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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in and relating to Silo Assemblies and like Containers

We, CONDER ENGINEERING COMPANY LIMITED, a British Company, of Winnal, Winchester, Hampshire, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention concerns silo assemblies and like containers for storing granular and fragmented materials, wherein the material is stored in the silo and extracted as and when required. Present day practice is to construct silos on the site from prefabricated components, such as cast concrete or steel panels, or to build up on the site, for example, by casting concrete *in situ*, or welding up steel plates and other components.

The use of prefabricated components has advantages in that the silos can be erected quicker and at lower cost than when built up. However, a problem exists with this method of construction where the material to be stored is not free flowing, as the interior of a silo must be free from projections which might cause bridging or otherwise hang up the material. In the case of prefabricated steel silos, these usually are circular in horizontal cross-section, blocks of individual units or containers adjacently located being constructed. Such an assembly, however, occupies unnecessary ground space, and is expensive to roof over, besides which long conveyor runs and associated heavy supports are required.

An object of this invention is to provide a construction of silo which is built up using plates as the walls, and which when built into an assembly of a number of adjacent containers occupy a minimum of ground space. Another object of the invention is to provide a construction of silo built up from metal, e.g. steel plates, in which the interior surface is smooth and unbroken, being devoid of ribs, corrugations or like internal projections, and

yet is of adequate strength particularly against bulging or bursting. A further object is to provide a construction of silo which can be produced economically and erected easily, and is strong yet not using an excessive amount of material in its construction.

Thus in its preferred form the invention provides a silo assembly built mainly from steel plates, each unit or container having smooth interior walls substantially free from internal horizontal projections, and which is economical in cost, and can be erected quickly and easily.

According to this invention there is provided a silo assembly consisting of a number of individual containers each with its walls built up from rectangular plates so as to present a substantially smooth interior to the container, and each container of polygonal shape in horizontal cross-section, the plates having flanges extending from their horizontal edges and on the outside of a wall, whereby contiguous flanges of adjacent plates, one above the other, of a wall can be secured together by bolts and nuts, rivets or like attachment means, the individual containers being set up in close proximity to one another, web strips being provided uniting flanges of an individual container where adjacent and substantially coplanar with those of another container, ties or straps also being provided at the corner junctions of the plates of a container from the end of a flange assembly of a side to the assembly at the adjacent side. The containers preferably are built from metal, e.g. steel plates and are rectangular in horizontal cross-section, and the flanges of the outer sides of a container are strengthened by horizontal strips which can be of L-section secured to the flanges, and the ends of the strengthening strips or strengthening strips and web plates are tied.

The use of the web strips enables

[Price 4s. 6d.]

rectangular metal plates of a light gauge which would not alone be able to withstand the pressure in a container to be used. Thus the strips virtually constitute shear members of beams, the rectangular plates forming the flange elements. The ties or straps serve to relieve the concentrated shear forces at the ends of the strips or flanges.

The horizontal flanges on the outer sides of the assembly can be strengthened by horizontal strips secured to the flanges, the ends of adjacent co-planar strips at the corners being united by ties or straps, whilst the ends of adjacent co-linear strips along the walls are tied together and also to the adjacent end of a web.

The ties or straps can be simply short bars, but preferably comprise L-shaped plates at the corners, and T-shaped plates along the walls.

According to a further feature of the invention, the silo is constructed so as to have a degree of fire resistance. This conveniently is obtained by using horizontal strips of open or lattice form around the assembly and providing outer vertical panels secured to the outer edges of the strips so that a space is formed between the plates and outer panels. This space is filled with fire-resistant material such as a light-weight concrete material.

Also, according to a further feature of this invention, a silo assembly as above set forth is provided, there also being provided a hopper or feed chute outlet at the bottom of each container, and of a cross-section corresponding therewith, each said hopper having at least one wall inclined to the vertical and sloping inwardly to form a downwardly tapering hopper narrowing to a bottom outlet, the top of each hopper being bounded by a channel-section inwardly facing ring rim, the relative widths of the flanges being such to accommodate any inclination of a wall of the hopper.

The construction according to this invention enables a silo assembly to be built comprising individual containers or cells, which assembly is rigid and light in weight in comparison with usual structures. The height of the rectangular plates will be such that an operator can reach down and unite the flanges of adjacent (one above the other) plates as the containers are erected. Further, the web strips can be apertured to permit a man's hand to pass through an aperture. This enables erection to proceed without resort to blind rivetting or other form of blind fixing.

The corners of plates of adjacent walls are, of course, united, for example by using vertical angle strips, and nuts and bolts or rivets. These strips can be covered by fairings.

In the case where the chutes are of some height, additional rings may be provided spaced apart therealong. Thus the chutes can be prefabricated from rectangular plates,

horizontal junctions of the plates of each chute being embraced by a rim or ring.

In order that a clear understanding of the invention may be obtained, reference will now be made to the drawings accompanying the Provisional Specification, and to the accompanying drawings. In the drawings accompanying the Provisional Specification:—

Figure 1 is a fragmentary perspective view showing the lower part of and form of silo and chute.

Figure 2 is a side view of a part of a chute.

Figure 3 is a plan view of Figure 2, and

Figure 4 is a longitudinal view of a detail showing one arrangement at the junction of the silo and chute.

In the accompanying drawings:—

Figure 5 is a fragmentary view similar to Figure 1 showing certain modifications, and

Figure 6 is a longitudinal view similar to Figure 4 of the modified arrangement shown in Figure 5.

Referring firstly to Figure 1, the silo assembly consists of four separate containers or cells C. Two, or more than four, could be built according to requirements. Each container is built up from rectangular steel plates P each having a flange F along top and bottom edges. Adjacent plate corners are united by angle-section uprights 10. It will be seen that the interior of each cell is unbroken, having no inwardly directed horizontal projections, and the uprights 10 may have fairing pieces arranged so that bolts connecting the plates and uprights are concealed. Such a fairing piece FP is shown in Figure 5.

The contiguous flanges F of adjacent containers C are united by web strips W, these having apertures 11 therethrough. This results in all of the containers being held rigidly together. Moreover, the web strips with the plates form an I-section beam structure. The plates P are of light gauge, and the web strips W ensure a lightweight, firm structure of silo assembly. The height of each plate, and the provision of the apertures, permits an operator to carry out building up, as the operator can reach down and insert bolts through holes through the flanges during construction.

On the walls, on the outside of the assembly, i.e. a wall where there is no parallel adjacent wall of another unit, L-section strips are secured, these also imparting strength to the assembly. In order to relieve shear forces concentrated on the ends of the web strips W, adjacent ends of strips are connected by straps T, in the example shown in Figure 1, in the form of tie bars. These straps are necessary between each web strip W and strip S, as shown.

In the construction illustrated in Figure 5, the straps T consist of L or T-shaped plates.



k S

Those uniting strips at the corner are L-shaped, and those between adjacent co-linear strips and the end of an adjacent web are T-shaped. Further, the construction shown in Figure 5 is one in which the outer walls of the assembly are built to have a degree of fire resistance.

In this construction the strips are of lattice or open form designated SL, each consisting of an inner L-section rail and an outer upright rail, united by a lattice of flat or round section. The outer upright rails provide support for an outer corrugated panel OP, between which and the panels P, a space is formed which contains a suitable lightweight fire resistant material such as a foamed concrete or other material F.R. Suitable cover plates (not shown) can be provided to prevent the material from entering into the gap between adjacent cells C.

Each container C is supported above a hopper or chute H, this also being built up from steel plates and of downwardly tapering form. In the example of Figure 1 of the drawings, two walls of each hopper are vertical, the other two inclining to produce a downwardly tapering construction, whilst in Figure 5, only one wall is inclined. The top of each hopper or chute H is embraced by a rim R of inwardly facing channel section, and it will be seen also that the flanges of this rim on the inclining walls are of different widths to accommodate the angle. This is shown in Figure 4, where the upper flange w is narrower than the lower flange w^1 . It will also be noted from this Figure that the lower flange F of the bottom of the unit C bears on the upper flange w of the rim to which it is secured, for example by welding. A horizontal beam B is provided to bear the adjacent rims R of adjacent hoppers.

Figure 6 shows an alternative and preferred arrangement in which a channel section member CH is welded on to the top of the flange w so that the bottom flange F of the bottom unit C bears on the top flange of the member CH to which it is secured, for example by bolts or rivets.

Further rims R are provided below the junction of the containers and hoppers to increase strength, and conveniently to embrace joints between plates. Additional stiffeners can be provided for the hopper units and silo containers if necessary. For example, stiffeners 12 (Figures 2 and 3) can be provided on the inclined walls of the hoppers, and also horizontal angle-section stiffeners can be provided, for example at the junction of plates. The hoppers have outlets O.

The construction of silo assembly as herein described is particularly suitable for containing fragmented materials such as meat, fish, cake, offal and nut meals, where the free flow characteristics compared with cereal grains are poor. The assembly is light in weight, yet of adequate strength, particularly to resist internal

pressure, and the parts can be set up and erected easily. The chutes also have a smooth interior, so that a good, free outlet flow is obtained.

WHAT WE CLAIM IS:—

1. A silo assembly consisting of a number of individual containers each with its walls built up from rectangular plates so as to present a substantially smooth interior to the container, and each container of polygonal shape in horizontal cross-section, the plates having flanges extending from their horizontal edges and on the outside of a wall, whereby contiguous flanges of adjacent plates one above the other of a wall can be secured together by bolts and nuts, rivets or like attachment means, the individual containers being set up in close proximity to one another, web strips being provided uniting flanges of an individual container where adjacent and substantially co-planar with those of another container, ties or straps also being provided at the corner functions of the plates of a container from the end of a flange assembly of a side to the assembly at the adjacent side.

2. A silo assembly as claimed in Claim 1, wherein the plates are metal plates.

3. A silo assembly as claimed in Claim 1 or 2, wherein the containers are rectangular in horizontal cross-section.

4. A silo assembly as claimed in Claim 1, 2 or 3, wherein the flanges on the outer sides of the assembly are strengthened by horizontal strips secured to the flanges, the ends of adjacent co-planar strips at the corners being united by ties or straps, whilst the ends of adjacent co-linear strips along the walls are tied together, and also to the adjacent end of a web.

5. A silo assembly as claimed in Claim 4, wherein the ties or straps comprise L-shaped plates at the corners, and T-shaped plates along the walls.

6. A silo assembly as claimed in Claim 4 or 5, wherein the horizontal strips are of open or lattice form, and outer vertical panels are provided secured to the outer edges of the strips so that a space is formed between the plates and outer panels, said space being filled with fire resistant material.

7. A silo assembly as claimed in any one of the preceding Claims, wherein a hopper or feed chute outlet is provided at the bottom of each container, and of a cross-section corresponding therewith, each said hopper having at least one wall inclined to the vertical and sloping inwardly to form a downwardly tapering hopper narrowing to a bottom outlet, the top of each hopper being bounded by a channel-section inwardly facing ring rim, the relative widths of the flanges being such to accommodate any inclination of a wall of the hopper.

8. A silo assembly as claimed in Claim 7, wherein each hopper is built up from plates,



Those uniting strips at the corner are L-shaped, and those between adjacent co-linear strips and the end of an adjacent web are T-shaped. Further, the construction shown in Figure 5 is one in which the outer walls of the assembly are built to have a degree of fire resistance.

In this construction the strips are of lattice or open form designated SL, each consisting of an inner L-section rail and an outer upright rail, united by a lattice of flat or round section. The outer upright rails provide support for an outer corrugated panel OP, between which and the panels P, a space is formed which contains a suitable lightweight fire resistant material such as a foamed concrete or other material F.R. Suitable cover plates (not shown) can be provided to prevent the material from entering into the gap between adjacent cells C.

Each container C is supported above a hopper or chute H, this also being built up from steel plates and of downwardly tapering form. In the example of Figure 1 of the drawings, two walls of each hopper are vertical, the other two inclining to produce a downwardly tapering construction, whilst in Figure 5, only one wall is inclined. The top of each hopper or chute H is embraced by a rim R of inwardly facing channel section, and it will be seen also that the flanges of this rim on the inclining walls are of different widths to accommodate the angle. This is shown in Figure 4, where the upper flange *w* is narrower than the lower flange *w*¹. It will also be noted from this Figure that the lower flange F of the bottom of the unit C bears on the upper flange *w* of the rim to which it is secured, for example by welding. A horizontal beam B is provided to bear the adjacent rims R of adjacent hoppers.

Figure 6 shows an alternative and preferred arrangement in which a channel section member CH is welded on to the top of the flange *w* so that the bottom flange F of the bottom unit C bears on the top flange of the member CH to which it is secured, for example by bolts or rivets.

Further rims R are provided below the junction of the containers and hoppers to increase strength, and conveniently to embrace joints between plates. Additional stiffeners can be provided for the hopper units and silo containers if necessary. For example, stiffeners 12 (Figures 2 and 3) can be provided on the inclined walls of the hoppers, and also horizontal angle-section stiffeners can be provided, for example at the junction of plates. The hoppers have outlets O.

The construction of silo assembly as herein described is particularly suitable for containing fragmented materials such as meat, fish, cake, offal and nut meals, where the free flow characteristics compared with cereal grains are poor. The assembly is light in weight, yet of adequate strength, particularly to resist internal

pressure, and the parts can be set up and erected easily. The chutes also have a smooth interior, so that a good, free outlet flow is obtained.

WHAT WE CLAIM IS:—

1. A silo assembly consisting of a number of individual containers each with its walls built up from rectangular plates so as to present a substantially smooth interior to the container, and each container of polygonal shape in horizontal cross-section, the plates having flanges extending from their horizontal edges and on the outside of a wall, whereby contiguous flanges of adjacent plates one above the other of a wall can be secured together by bolts and nuts, rivets or like attachment means, the individual containers being set up in close proximity to one another, web strips being provided uniting flanges of an individual container where adjacent and substantially co-planar with those of another container, ties or straps also being provided at the corner functions of the plates of a container from the end of a flange assembly of a side to the assembly at the adjacent side.

2. A silo assembly as claimed in Claim 1, wherein the plates are metal plates.

3. A silo assembly as claimed in Claim 1 or 2, wherein the containers are rectangular in horizontal cross-section.

4. A silo assembly as claimed in Claim 1, 2 or 3, wherein the flanges on the outer sides of the assembly are strengthened by horizontal strips secured to the flanges, the ends of adjacent co-planar strips at the corners being united by ties or straps, whilst the ends of adjacent co-linear strips along the walls are tied together, and also to the adjacent end of a web.

5. A silo assembly as claimed in Claim 4, wherein the ties or straps comprise L-shaped plates at the corners, and T-shaped plates along the walls.

6. A silo assembly as claimed in Claim 4 or 5, wherein the horizontal strips are of open or lattice form, and outer vertical panels are provided secured to the outer edges of the strips so that a space is formed between the plates and outer panels, said space being filled with fire resistant material.

7. A silo assembly as claimed in any one of the preceding Claims, wherein a hopper or feed chute outlet is provided at the bottom of each container, and of a cross-section corresponding therewith, each said hopper having at least one wall inclined to the vertical and sloping inwardly to form a downwardly tapering hopper narrowing to a bottom outlet, the top of each hopper being bounded by a channel-section inwardly facing ring rim, the relative widths of the flanges being such to accommodate any inclination of a wall of the hopper.

8. A silo assembly as claimed in Claim 7, wherein each hopper is built up from plates,

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and further bounding ring rims are provided around each hopper at plate junctions.

- 5 9. A silo assembly as claimed in Claim 7 or 8, and as limited by Claim 2, comprising pairs of containers in side-by-side relation, at least two pairs in line, with opposite sides of the hopper sloping in towards one another.

- 10 10. A silo assembly as claimed in any one of the Claims 7, 8 or 9, wherein the lower plate of each container is secured on to the channel section ring rim by a channel section member.

11. A silo assembly substantially as herein described with reference to the drawings accompanying the Provisional Specification or Complete Specification.

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