June 23, 1953 A. S. BEECH 2,642,979

HOPPER AND LIKE CONTAINERS

Filed Nov. 30, 1949 2 Sheets-Sheet 1

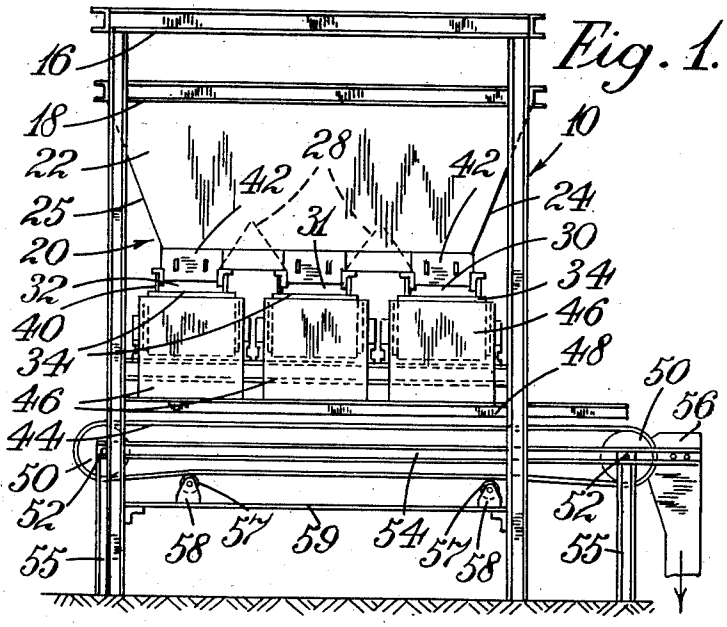


Fig. 1.

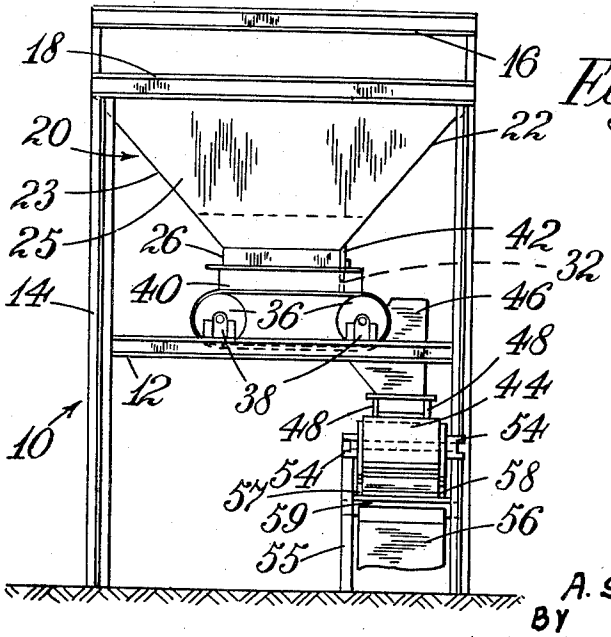


Fig. 2.

INVENTOR
A. S. BEECH
BY
Wilkinson & Mawhinney
Attorneys

June 23, 1953 A. S. BEECH 2,642,979

HOPPER AND LIKE CONTAINERS

Filed Nov. 30, 1949 2 Sheets-Sheet 2

Fig. 3.

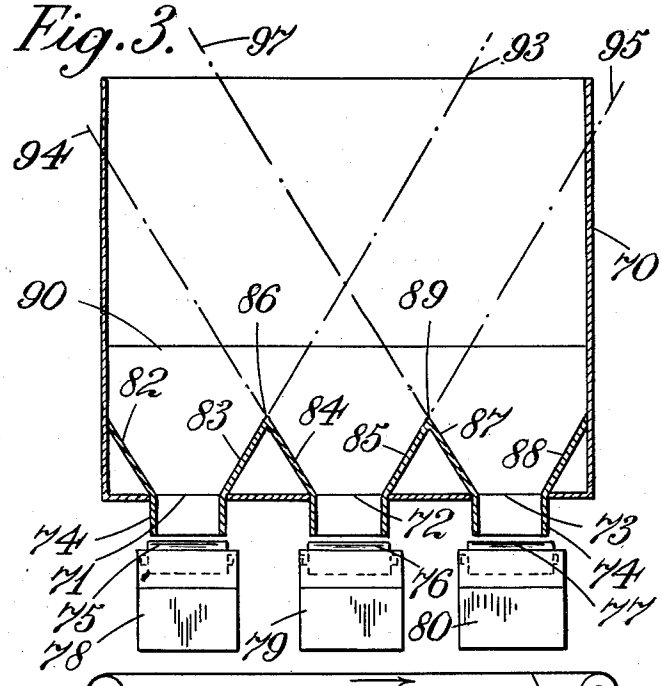


Fig. 5.

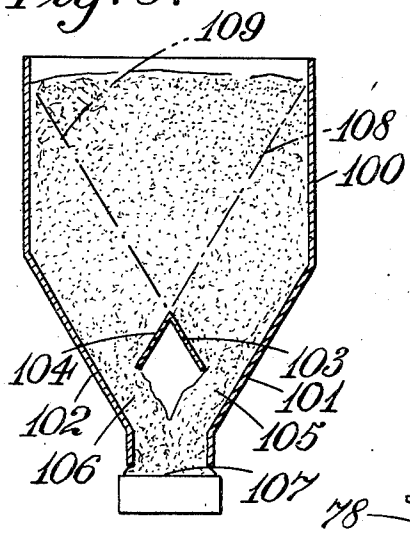
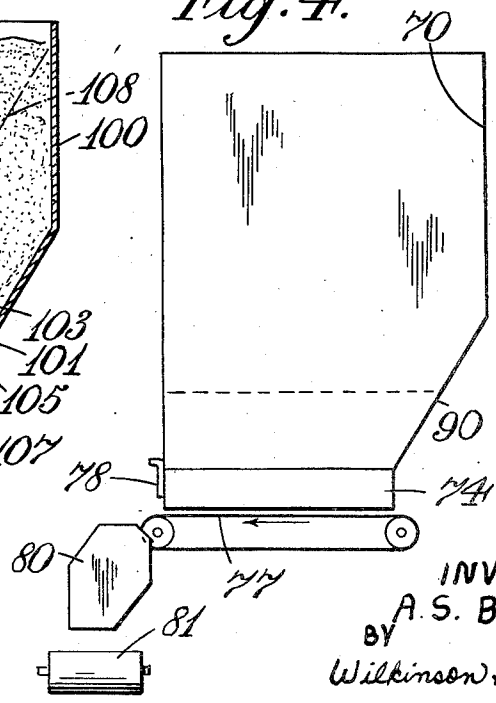


Fig. 4.



INVENTOR
A. S. BEECH
BY
Wilkinson & Mawhinney
Attorneys

Patented June 23, 1953

2,642,979

UNITED STATES PATENT OFFICE

2,642,979

HOPPER AND LIKE CONTAINERS

Austin Sidney Beech, Leighton Buzzard, England, assignor to Foundry Equipment Limited, Leighton Buzzard, England, a British company

Application November 30, 1949, Serial No. 130,280
In Great Britain September 15, 1947

2 Claims. (Cl. 198—56)

1

This invention relates to hoppers for receiving pulverulent material, particularly foundry moulding sand, and apparatus for feeding the material from the bottom thereof, which apparatus is of the type wherein endless conveyor means closes the bottom of the downwardly-opening hopper except for a plurality of feed outlets arranged across the width of the conveyor means, the size of each of which feed outlets, through which the material is entrained, serving to determine the thickness of the layer of the entrained material and the rate of feed thereof. This is a continuation-in-part of application, now abandoned, Serial Number 45,881 filed August 24, 1948, by applicant.

Hoppers used for storing sand for foundry purposes, particularly such sand storage hoppers of large size, have the drawback that the sand tends to build up inside them at various places, such as at the rear, or at the front, or in the middle. The present invention has for its main object to obviate this drawback, and to provide improved apparatus of the type described, wherein the conveyor means is constructed and arranged in an improved manner.

Foundry moulding sand is not like ordinary sand because it contains a binder which enables it to cake together firmly when pressure is exerted upon it, as for example when sand is rammed in the mould, and it is very important that this property of cohesion under pressure should be maintained in the moulding sand.

In the foundry, after use in the boxes where the sand is moulded on the patterns, when the castings have been made the sand is knocked out of the boxes and returned to the sand mills, to be broken up, mixed with a certain proportion of fresh sand and rendered fit for reuse. The sand is therefore kept in circulation through a definite cycle of operations in the foundry, and in order that it may have time to cool down and be reprepared, and to allow for irregularities in the rate of use in the foundry, it is necessary that a certain total quantity of sand should be kept in circulation. This necessitates the provision of storage hoppers of appropriate capacity to the size of the plant at a proper point in the cycle. Such storage hoppers in order to be effective, must be capable of receiving sand continuously and discharging it regularly in such a way that no part of the sand in store occupies any substantially longer time in passage through the hopper than other parts of the sand therein.

Storage hoppers having a capacity of 60 or 120 tons or more of sand are quite common and in

2

such hoppers it is a well known problem that the sand tends to cake under its own weight and to form "pipes." That is to say, the sand in a particular part of the hopper will feed down on to a conveyor placed on the bottom of the hopper while sand in another part of the hopper will be caked together and will form a bridge over the conveyor. Under these conditions only that part of the sand which is in the "pipe" is being effectively fed and the remainder of the sand in the storage hopper is idle; it is not taking any part in the circulation of material and the part of the hopper which contains it might as well be out of existence. In other words, the storage capacity of the system is reduced to that part which is actually in flow through the hopper. This means that the sand gets around the cycle too quickly and does not have time for proper repreparation before re-use.

Numerous devices have been proposed for avoiding piping without giving complete satisfaction and it is an object of the present invention to provide a new construction of storage hopper which will effectually attain the end in view.

It will be appreciated in this connection that in order to attain adequate capacity within a reasonable ground space, it is necessary that the storage hopper should have a substantial depth, but increase of depth tends to increase the tendency to cake. On the other hand, if the length and width of the hopper are increased, the length of the conveyor which is necessary at the bottom of the hopper to remove the sand continuously therefrom is correspondingly increased and it is found that long runs of conveyor tend to increase piping.

One of the features of the present invention which is employed to overcome this difficulty envisages the employment of a series of elongated discharge openings in the bottom of the hopper which are associated as hereinafter described with inclined deflector walls within the hopper which converge downwardly at an angle steeper than the angle of repose of normal moulding sand and are set sufficiently close together to enable each opening to draw from parts of the hopper which lie above other openings. It is found in this way that the flow of sand through one discharge opening assists the flow through others and piping is minimised or obviated. Normally, this feature of the invention is employed in combination with separate endless gated conveyor means below each opening as hereinbefore described.

Further features of the invention will appear in the following description which is given by way of example of certain embodiments of storage hopper means according to this invention.

In the accompanying drawings:

Figure 1 is a side elevation showing one construction of apparatus according to the invention for feeding moulding sand;

Figure 2 is an end elevation thereof as viewed from the left-hand of Figure 4;

Figure 3 is a vertical section through a second construction upon the line 3—3 of Figure 4;

Figure 4 is an end elevation of the same, and

Figure 5 is a vertical section through a third construction.

Referring first to Figures 1 and 2, the apparatus has a rectangular vertical framework, designated generally 10, which comprises a bed 12 carried by vertical frame members 14 that extend upwards above the bed and are tied together at the top by four upper horizontal members 16, as well as by four lower horizontal members 18 situated below the members 16. A downwardly-opening container, designated generally 20, in the form of a hopper for foundry sand is mounted in the upper part of the framework at a convenient height above the bed 12 for delivering the sand to foundry apparatus as described hereinafter. As illustrated, this hopper 20 is suspended from the horizontal frame-members 18.

The hopper 20 has two longitudinal side walls 22, 23 and two end walls 24, 25, all of which walls slope downwards and join the top of a rectangular downwardly-opening outlet portion 26. Two deflectors 28 of inverted V-shape in cross-section lie transversely of the outlet portion 26 in spaced relation from one another and from the end walls 24, 25 of the hopper, so that the bottom of the hopper is sub-divided to form three rectangular delivery outlets at 30, 31, and 32 that lie in spaced parallel relation in the longitudinal direction of the framework.

The deflectors 28, it is important to observe, are somewhat steep-sided, the angle at which their sides lie to the horizontal being steeper than the normal angle of repose or sliding angle of foundry moulding sand and the sides of the hopper are also steeper than this angle for reasons hereinafter pointed out.

It will be observed that the sides of the deflectors 28 lie in planes which, if extended upwardly above the tops of the deflectors, reach positions where each plane overlies one of the adjacent hopper openings. Thus for example, the inner sides of the two deflectors 28, which converge downwardly toward the central discharge opening of the hopper, lie in planes which, if one imagines them extended upwardly and outwardly, would overlie the two side openings 42 and the sides of the deflector plates which extend downwardly towards the side openings 42, lie in planes which, if extended upwardly above the deflector plates, would overlie the central opening. If now it is borne in mind that these planes lie at an angle which is not less than, but is in fact somewhat steeper than, the angle of repose of flowing moulding sand, it will be appreciated that if the sand blocks over the central opening 42 it will still run down from the centre of the hopper into one or other of the side openings. Conversely, if it blocks over one of the side openings it can still run down into the centre one. It is found that this dual possibility of flow for the particles of sand in the upper part of the hopper is an effective feature in preventing "piping."

It will further be observed from Figure 2 that the run of the conveyor 36 is a short one relatively to the width of the hopper from front to back and is even shorter relatively to the width of the hopper from side to side. In hoppers as heretofore constructed it has been usual to make the conveyor in the bottom of the hopper run beneath an elongated central opening which is extended along the hopper from end to end, the object being to bring the sand from all parts of the hopper by as short a path as possible to the conveyor, but this involves a long conveyor run and it has been found that there is a distinct tendency to pipe under these conditions. The present invention by providing three short conveyors extending transversely across the hopper, that is across the shortest dimension of it, in conjunction with the deflector plates, serves to avoid piping. It is to be observed however that the deflector plates are kept low in the bottom of the hopper by this means so that the upper portion of the hopper is not separately divided in any way and the various particles of sand each have several possible paths so that if one path tends to choke, one of the other paths may remain open and the inclusion in the hopper of large quantities of choked or caked sand is obviated.

Three endless feeder belts 34 are arranged side-by-side extending in the transverse direction of the framework, one below each delivery outlet, for receiving material from the hopper. Each of these feeder belts extends round two end drums 36 journalled in bearings 38 mounted on the bed 12. Between each feeder belt and the delivery outlet above it there is a box-like structure 40, in each of which is movable vertically a valve member 42 in the form of a manually adjustable gate valve. The bottom of the downwardly-opening hopper is thus closed except for the three vertical feed outlets arranged in a row extending across the width of the conveyor means constituted by the feeder belts, and the size of each feed outlet, through which the material is entrained, can be adjusted by its gate valve so as to determine the thickness of the layer of the entrained material and the rate of feed thereof.

An endless delivery conveyor belt 44 lies in the longitudinal direction of the framework and transversely of the feeder belts 34 at a situation below the delivery ends of the latter. Three feeder chutes 46 are arranged in a row above the belt 44, one at the delivery end of each feeder belt, which chutes are supported by a bearer structure 48 mounted on the framework. End drums 50 of the delivery conveyor 44 are journalled in bearings at 52 on a supporting structure 54, 55 comprising horizontal members 54 and vertical supports 55. A delivery chute 56 is carried by the horizontal members 54 at the delivery end of the conveyor belt 44 for delivering the sand towards or to its place of use as indicated by the arrow. The lower run of the belt 44 is preferably supported by idler rollers 57 journalled in bearings 58 carried by a longitudinal support 59 on the framework.

It is found in practice that owing to the provision of the described discharge apparatus comprising the feeder belts 34, the delivery conveyor belt 44, and the deflectors 28 between the subdivided outlet of the hopper, the trouble experienced heretofore with large sand-storage hoppers, owing to the sand building up at vari-

ous places inside them, is obviated, and blocking up of their outlets is effectively prevented.

Referring now to Figures 3 and 4, these show a hopper 70 of rectangular form having at the bottom three rectangular outlet openings 71, 72, 73. The openings 71, 72, 73 extend across the hopper from front to back and below them are vertical side walls 74 which lead the material downwards on to three conveyor belts 75, 76, 77. At the front end of each opening is a gate 78 similar to the gates 42 of Figures 1 and 2, for regulating the thickness of the layer of material which is carried out from below the openings by the conveyors. This is delivered into chutes 78, 79, 80 respectively which deliver it on to a transverse conveyor 81 on which all the material is collected and by which it is carried away.

Above the opening 71 there are two inclined deflector plates 82, 83 which converge downwardly and adjoin the side edges of the opening 71. The plates extend upwardly at an angle which is somewhat steeper than the normal angle of repose of unpacked (freely flowing) moulding sand. Above the opening 72 there are two similar deflector plates 84, 85, and the plate 84 extends upwardly at the same angle as the upper plates until it meets the plate 83 and forms a dividing apex 86 within the hopper. Similarly, above the opening 73 are two deflector plates 87, 88 and the plate 87 meets the plate 85 at an apex 89. The back of the hopper has a sloping wall 90 which is set at the same angle as the deflector plates just referred to and which serves to reduce the length of the openings 71, 72, 73 somewhat as compared with the distance from front to back of the hopper 70.

The planes in which the deflector plates 83 to 87 lie are indicated by the chain lines 93, 94, 95 and 97 and it will be seen that the plane 94 of the plate 84 extends up within the hopper to a region where it overlies the opening 71. The hopper is made deep enough to ensure that this is so. Similarly, the plane 97 of the plate 87 overlies the opening 72, the plane 93 of the plate 83 also overlies the opening 72 and the plane 95 of the plate 85 overlies the opening 73.

If the sand in the hopper which is gravitating downwards into, say, the opening 72 should become packed above the opening and cease to flow over any part of the area of the opening, it will be seen that as the plane 93 is steeper than the angle of repose of loose moulding sand the loose sand can slide over the top of the packed sand to one side into the opening 71. Similarly, this sand has another alternative direction in which it can slide down the plane 97 into the opening 73. In a similar way if any material becomes packed in the bottom of the hopper above the opening 71 the loose material in the upper part of the hopper can slide down the plane 94 into the opening 72. The packing above the opening 73 still leaves the material free to slide down the plane 95 into the opening 72. Thus, there are several possible alternative paths for loose material fed into the hopper to pass downwardly onto the conveyor system below and this prevents material from becoming packed in large volumes in the hopper and ceasing to circulate in the sand-recovery system.

It is seldom that sand clogs completely over any conveyor but it may clog over a part of the area of any one of the openings. The tendency so to do is diminished by the fact that the length of the opening, represented by the side walls 74, is diminished. According to this invention, for a given size of hopper the length of the opening is diminished because the openings are set to run transversely across the hopper, that is to say, across its narrowest dimension, but they are further reduced in length by the inclined rear wall 90. It will be appreciated that if there were only one opening in the bottom of the hopper it would have to run along under the whole length of the hopper because otherwise it would be much too far from the front and back walls and under these conditions it would not be practicable to reduce the length of the conveyor to a point at which clogging is improbable.

It is further to be observed that as the whole of the sand in the upper part of the hopper is kept by the construction according to this invention in a free flowing state, clogging as it descends towards the openings 71, 72, 73 is very much less liable to develop, and in practice it is found that a hopper constructed as herein described operates for long periods without clogging and without special attention.

The particular dimensions of the hopper constructed to prevent clogging or piping are not without importance, according to this invention. In a particular example of a hopper constructed in accordance with Figures 3 and 4 of the drawings to hold 60 tons of sand the width of the hopper from front to back was 10 feet, the dimension from side to side as shown in Figure 3 was 15 feet and the depth of the hopper from the top down to the conveyor belts was 14 feet, while the length of the openings 71, 72, 73 from front to back of the hopper was 7 feet and the width 2 feet. With these dimensions no piping or clogging was found to occur notwithstanding the large size of the hopper. By putting two such hoppers back to back an economical arrangement for holding 120 tons of sand was achieved.

On the other hand, when a hopper was constructed without deflector plates as 82—88 and with a single opening extending nearly the whole length of the hopper, about 10 feet 6 inches, bad piping was experienced. As a rough guide it may be said that the length of run of the conveyor belt multiplied by the depth of moulding sand in the hopper above the opening should not give a product, when the dimensions are taken in feet, exceeding about 120.

It will be appreciated that with both the constructions of Figures 1 and 2 and Figures 3 and 4 the several conveyor belts can be independently regulated as to output by the gates and also independently started, stopped and varied in speed. If the operator finds a tendency for the sand to cake or pipe at any one opening he can speed up the flow by increasing the output of one or more of the conveyors to keep the rate of flow of moulding sand constant while the blockage is attended to, or one of the conveyors can be stopped for the purpose of attending to a blockage due to piping or caking of the sand, without interfering with the others. For larger hoppers the number of discharge openings and conveyors can be increased as may be desired.

The normal angle of repose of freely flowing (i. e. not compacted) moulding sand may be taken as 45° or steeper and the deflector plates should be steeper than this, as shown in the drawings.

Figure 5 of the drawing shows a possible alternative construction, in accordance with the invention, for hoppers of smaller capacity than

are illustrated in Figures 3 and 4. In this case there is a parallel-sided rectangular hopper 100 having inclined walls 101, 102 in the bottom which are sloped at an angle steeper than the angle of repose of freely flowing moulding sand. Between the inclined walls 101, 102 there are two similarly-sloped deflector plates 103, 104 which meet at an apex 110 and are spaced at their lower edges from the walls 101, 102 sufficiently to provide two discharge openings 105, 106. Through these openings the sand can descend onto a single conveyor 107. It will be noted that the planes in which the deflector plates 103, 104 lie, which are indicated by the chain lines 108, 109, extend upwardly within the hopper to a point at which they overlie respectively the openings 105, 106 and therefore the same action can take place as has already been described in connection with Figures 3 and 4.

It will be observed that the deflector plates 103, 104 in Figure 5 operate to prevent the full weight of the sand in the hopper from pressing upon the sand on the conveyor belt below and this is a further advantage of this construction.

By this invention it becomes possible to provide relatively deep hoppers for storing large quantities without leading to undue piping and blockage of the flow of sand.

I claim:

1. In a storage means for moulding sand, the combination of a hopper which is rectangular in plan, having a plurality of discharge openings elongated in the direction of the length of the hopper and extending in the direction of the width of the hopper, continuously acting conveyor means close to and below said openings to remove material longitudinally from the hopper, inclined deflector walls within the hopper positioned at the sides of each opening, which walls converge downwardly at an angle steeper than the angle of repose of loose moulding sand, the said deflector walls where they lie between the openings extending upwardly until they meet each other and each of said walls lying in a plane that diagonally overlies the greater part of a neighboring opening and the hopper being of a depth to extend to a height equal to that where the plane overlies the greater part of the neighboring opening.

2. In storage means for moulding sand, the combination of a hopper which is rectangular in plan, having a plurality of discharge openings elongated in the direction of the length of the hopper and extending transversely across the width of the hopper, continuously acting conveyor means close to and below said openings to remove material longitudinally from the hopper, inclined deflector walls within the hopper connected with the sides of each opening, which walls converge downwardly at an angle steeper than the angle of repose of loose moulding sand, the said deflector walls where they lie between the openings extending upwardly until they meet each other at an apex and each of said walls lying in a plane that diagonally overlies the greater part of a neighboring opening and the hopper being of a depth to extend to a height equal to that where the plane overlies the greater part of the neighboring opening, said conveyor means comprising a separate conveyor beneath each discharge opening, a box-like member surrounding each discharge opening and depending from the hopper, each of said members being positioned between its discharge opening and its separate conveyor and having its top and bottom open to communicate with its discharge opening and its separate conveyor, each of said members also having one of its sides open, and a gate valve movably mounted on each member to regulate the thickness of material removed by its separate conveyor.

AUSTIN SIDNEY BEECH.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
754,899	Seaver	Mar. 15, 1904
935,504	Heybach	Sept. 28, 1909
1,234,532	Dickerson	July 24, 1917
1,395,089	Burhans	Oct. 25, 1921
1,554,486	Bell	Sept. 22, 1925
1,778,389	Hund	Oct. 14, 1930
1,822,530	Kind	Sept. 8, 1931
1,922,883	Crago	Aug. 15, 1933
2,116,807	Thrall	May 10, 1938

FOREIGN PATENTS

Number	Country	Date
567,267	Germany	Dec. 15, 1932
778,238	France	Mar. 12, 1935
481,885	Great Britain	Mar. 18, 1938