

May 15, 1956

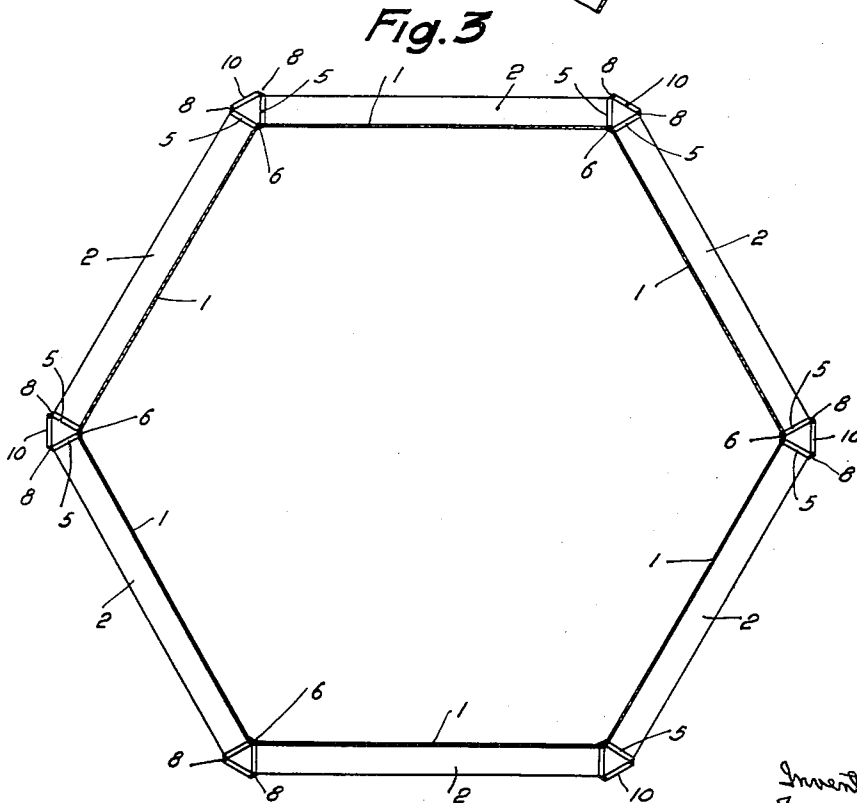
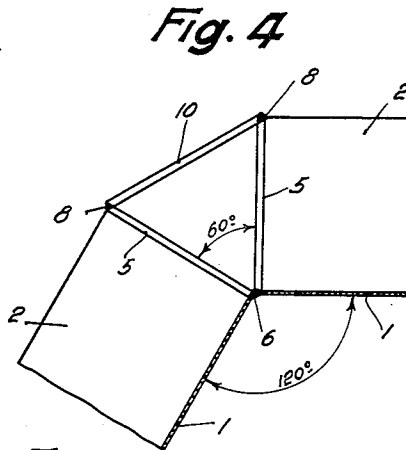
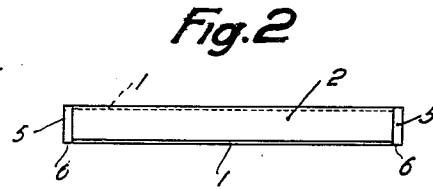
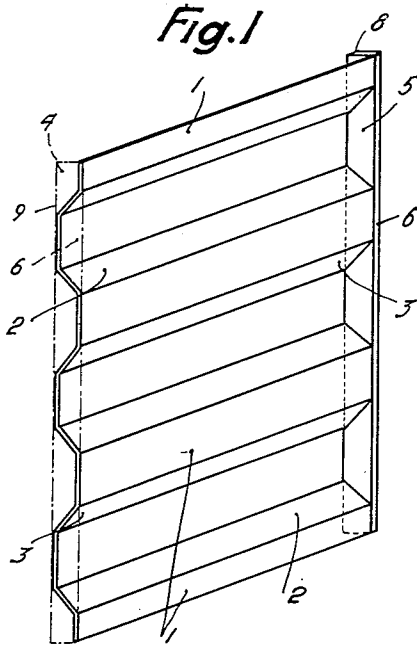
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2,745,520

SILO FOR GRANULOUS MATERIAL

Filed April 2, 1951

4 Sheets-Sheet 1



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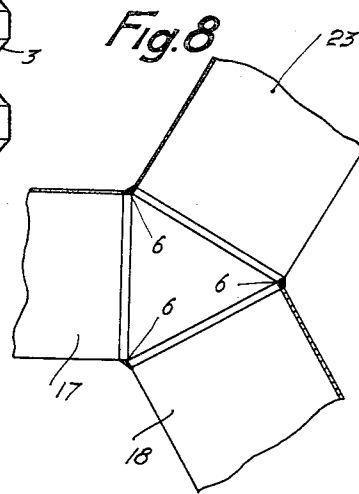
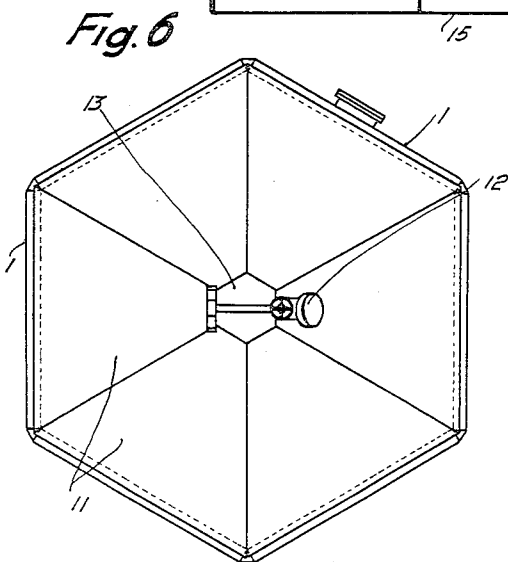
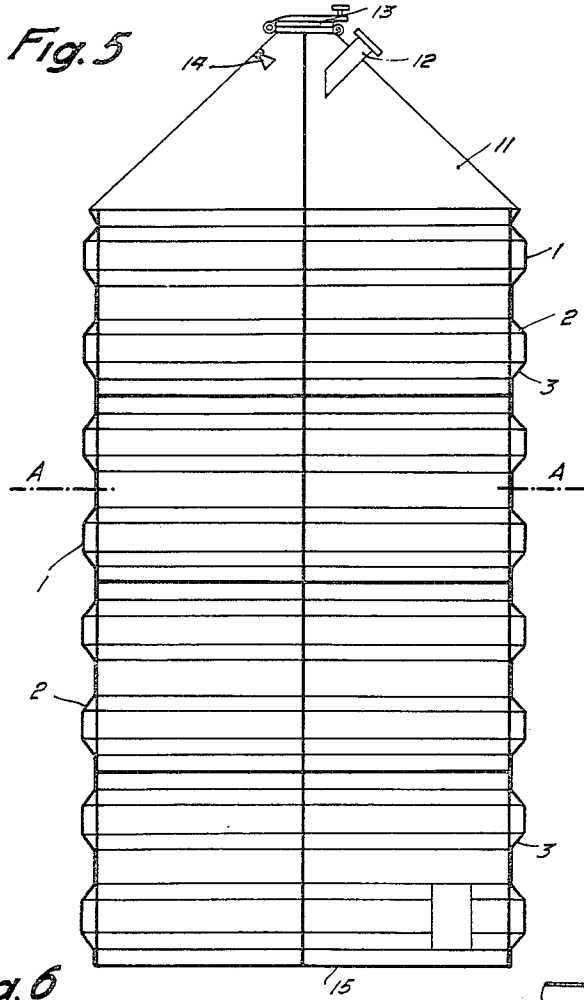
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SILO FOR GRANULOUS MATERIAL

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4 Sheets-Sheet 2



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Fig. 9

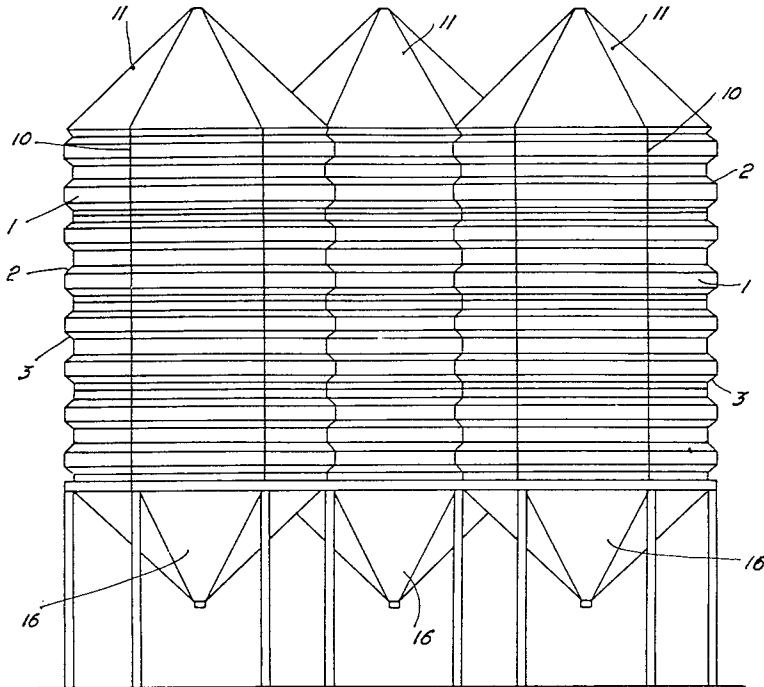
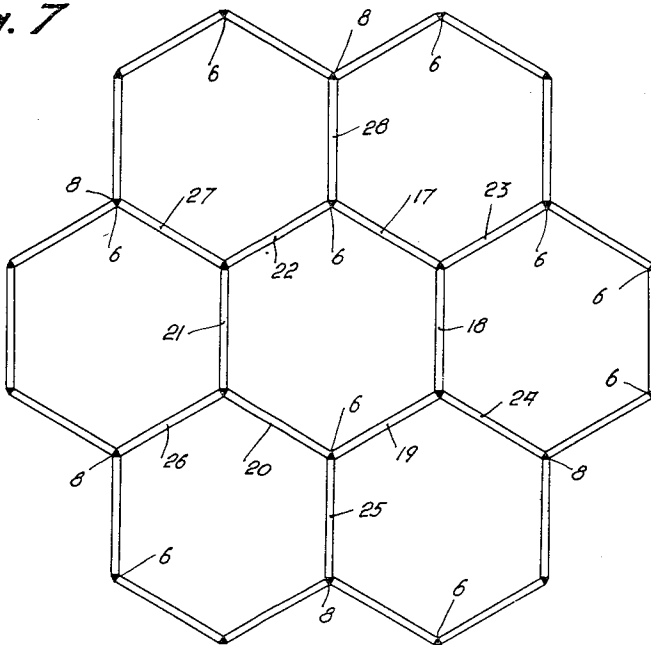


Fig. 7



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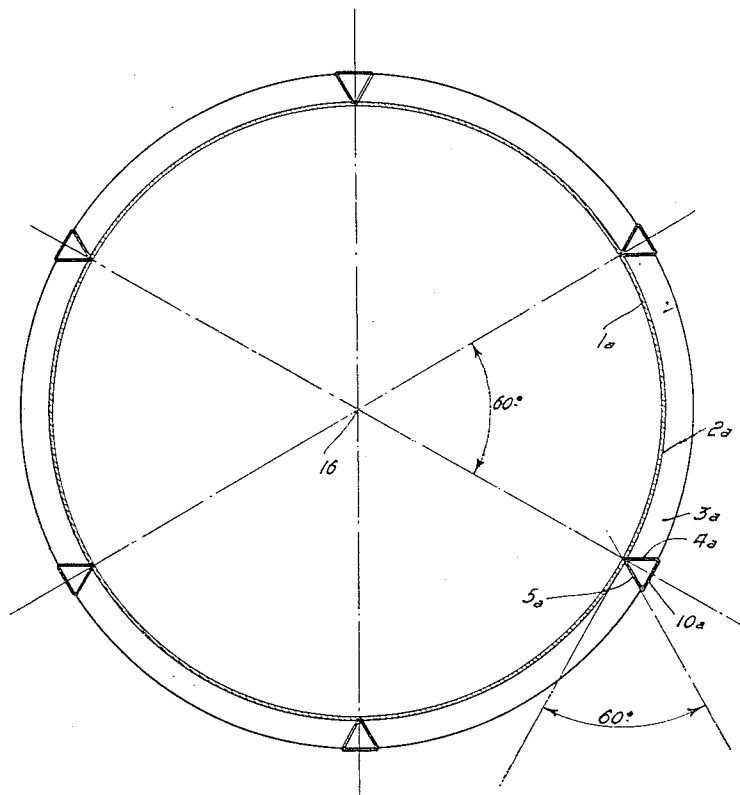
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4 Sheets-Sheet 4

Fig. 10



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SILO FOR GRANULOUS MATERIAL

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Application April 2, 1951, Serial No. 218,761

Claims priority, application France June 20, 1950

13 Claims. (Cl. 189—3)

It has been proposed in order to reduce the values of the stresses exerted on the walls of silos to give the latter such a shape that they offer to the granulous material a series of elemental resting surfaces which are inclined and superimposed upon one another with the interposition of vertical surfaces, the sloping of these elemental surfaces and their vertical dimensions being such that not only they may give rise to the formation of natural crumbling banks as concerns each of said loping resting surfaces but furthermore that the height of each of said crumbling banks may be small enough, on the one hand, that they do not give undue transversal dimensions to the silo and, on the other hand, that they stiffen the walls of the silo and thus enable it to better withstand the radial thrusts exerted thereon.

It has been proposed to carry this general idea into practice by means of structures of reinforced concrete but the construction of silos when using this building material is very expensive whether a circular or a polygonal shape is given to such silos. Moreover in such cases the construction of the walls with the sloping planes under consideration requires complicated and expensive moulds and the construction of vertical reinforced concrete girders which are necessary for conveniently supporting the sloping planes, complicates the problem to a very high extent and finally leads to the use of a very important weight of material, to difficult handlings and to the necessity of insuring very important foundations for the whole of the so formed silo.

One object of the present invention is to provide a silo which is very light in relation to its capacity.

Another object of the invention is to provide a silo in which the flowing of the granulous material in the direction of the outlet of the same is very easy.

A further object of the invention is to provide a silo the walls of which are very easy to build separately and can be premanufactured in a workshop and can be easily transported to the place where the silo is to be erected.

Another further object of the invention is to provide a silo which is very easy to erect and which necessitates but small and cheap foundations.

Still another object of the invention is a silo which can easily be made airtight.

A further object of the invention is also to easily build very light polycellular silos on a small ground, practically all the surface of the latter being used.

In order to realise the above said objects the present invention applies the hereabove recited principle to the construction of metallic silos by making the latter of premanufactured panels starting from metal sheets, plane or cylindrical, said sheets being corrugated by folding them in such a manner that they are made to comprise sloping and vertical surfaces, such as those which are mentioned above as used in silos of reinforced concrete. To the lateral or side edges of these corrugated sheets are welded flat bands of metal, such e. g. as flat-billets. By placing several of such panels vertically side by side along the edges of their flat-billets and by welding said edges onto one an-

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other a continuous ring or cell member is formed which constitutes the first layer of the silo wall. On the other hand, by welding a third flat-billet on both other edges of each side flat-billet of two premanufactured panels so joined together a caisson-beam is formed at each joining line of two panels which contributes to stiffen the whole of the said cell-member and constitutes a vertical supporting girder.

By forming in such a manner a series of cell-members, starting from a flat metal-sheet, one over the other and welding them to one another through the respective upper and lower edges of the said cell-members sheets and abutting ends of flat-billets a polygonal silo of the desired height is thus raised.

By starting from a cylindrical metal-sheet generally cylindrical premanufactured panels are formed when joining together a member of so formed panels side by side and one upon another in the hereabove indicated manner, a complete cylindrical metallic silo having a circular base, is formed.

Whilst it is preferable in such a construction to cut the side edges of the premanufactured panels along an angle of 90° in relation to the theoretical median plane of the said panels, when a polygonal silo is wanted, it is advantageous to cut the said side edges at an angle of less than 90° when a cylindrical silo is wanted, in order to keep the possibility of building a triangular beam at the contact line of two panels.

The use of six panels of general plane shape possessing side flat-billets welded perpendicularly to the theoretical median surface of the panel makes it possible with flat-billets of the same width as those which are welded on the edges of the said members to form a mono-cellular silo constituted by an unique hexagonal cell or when using more than six panels to form a multi-cellular silo formed of a plurality of cells joined side by side and in which one wall may be common to two adjacent cells and in which the flat-billet which gives rise to the formation of the triangular beam may be the side flat-billet of a panel belonging to two adjacent silo units.

The use of metal for such a structure offers considerable advantages in that it makes it possible to make in a workshop panels showing perfectly predetermined shapes and which, since they are indeformable in the presence of the stresses which are necessary for their conveyance and for the construction of the whole of the silo, render it possible on easy transport of the same from the workshop to the building yard, an easy handling and an easy reciprocal setting in place of the panels by means of hoists of small power. No moulds are necessary and the scaffolds are minimized. Furthermore, owing to the considerable reduction of the stresses exerted on the sheets of the silo's walls the metal may be chosen of a much smaller thickness than in an ordinary metallic silo. Either in the case of the walls proper or in the case of the supporting caisson-beams the distribution of the metal is definitely more rational which explains the smaller weight of such a silo for an equal capacity of the same.

Owing to the reduced weight of the so formed silo it is sufficient in order to support it, to erect it on foundation bodies of a reduced pattern. Furthermore, the covering of any silo-cell so formed by means of a metal sheet cap made of premanufactured members joined together and to the upper cell member of the silo, and also the adjunction to the lower part of the said silo-cell of a metallic hopper formed of premanufactured elements also joined through welding, give remarkable construction facilities. Furthermore by the welding together of all the parts of the silo it is possible to render it air-tight.

On the other hand, metal offers with respect to concrete the advantages of tightness even along the junction lines or junction surfaces and smaller rubbing coefficient.

Consequently, the qualities of such a silo are due not only to the physical and chemical properties of metal with respect to reinforced concrete but also to the possibility of premanufacturing and joining together the panels by means of autogenous welding or arc welding or through any other convenient means, with formation of stiffening and supporting beams by using certain parts of the pre-manufactured parts themselves of the panels.

Different kinds of silos built according to the invention and certain detail arrangements and possible modifications are shown by way of example in the accompanying drawings.

In said drawings:

Fig. 1 is a perspective elevational view showing a wall member as obtained in a premanufacturing workshop.

Fig. 2 is a plan view of the said member.

Fig. 3 is a horizontal sectional view showing a portion of a hexagonal cell made with such members.

Fig. 4 is a horizontal sectional view, on a larger scale, showing the assembly of the sides of two wall members.

Fig. 5 is an elevational view showing a complete cell with a flat bottom.

Fig. 6 is a top view showing this cell.

Fig. 7 is a cross-sectional view showing a multi-cellular silo comprising hexagonal cells joined side by side with one another.

Fig. 8 is a view, on a larger scale, showing an assembly knot of the wall members of such a silo.

Fig. 9 is an elevational view of the multi-cellular silo shown in Fig. 7.

Fig. 10 is a plan view of a cylindrical silo.

According to Figs. 1 and 2 a panel or wall member of a silo is formed of a thin metal sheet folded in order to include, once the panel is put in place, vertical portions or parts such as 1 and portion or parts sloping in reverse directions such as 2 and 3.

The side edges of the so folded sheets are joined to flat billets or bands 4 and 5 by means of autogenous welding, the flat billets or bands 4 being shown in chain dotted lines in order to cause the design of the folded edge of the sheet to appear in said Figs. 1 and 2. A wall member is thus formed which will be used in building a silo.

The design of the panel or wall member formed by the folding of the parts or portions 1, 2 and 3 of the sheets of the panels may also be established in such a manner that the sides of the same show declivities which are greater than those of the natural crumbling slopes of the granulous material to be stored in the silo. In such a case the panel is completely filled with pulverulent material and as concerns this part of the wall there is no longer a rubbing of the stored material against the metal of the wall member; but a rubbing of stored material on stored material which leads to a considerable reduction of the rubbing stresses exerted on the walls, more particularly at the moment of the emptying of the silo.

For making a silo with a horizontal hexagonal section such as shown in Figs. 3, 4, 5 and 6 two panels of this kind are first welded together while being orientated at 120° with respect to each other as shown in Figs. 3, 4 and 6 the welding being effected along the edges 6 of both flat-billets or bands contacting side by side, and then another flat-billet 10 is welded along the two other edges 8 of both flat-billets already welded at 6, which not only insures an indeformable connection of both wall elements owing to the so formed triangulation but gives also rise to the formation of a triangular caisson-beam 5, 5, 10 (Figs. 3 and 4).

By welding six identical wall panels one against the other along a hexagon a first cell ring is obtained. Then another panel is superimposed to each panel of the said first cell-ring and the upper end edge of the flat-billets or bands 4, 5 of each panel of the first cell ring is welded to the lower edge of the corresponding flat-billets of the so added further panel and the vertical edges of the

flat-billets of each the added panels are respectively welded together. The upper and lower edges of the sheets of the superimposed panels are then welded in the same manner and a second cell-ring is thus formed, and so on up to the upper part of the silo, the latter finally appearing as a hexagonal prism, an elevational view of which is shown in Fig. 5 and a horizontal section of which is shown in Fig. 3 on an enlarged scale.

In order to cover the silo a pyramidal cap showing a hexagonal section (Figs. 5 and 6) is welded on the upper part of the upper cell-ring, said cap being provided with a filling opening 12, a hermetic access door 13 and, as the case may be, a sound-indicator 14 intended for signalling the moment the silo is filled with the pulverulent material introduced therein through opening 12.

In a like manner either a flat sheet bottom 15 as shown in Fig. 5 or a hopper 16 is welded onto the base of the lower cell-ring as shown in Fig. 9.

The hexagonal shape of a so established silo-cell renders it very easy to join side by side a plurality of such cells for forming a cellular silo such as shown in Figs. 7 and 9, the walls 17, 18, 19, 20, 21 and 22 of the middle cell forming both a wall for said middle cell and a wall for the cells surrounding the same, and the walls 23, 24, 25, 26, 27 and 28 becoming common to the six cells which surround the middle cell. The vertical tubular stiffening and supporting caisson-beams are formed of the flat-billets of the sides of the three panels 17, 18, 23 which converge to one and the same junction knot (Fig. 8) and are welded together.

When a cylindrical silo is wanted it can be built of panels constructed as those shown on 1 and 2 but possessing a theoretical median surface which is cylindrical. Such a silo is represented in plan view on Fig. 10. Instead of being cut at an angle of 90° the edges of said circular panels are cut at an angle of, let us say, 60° (Fig. 10). Flat-billets 4a and 5a are welded on the lateral sides of the sheet 1a, 2a, 3a and a flat-billet 10a is welded onto the billets 4a, 5a. When giving to the steel sheet a length corresponding to an angle of 60° at the center 16 of a circumference it is possible to build a circular silo such as shown on Fig. 10 by welding together six panels.

A silo made according to the invention is perfectly well adapted for being combined with receiving and cleaning stores, with emptying spouts, channels with worms, man-holes and other arrangements commonly used in silos.

What I claim is:

1. A metallic silo formed of vertically superimposed and laterally adjacent panels each of them comprising a horizontally corrugated metal sheet, a metal-band at each side of each metal sheet, each sheet being welded along each of the vertical lateral sinuous sides to faces of said metal-bands respectively, the breadth of each said metal-band being disposed at an angle with respect to the theoretical median surface of the said corrugated metal-sheet and the length of which substantially corresponds to the length of the lateral side of the said corrugated metal-sheet, the upper edge of the said corrugated metal-sheet lying in one and the same line as the lower edge of the corrugated metal-sheet of the upper adjacent panel and being welded thereto, two adjacent vertical edges of the metal-bands of two laterally adjacent panels being welded together along their said edges and the upper end of each of said metal-bands being welded to the lower end of the corresponding metal band of the adjacent panel located above, and both so together welded metal-bands being welded along their respective other edges to the respective edges of a third metal-band with a hollow space existing between the three so welded metal-bands.

2. A metallic silo such as is claimed in claim 1 in the structure of which are comprised panels the theoretical

median surface of the corrugated metal sheets of which is plane.

3. A metallic silo such as is claimed in claim 1 in the structure of which are comprised panels the theoretical median surface of the corrugated metal sheets of which is cylindrical.

4. A metallic silo such as is claimed in claim 1 in which the angle at which the breadth of the metal-band is disposed with respect to the theoretical median surface of the said metal sheet is 90°.

5. A metallic silo such as is claimed in claim 1 in which the angle at which the breath of the metal band is disposed with respect to the theoretical median surface of the said metal sheet is less than 90°.

6. A metallic silo such as is claimed in claim 1 in which the corrugations of the sheet metal forming the body of the panels alternatively comprise a part which is parallel to the theoretical median surface of the panel, a part which is inclined with respect to the said surface, a further part which is again parallel to the said surface, a still further inclined part which is again inclined with respect to the said median surface but in the reverse direction, said sequence being repeated according to the desired length of said panels.

7. A metallic silo such as is claimed in claim 6 in which the slope of the inclined parts of the corrugated metal-sheet corresponds to the inclination of the natural crumbling bank of the material to be stored.

8. A metallic silo such as is claimed in claim 6 in which the slope of the inclined parts of the corrugated metal-sheet is greater than the inclination of the natural crumbling bank of the material to be stored.

9. A metallic silo such as claimed in claim 1, in which substantially triangular metallic panels are welded by their base onto the upper edge of the corrugated metal sheet of the upper panels and onto the upper ends of the metal-bands of the said upper panels, the said substantially triangular metallic panels being welded together along their convergent sides.

10. A metallic silo comprising a central hexagonal silo-unit surrounded by six silo-units, each of the same central and surrounding silo-units being formed of vertical superimposed and laterally adjacent panels, each panel comprising a horizontal corrugated metal-sheet, a corresponding metal-band welded along each of the vertical lateral sinuous sides of said metal-sheet respectively, the breadth of each of said metal-bands being disposed at 90° with respect to the theoretical median surface of the corresponding corrugated metal sheet and the length of which substantially corresponds to the length of the lateral side of the said corrugated metal sheet, the upper edge of the said corrugated metal-sheet laying in the same line as the lower edge of the corrugated metal-sheet of the upper adjacent panels and being welded thereto, two adjacent vertical edges of the metal bands of two laterally adjacent panels being welded together along

their said edges and the upper end of each of the said metal bands being welded to the lower end of the corresponding metal-band of the adjacent panel located above, and both so together welded metal-bands being welded along their respective other edges to the respective edges of a third unit metal-band with a hollow space existing between the three so welded metal-bands, each wall of the central silo-unit forming a wall of one of the surrounding silo-units and each third metal-band of the central hexagonal silo-unit being one of the metal-bands of one of the surrounding silo-units, each of the corresponding hollow beams so formed being common to the central silo-unit and to two of the surrounding silo-units.

11. In a metallic construction, more than two horizontally corrugated vertical panels, the panels of each pair of two adjacent panels being disposed at an angle with respect to each other with the adjacent lateral edges thereof terminating respectively in a vertical plane, billets of substantially the same height as the corrugated panels crossing and vertically secured flatwise against the said edges of the corrugations of the panels, the said billets convergently contacting with each other along their adjacent edges and being secured to one another at their said edges, and a third vertical billet secured by and along its two lateral edges to the opposite adjacent edges of the first mentioned billets to form a hollow vertical beam at each convergent line of adjacent panels.

12. In a metallic construction, two horizontally corrugated panels with the corrugations extending to the edges thereof, each panel being disposed at an angle with respect to each other and with the side edges terminating in vertical planes, flat vertical billets contacting and secured to the corrugated edges of the panels with the flat faces of the billets closing the corrugations, said billets being secured to each other along adjacent vertical edges in angular relation, and a vertical billet having opposed vertical edges secured to the other vertical edges of the first-mentioned billets to form a beam at the intersection of the panels.

13. A metallic structure such as is claimed in claim 11 in which said third-mentioned billet closes the corrugations of another panel.

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