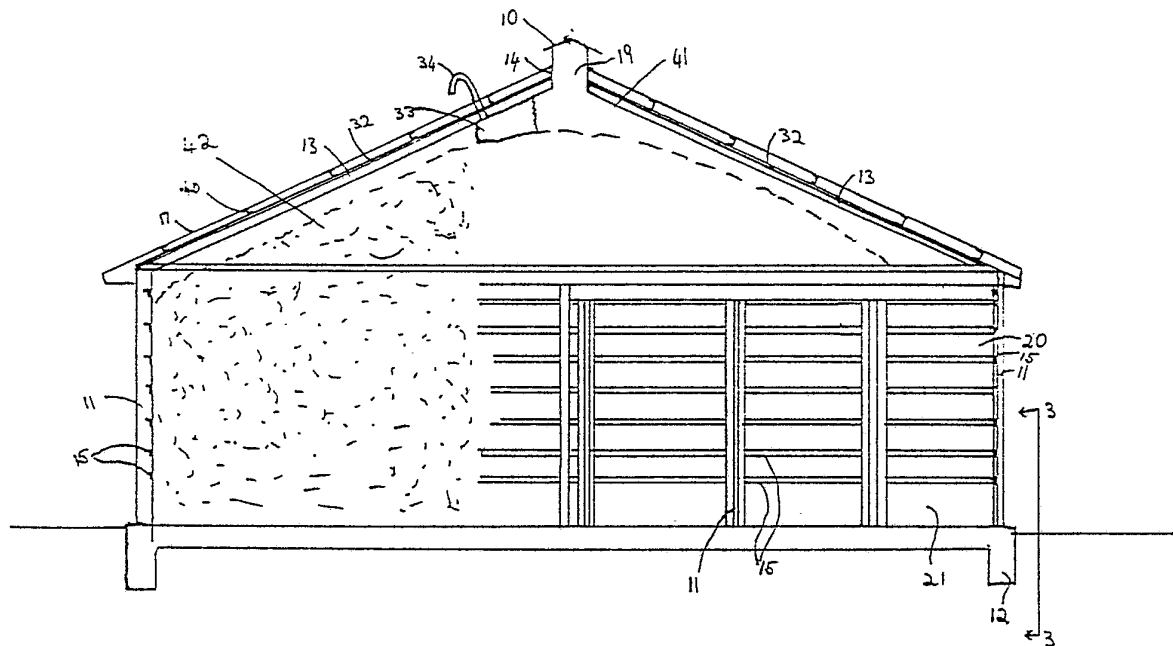
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<p>(21) International Application Number: PCT/AU81/00006 (22) International Filing Date: 15 January 1981 (15.01.81) (31) Priority Application Number: PE 2016 (32) Priority Date: 15 January 1980 (15.01.80) (33) Priority Country: AU  (71) Applicants (for all designated States except US): JOHN VINCENT MOORE PTY. LIMITED [AU/AU]; 100 Miller Street, North Sydney, N.S.W. 2060 (AU). LEE-TON STEELWORKS PTY. LIMITED [AU/AU]; 12-14 Pine Avenue, Leeton, N.S.W. 2075 (AU).  (72) Inventor; and (75) Inventor/Applicant: (for US only): MOORE, John, Vincent [AU/AU]; 100 Miller Street, North Sydney, N.S.W. 2060 (AU).</p>		<p>(74) Agent: GRIFFITH, David, Carlyle; Spruson &amp; Ferguson, G. P. O. Box 3898, Sydney, N.S.W. 2001 (AU).  (81) Designated States: AU, DE (European patent), FR (European patent), GB (European patent), JP, SU, US.  <b>Published</b> <i>With international search report</i></p>

(54) Title: SILO



(57) Abstract

Enclosed structure such as a silo, particularly suitable for containing grain crops. The structure has a series of vertical posts (11) disposed in a circle. A series of horizontal girts (15) are attached to the inside of the posts. The inside surface defined by the girts is clad with lightweight sheet material (20). A roof (17) is added and the structure may be sealed.

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SILO

This invention relates to an enclosed structure and has been devised particularly, though not solely, as a grain silo.

Background Art

Most silos and containers or storage bins for large amounts of particulate solids, are made from reinforced concrete or heavy steel plate. Such constructions require skilled engineering and manpower to erect. They are also very costly to build.

Summary of the Invention

It is desirable to provide an enclosed structure which may be used as a grain silo and which is simple and cheap to construct to enable grain to be simply and cheaply stored at a desired location.

It is therefore an object of the present invention to provide an enclosed structure which will go at least part of the way towards meeting the foregoing desiderata in a simple yet effective manner, or which will at least provide the public with a useful choice.

Accordingly, in one aspect the invention may broadly be said to consist in an enclosed structure suitable for containing particulate solids characterized by a plurality of posts set on foundations so as to define the line of a cornerless wall, a plurality of rafters extending upwardly and inwardly from each said post to a central point or ridge, a plurality of circumferential girts extending substantially horizontally between said posts along the line of said wall, sheet wall cladding extending the height of said wall fastened to said girts, the vertical edges of the adjoining sheets of cladding being secured together in a structural manner, and roof cladding placed over said rafters form a roof.

Preferably, the cladding is of corrugated or ribbed cross-section sheet metal, although many non-metallic materials would also be suitable.

This mode of construction utilises girts to carry the majority of the stresses imposed by the particulate solids contained therein. The internal cladding does not



carry high loadings over large spans as the girts are placed sufficiently close together to spread the load. Thus the thickness of the sheet cladding used is very much reduced from that used in conventional silos.

5           The girts are preferably angle or T-section steel members spaced at suitable distances generally from 100 mm to 900 mm. The girts are attached to the posts and the internal cladding attached to the girts. The joins of adjacent sheets of cladding are preferably sealed with a  
10 flexible sealing compound.

The sheets of cladding are preferably oriented with their ribs or corrugations disposed in the vertical direction.

15           The technique of building a silo in accordance with the invention enables silos capable of holding up to 35,000 kg to be readily constructed. As the silo is filled there is slight expansion of the walls. This expansion creates a significant problem if the bottom edge of the cladding is merely directly secured to the  
20 foundations as it will be sheered open or will crack after a number of loadings.

To overcome this problem the invention provides a lower circumferential wall of heavier gauge sheet steel secured at its lower end to the foundations and at its  
25 upper end to the sheet metal cladding. There is no need, in general, to have girts around this lower wall if it is made of sufficiently thick metal. Thus when the silo is loaded the upper end of the lower wall can expand with the sheet metal cladding, whilst the lower end remains fixed.  
30 The lower wall is preferably about two metres high although obviously it could range from 1 metre to, say, 4 metres depending on the size of the silo being constructed.

The lower wall is preferably formed from a series of plates which are joined along their vertical  
35 intersection.

In order to construct silos in accordance with this invention a very simple procedure is followed.

The floor and foundations of the silo are prepared. The floor will generally include one or more  
40 conveyor or screw type solids removal units therein. The



posts are erected by a crane and secured to the foundations, by say four bolts. The posts will generally define a circular area. The girts are attached to the inside of the posts. The bottom wall section is erected.  
5 The main sheet cladding walls are secured to the girts. The roof rafters and cladding are finally added.

Where the container (silo) is to be used for longer term storage of degradable materials, such as grain crops, it is desirable to seal the roof to the walls so  
10 that the silo may be filled with a suitable gas to prevent such degradation. To achieve this, a foil-type membrane may be laid, say, under or on top of the roof rafters and attached to the top of the walls.

In a further aspect the invention may broadly be said to consist in a silo air space bag, comprising an enclosed bag of flexible material adapted to be inserted  
15 into the air space of a grain silo between the grain and the roof of the silo and a connecting conduit between the interior of said bag and the atmosphere.

The air bag allows for expansion and contraction of the gas within the silo due to temperature effects, to be accommodated. This is achieved by expelling air from the bag to the atmosphere or drawing air into the bag from the atmosphere. This allows a sealed silo filled with an  
20 expensive gas to be stabilised over a long period without the need to have a continual gas bleed or recharge.  
25

There is thus provided a structure which is inexpensive, lightweight, sealable and of exceptionally strong construction. The structure can be readily  
30 constructed by unskilled labour with a minimum of supervision without the need for exotic equipment or techniques.

Notwithstanding any other forms that may fall within its scope one preferred form of the present  
35 invention will now be described by way of example only with reference to the accompanying drawings, in which:

Figures of the Drawings

Figure 1 is a cross sectional elevation of an enclosed structure according to the invention;

40 Figure 2 is a diagrammatic partially cut-away view



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of the structure shown in Figure 1; and

Figure 3 is a view of section 3-3 of Figure 1.

Description of the Preferred Embodiment

In the preferred form of the invention an  
5 enclosed structure, particularly suitable for use as a  
grain silo, is constructed as follows.

A plurality of vertical posts 11 are provided set  
on foundations 12 so as to define the line of a cornerless  
wall. In the preferred form of the invention shown in the  
10 accompanying drawings, 8 vertical posts are provided set  
so as to define a circular wall.

The upper ends of the posts are arranged to  
support roof rafters which may be trusses 3, which extend  
inwardly and upwardly from the posts to be a central  
15 receiving member point 14. The posts 11 and rafters 13  
may, for example, be universal beams, alternatively the  
trusses 13 may be fabricated by welding from metal  
sections.

The vertical posts 11 are interconnected by a  
20 plurality of horizontal circumferential girts 15 which may  
for example be formed from angle iron or T-section as  
shown in cross section at 15 in Figure 3. The girts 15  
form continuous circumferential hoops around the line of  
the posts 11. The girts may be attached to the posts 11  
25 by rivetting 23 onto a flange 22 extending from the posts  
11.

The roof framing of the embodiment shown in the  
accompanying drawings consist of a series of intersecting  
radial rafters which, in turn, support purlins 40.

30 The roof is covered with sheet cladding material  
shown at 17 in Figure 2 which is joined on the line of the  
main trusses 13 by a ridge cap 18. The peak of the roof  
is provided with an opening 19 provided with a removable  
covering 10 to allow the silo to be filled with grain.

35 The walls of the silo are clad with corrugated  
sheet wall cladding 20 extending the height of the wall  
and fastened to the girts 15, for example by rivetting or  
bolting. The vertical edges of adjoining sheets of  
cladding 20 are lapped, sealed and secured together in a  
40 structural manner, for example by a line of mastic



compound, and fastening with heavy gauge rivets so that the sheet becomes one homogeneous structural element.

There is also in the roof system a tie member near the eaves which attaches to the posts 11 to act both in tension and compression and completes a structural system of exceptional strength and lightness since it embodies a skin membrane construction and provides a monolithic structure.

The girts 15 which support the wall sheeting 20 are of sufficient strength to resist wind loads on the whole structure and keep the building stable and at the same time provide necessary strength to cater for internal pressures due to the grain load.

The lower part of the container wall (see Figure 3) is formed from heavier gauge steel plates 21 joined together at their vertical intersection by means of overlapping plates (not shown).

The bottom edge of the plates 21 have a horizontal flange 28 which is fixed to the floor 30 or foundations 24 of the structure by bolts 27 which secure an overlying plate 29 on the flange 28.

The upper edge of the plates 21 are attached to a pair of angle members 30, 31 which provide a suitable seat for the base of the corrugated cladding 20. The seat formed by members 30 and 31 provides a vertical and horizontal resistance to the outward forces on the bottom of the cladding 20. The member 31 is attached to a flange 22 protruding from the post 11.

In Figure 3 the cladding 20 is illustrated showing the depth of a typical corrugation.

The construction of the wall as shown in Figure 3 allows for the outwards deflection of the wall at the intersection of the cladding 20 with the wall section 21 without damage to the bottom of the cladding 20.

There are two major aspects for applications of the design of the enclosed structure. The first is for a silo which would be built as part of a grain storage system. It would be a single purpose building for storing grain. The second application is one for a smaller silo which might be built on a farm and would have incorporated



in the design doors so that the silo would become a multi-purpose building suitable for recreation or storage of machinery when not in use as a silo. In the first application one of the improved features will be the sealability of the structure. To achieve sealability a special sealing member 32 is introduced in the plane of the under side of the roof sheeting 17. To this sealing member 32 will be attached flashing and sealing materials so as to enable the structure to be rendered airtight and so make it suitable for fumigating the contents of the silo.

Another feature of this application is the introduction of a "balloon" or breather bag 33 in the air space under the roof. This bag is connected to the atmosphere by means of a breather tube 34 so that as diurnal temperature affects the gas in the head space 41 above the stored grain 42, gases are not expelled from the structure during the day due to heating of the gas, or diluted by air as the gases cool down during the night. Instead, air is expelled from the balloon 33 during the day and drawn into the balloon during the night so that the expensive gases which are used for fumigation remain intact and do not require expensive topping up.

In this manner an enclosed structure is provided which is particularly suitable for the storage of grain in a simple and yet effective manner and which may also be used as a farm building by replacing one section of the wall between adjacent posts by suitable doors.





CLAIMS

1. An enclosed structure suitable for containing particulate solids characterized by a plurality of posts set on foundations so as to define the line of a cornerless wall, a plurality of rafters extending upwardly and inwardly from each said post to a central point or ridge, a plurality of circumferential girts extending substantially horizontally between said posts along the line of said wall, sheet wall cladding extending the height of said wall fastened to said girts, the vertical edges of the adjoining sheets of cladding being secured together in a structural manner, and roof cladding placed over said rafters form a roof.

2. The structure of claim 1 characterized in that the lower portion of the wall comprises a cladding of sufficient strength to be self-supporting, which cladding is fixed to the floor of the structure at its lower end and fixed to the sheet wall cladding at its upper end.

3. The structure of claim 1 or 2, characterized in that the cladding is sealably joined.

4. The structure of claim 1 or 2 characterized in that the cladding is a corrugated or ribbed sheet metal with the corrugations or ribs being disposed in the upright orientation.

5. The structure of claim 1 or 2 characterized in that a sealing member is located beneath the roof cladding and is sealably affixed to said wall.

6. An enclosed sealable structure for holding particulate solids, characterized in that a pressure compensation member is disposed in the roof portion of the structure in such a manner that it allows for pressure increases above atmospheric to compress said member to expell air to the atmosphere, and to expand said member by the introduction of atmospheric air on a drop in pressure, below atmospheric, within said structure.

7. The structure of claim 1 or 2 characterized in that means are provided to deposit or withdraw particulate solids from said structure.

8. A method of constructing an enclosed structure suitable for containing particulate solids characterized



by forming a foundation for supporting a series of posts, standing and securing said posts on said foundation, attaching a series of girts in the horizontal orientation to the inside of said posts, applying a cladding to the inside of said girts, and attaching a roof structure to the top of said cladding.

9. The method of claim 8, characterized in that the lower portion of said wall is a self-supporting cladding affixed to the said foundations and to said cladding.

10. The method of claim 8, characterized in that all joins of sheets of cladding are sealed.



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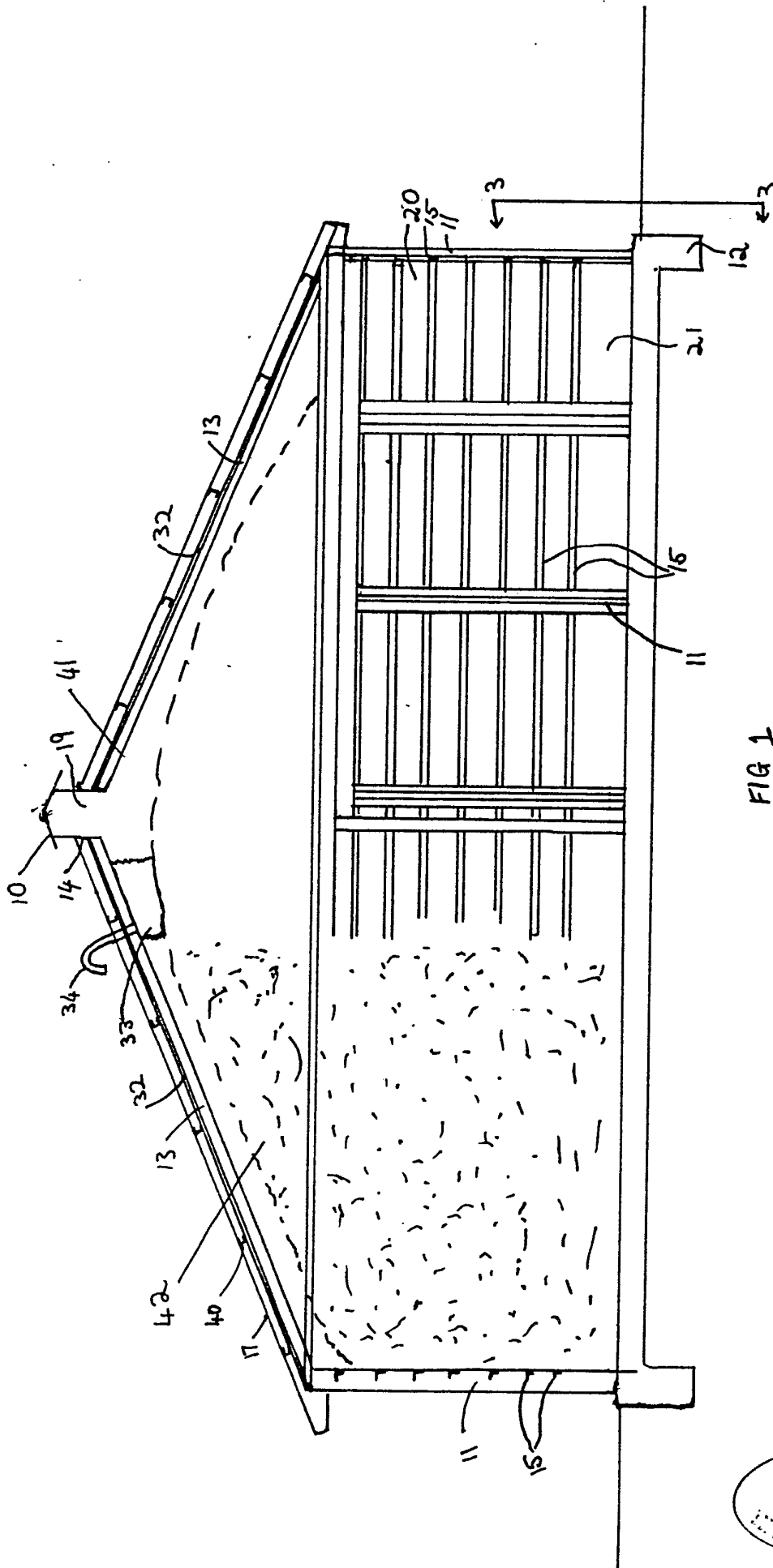


FIG 1



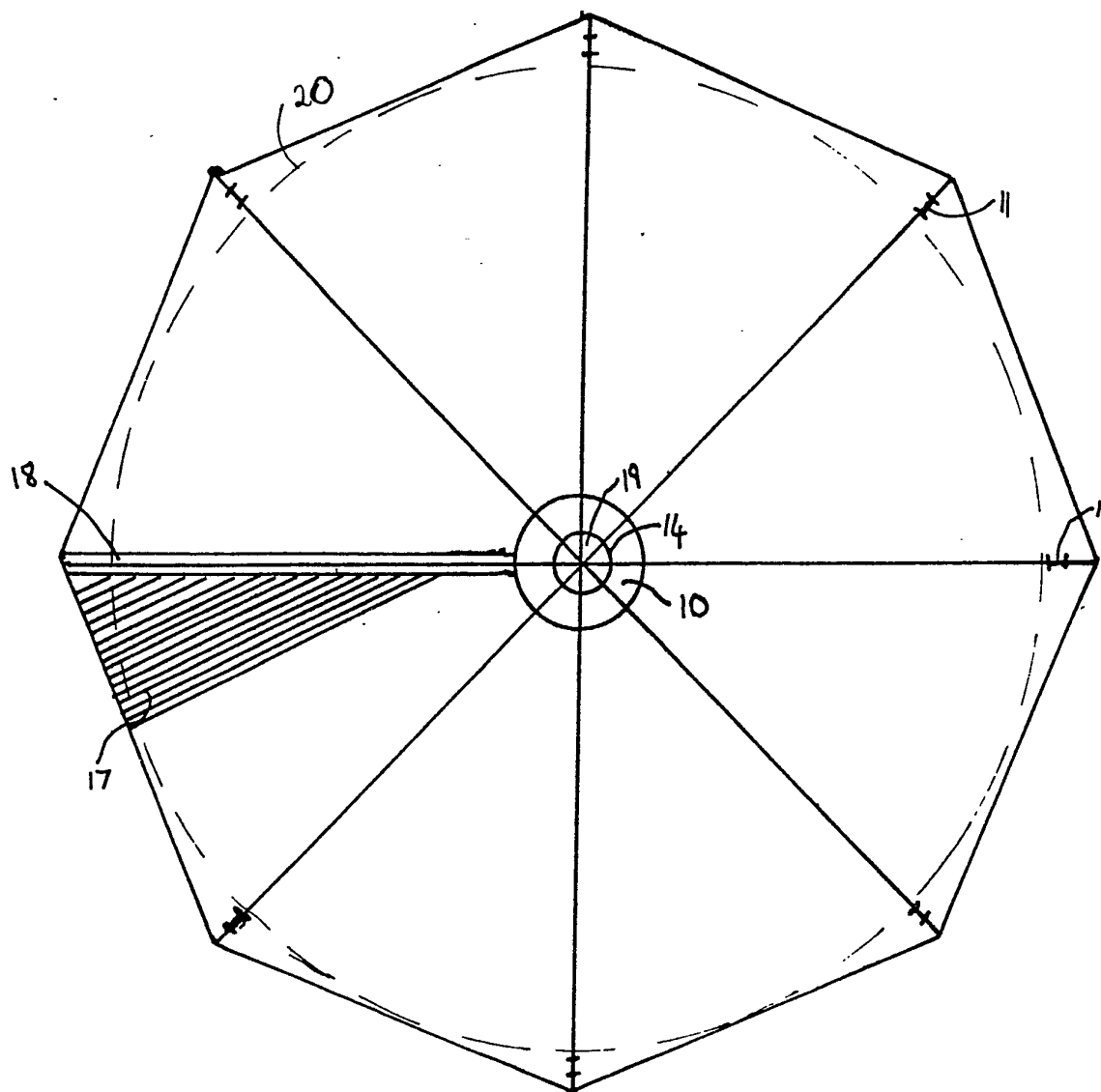
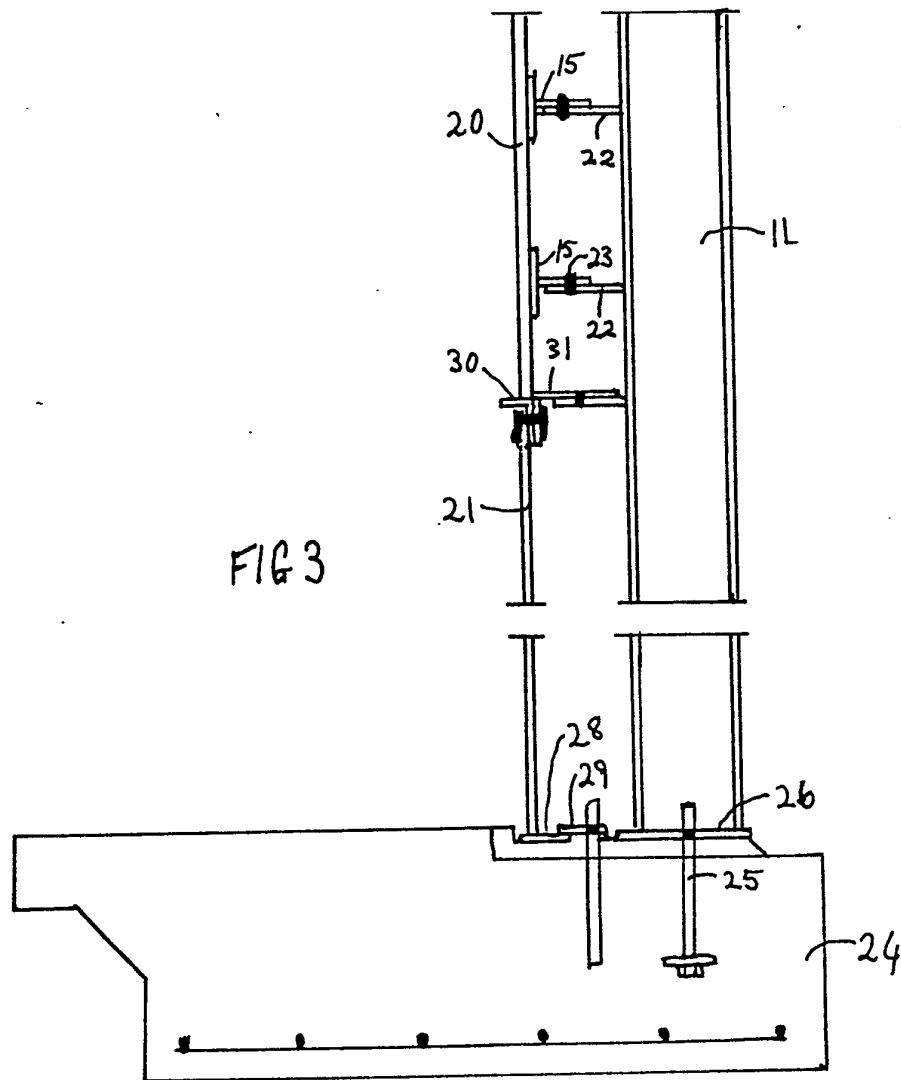


FIG 2

3/3



# INTERNATIONAL SEARCH REPORT

International Application No PCT/AU81/00006

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>3</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int. Cl. <sup>3</sup> E04H 7/22, 7/30		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>4</sup>		
Classification System	Classification Symbols	
IPC	E04H 7/22, 7/30	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>5</sup>		
AU: IPC as above		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup>		
Category <sup>6</sup>	Citation of Document, <sup>15</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>
X	AU, B, 1501/39 (110311) published 1940, April 18, Watt.	1
X	CA, A, 1066013, published 1979, November 13, A.O. Smith Harvestore Products Inc.	6
X	GB, A, 1207966, published 1970, October 7, Cherwell Valley Silos Ltd.	6
X	GB, A, 1037177, published 1966, July 27, Wm. Miller Ltd.	1
X	FR, A, 1384882, published 1964, November 30, Selz.	1
X	FR, A, 1012258, published 1952, July 8, Tamini.	1
X	DE, A, 1301170, published 1961, November 24, Martini.	6
X	DE, A, 1066382, published 1960, March 24, Seeger.	6
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<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search <sup>9</sup>	Date of Mailing of this International Search Report <sup>8</sup>	
27 February 1981 (27.02.81)	04 MARCH 1981 (04-03-81)	
International Searching Authority <sup>1</sup>	Signature of Authorized Officer <sup>10</sup>	
Australian Patent Office	A.S. Moore. <i>A.S. Moore</i>	