Sept. 20, 1971 R. P. CHAPMAN ET AL 3,605,869

SUPPORT MEANS FOR CERAMIC SHELL MOULDS

Filed Oct. 22, 1969 3 Sheets-Sheet 1

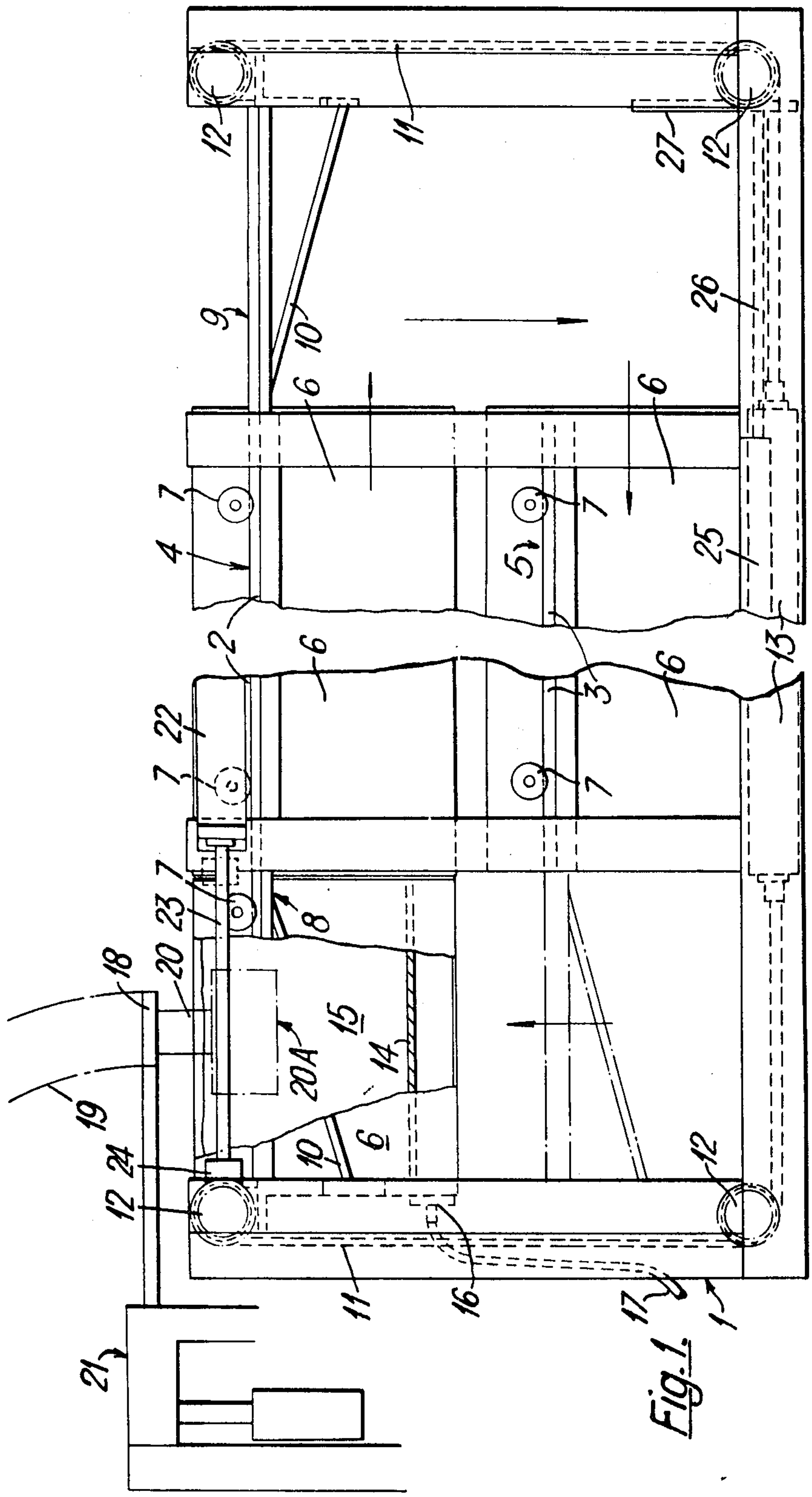

Fig. 1.

SUPPORT MEANS FOR CERAMIC SHELL MOULDS

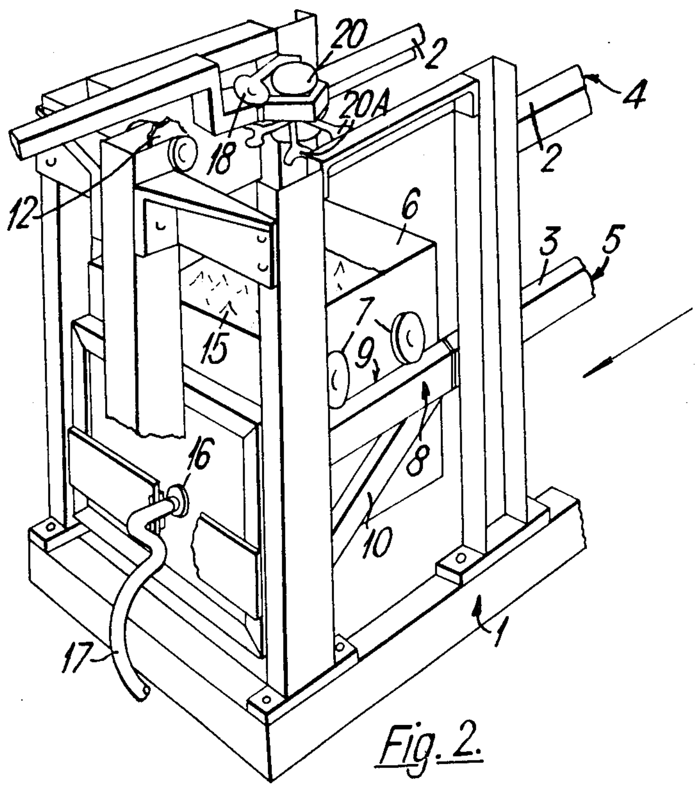

Fig. 2.

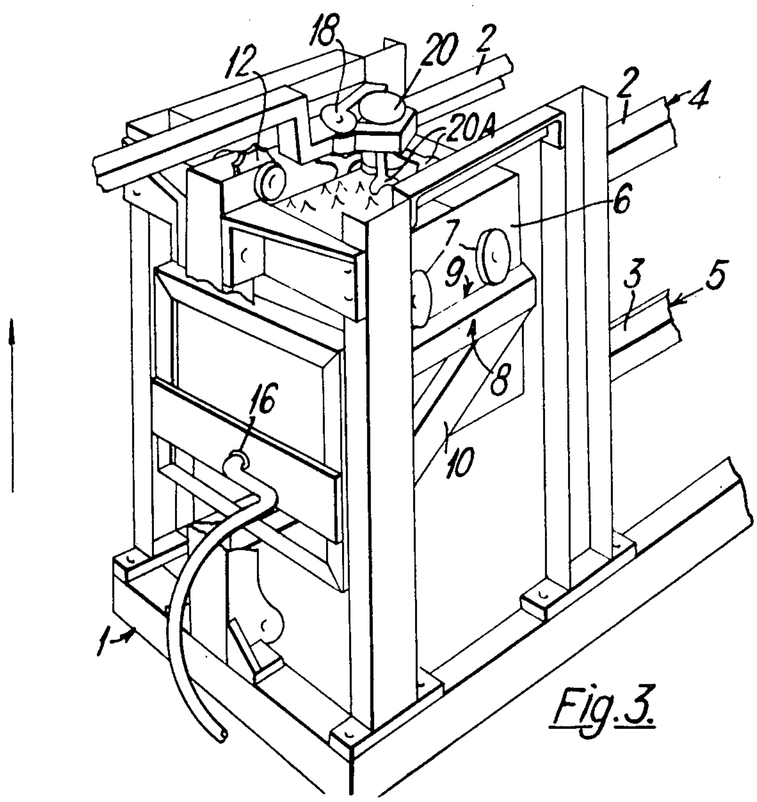

Fig. 3.

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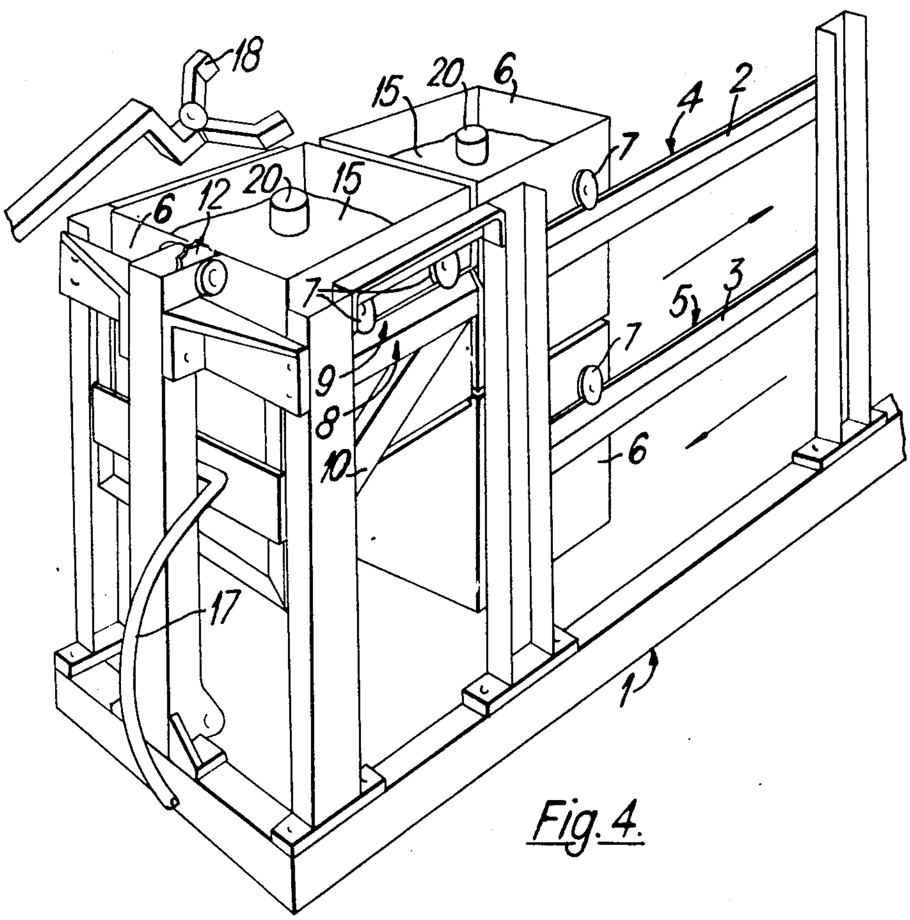

Fig. 4.

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SUPPORT MEANS FOR CERAMIC SHELL MOULDS

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U.S. Cl. 164—324 4 Claims

ABSTRACT OF THE DISCLOSURE

A ceramic shell mold is partially immersed in a fluidized bed of granular refractory material. The bed is then de-fluidized so that the shell mold is firmly embedded in readiness to receive a charge of molten metal.

This invention relates to methods of, and means for, supporting ceramic shell moulds while molten metal is poured into them, as in the process of investment casting.

In the process of investment casting, a wax pattern of the article which is to be cast in metal is first produced in an injection-moulding die, and is then subjected to a sequence of operations which result in its receiving (in addition to repeated coatings of slurry) several coatings of powdered ceramic material. The ceramic shell progressively formed in that way is dried, the wax is removed by melting, and then the shell is fired to produce the finished shell mould which is now ready for receiving its charge of molten metal.

As the ceramic shell mould is rather thin-walled, it is necessary to arrange for it to be adequately supported so that it is able to withstand the charge of molten metal. This may be accomplished by manually packing a granular refractory material around the mould, but this expedient is hardly appropriate in the case of an automatic flow-production investment casting plant.

According to this invention a method of supporting a ceramic shell mould while it receives a charge of molten metal comprises: fluidizing a bed of a granular refractory material, partially immersing the shell mould in the fluidized bed, and then de-fluidizing the bed so that the shell mould is held firmly embedded in readiness to receive the charge of molten metal. More specifically, the preferred method comprises initially positioning the ceramic shell mould above the fluidized bed, and then raising the bed to effect the partial immersion of the shell mould.

In order to enable the invention to be employed in an automatic flow-production investment casting plant, a fluidized bed conveyor incorporating the invention has been devised. It comprises: two pairs of horizontal rails spaced apart vertically to form top and bottom rail tracks; a plurality of tanks, each containing a bed of granular refractory material, mounted for indexing movement along the tracks; a pair of automatic lifts, each incorporating a section of the rail tracks, located at opposite ends of the tracks and arranged to operate in phase with each other; separate indexing means pertaining to the respective tracks; and means effective automatically to fluidize the bed in a tank while it is being raised from the bottom track by one of the lifts.

Referring to the accompanying drawings:

FIG. 1 is a schematic broken side elevation of a fluidized bed conveyor incorporating the invention, and enabling it to be employed in an automatic flow-production investment casting plant; and

FIGS. 2, 3 and 4 are fragmentary perspective views depicting various stages in the operation of the fluidized bed conveyor shown in FIG. 1.

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The fluidized bed conveyor illustrated, which consistitutes part of an automatic investment casting plant, has an open frame **1** of rectangular box-like form. This frame incorporates two pairs of horizontal rails **2** and **3**, spaced apart vertically to form top and bottom tracks **4** and **5** upon which tanks **6** containing sand are individually supported by rollers **7** that run on the respective rails. At the loading end of the conveyor there is an automatic lift **8** by which each of the tanks **6**, in turn, is raised from the bottom track **5** to the level of the top track **4**. At the unloading end of the conveyor there is an automatic lift **9** by which each of the tanks **6**, in turn, is lowered from the top track **4** to the level of the bottom track **5**. The two lifts **8** and **9** are of identical construction, each comprising a section of the rail tracks supported by a pair of struts **10**, and are operated pneumatically. Each lift is mounted on one end of a chain **11** that passes around idler sprockets **12**, the other end of the chain being coupled to the piston of a pneumatic cylinder **13**. Although the lifts **8** and **9** are operated by separate pneumatic cylinders **13**, and separate chains **11**, they are arranged to work in phase with each other. That is to say, they rise and descend together and are at the same level at any time.

In a manner which will be described later, the conveyor indexes the tanks **6** along the top track **4** from left to right in FIG. 1, and along the bottom track **5** from right to left. Either of the lifts **8** and **9** can only receive one of the tanks **6** when another tank is simultaneously moved out of the other lift.

When the conveyor indexes the tanks **6** along the bottom track **5**, the lift **8** is at the level of that track (see FIG. 2). Each of the tanks **6** has a false bottom which is constituted by a porous ceramic tile **14** (FIG. 1). A bed of sand **15** rests upon this tile, and the left hand end of the tank has an air inlet located below the tile **14**. This air inlet, through a taper union connection **16**, becomes automatically connected to a flexible compressed air line **17** by the final stage of movement of the tank **6** onto the lift **8**. The bed of sand is now fluidized by the air bubbling through it. The air escaping from the top of the bed tends to create tiny mounds on the surface of the sand, as depicted in FIGS. 2 and 3.

By means of a mechanical hand **18**, which has moved downwardly along the path indicated at **19** (FIG. 1), a ceramic shell mould **20** (which is depicted as having branches **20A**) has been withdrawn from a furnace in which it was fired, and is held in position over that tank **6** which is shown in FIG. 2. Although FIG. 1 indicates (at **21**) part of the mechanism for operating the mechanical hand **18**, this mechanism need not be described as it is not relevant to the invention.

FIG. 3 depicts the lift **8** during its ascent from the bottom track (FIG. 2) to the top track. When this lift reaches the top of its travel (FIG. 1), the shell mould **20** has become partially immersed in the fluidized sand. The bed of sand **15** is then de-fluidized, by shutting off the air supply to the line **17**, and the mechanical hand **18** releases and withdraws (see FIG. 4). The shell mould **20**, which is held embedded in, and firmly supported by, the sand immediately the aeration of the bed has been stopped, is now ready to receive its charge of molten metal (which is poured at another station on the top track **4**).

The conveyor now indexes the tanks **6** on the top track **4**. This is accomplished by a pair of pneumatic cylinders **22** disposed at opposite sides of the top track **4**; a piston rod **23** of each cylinder having at its outer end an L-shaped bracket **24** that embraces the corresponding corner at the trailing end of the tank **6** which is on the lift **8**. As that tank is moved, by the brackets **24**, it releases itself from the air-connection **16** and pushes the other tanks on the top track **4** one stage forward, so that the endmost tank is moved onto the lift **9** simultaneously with the lift **8** becoming empty. Upon completion of the indexing, the pneumatic cylinders **22** return the brackets **24** to their starting position. The charged shell mould **20** is now removed from the tank on the lift **9**, and transferred to a cooling conveyor (not shown). Both lifts **8** and **9** are then lowered to the level of the bottom track **5**.

The next operation is that the tanks **6** on the bottom track **5** are indexed from right to left in FIG. 1. This is effected by a pneumatic cylinder **25** that has the outer end of its piston rod **26** fitted with an upright plate-like bracket **27** which is engageable with the outer end of the tank **6** that has been lowered by the lift **9**. As that tank is moved, by the bracket **27**, it pushes the other tanks on the bottom track **5** one stage forward, so that the endmost tank is moved onto the lift **8** simultaneously with the lift **9** becoming empty. The final stage of movement of that tank onto the lift **8**, as has already been explained, results in the bed of sand becoming fluidized. Upon completion of the indexing of the tanks **6** on the bottom track **5**, the pneumatic cylinder **25** returns the bracket **27** to its initial position.

The arrangement is such that the total of the tanks **6** must be an odd number, and, upon completion of each indexing movement, there must always be two superposed vacant places at one end of the conveyor and a third vacant place at its other end. It is also to be noted that if, for example, the total number of the tanks **6** is nine then, at any given time, five of them are located on either the top track **4** or the bottom track **5** (as the case may be).

When the mechanical hand **18** has brought another shell mould **20** into position above the lift **8**, the cycle of operations is repeated.

We claim:

1. Means for supporting a ceramic shell mould while it receives a charge of molten metal, said means comprising: two pairs of horizontal rails spaced apart vertically to form top and bottom rail tracks; a plurality of tanks, each containing a bed of granular refractory material, and mounted for indexing movement along the tracks; a pair of automatic lifts, each incorporating a section of the rail tracks, located at opposite ends of the tracks and arranged to operate in phase with each other; separate indexing means for each track; means for automatically fluidizing the bed in a tank while it is being raised from the bottom track by one of the lifts; mechanical means which holds the shell mould above the ascending fluidized bed so that the shell mould becomes partially immersed therein when the corresponding lift reaches the top of its travel; and means for automatically de-fluidizing the bed after the shell mould has been partially immersed therein.

2. Supporting means according to claim **1**, comprising at least one pneumatic cylinder for operating said lifts, each lift being mounted on one end of a chain that passes around idler sprockets, the other end of the chain being coupled to the piston of a pneumatic cylinder.

3. Supporting means according to claim **1** in which said separate indexing means comprise a pair of pneumatic cylinders disposed at opposite sides of the top track, and a single pneumatic cylinder for advancing a tank along the bottom track.

4. Supporting means according to claim **1** in which each tank has, near its bottom, an air inlet which, through a taper union connection, becomes automatically connected to a flexible compressed air line by the final stage of movement of the tank onto that lift by which the tank ascends from the bottom to the top track.

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