



PATENT SPECIFICATION

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(54) Title: A pressure forming machine for a thermoplastics material

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A pressure forming machine for a thermoplastics material

This invention relates to a pressure forming machine for a thermoplastics material and, in particular, to a pressure forming machine for forming sheets of thermoplastics material.

5 A pressure forming process is more generally described as being a type of thermoforming process. Thermoforming is a method of shaping a thermoplastics sheet to conform to the contours of a mould through the application of heat and pressure. Two types of process are employed viz. vacuum forming and pressure forming. Both processes employ the same
10 basic process steps of sheet clamping, heating and forming. However, the vacuum forming process uses a negative pressure between the thermoplastics sheet and the mould, whereas the pressure forming process uses a positive pressure on the side of the thermoplastics sheet remote from the mould in addition to a negative pressure between the
15 sheet and the mould.

Pressure forming is used in preference to vacuum forming, where it is important for the sheet to pick up the finer details of the mould. The application of positive pressure has the effect of pushing the sheet material fully into any recesses in the mould to produce sharper features
20 on the finished product. The process involves the steps of clamping a sheet of thermoplastics material in the machine, heating the thermoplastics sheet to a controlled softening temperature, stretching the sheet to conform to the mould contours and cooling the formed sheet to a temperature at which the sheet becomes rigid and maintains a desired

shape for the formed product. The formed product is then removed from the machine to undergo further processing steps, such as trimming and fabrication, to produce the finished product.

Each step in the forming process has a bearing on the quality of the finished product. The quality of the thermoplastics sheet material, the heating processes, the forming parameters and the cooling conditions must all be monitored and controlled to obtain quality products.

A pressure forming machine is known, which is manufactured by ZMD International, Inc., of Long Beach, CA 90813, U.S.A., and sold under the model number HT-400CPF. This machine has features in common with other known pressure forming machines. Thus, it features an upper platen and an opposed lower platen, one or both of which carries a mould. In use, a sheet of thermoplastics material is clamped in a space between the two platens. An upper and lower heating unit is introduced to each side of the sheet and the sheet is heated to the required temperature.

Once the sheet has reached the required temperature the heater units are withdrawn and the upper and lower platens are driven towards each other and sandwich the sheet therebetween. The machine also includes a pressure plate, which seals in the sheet and the mould so as to enable air at high pressure to be applied to the sheet in order to force it onto the mould. The sealing of the pressure plate is achieved by the addition of a suitable number of inflatable air bags that cover the whole forming area. This means that high-pressure air can be applied to the

sheet and that this air pressure can be distributed evenly thereover. At the same time the air between the sheet and the mould is withdrawn under vacuum, to further assist in the forming process.

In order to ensure that the opposed platens stay together while the high-pressure air is being applied it is necessary to include a heavy duty locking system.

As described above, each stage in the forming process is important. Thus, a problem, which can arise with the use of a machine as described above, is that any delay between the time when the sheet reaches optimum temperature to the time when the sheet is applied to the mould can be critical. A delay of time at this stage can cause the sheet to sag, causing stretching, which will affect the final thickness of the formed product. A delay of time after the heating units have been withdrawn can also cause the sheet to cool down, which will affect the quality of the formed product.

It is an object of the present invention to overcome the disadvantages of the machines as hereinbefore described.

Thus, the invention provides a pressure forming machine for a sheet of thermoplastics material, comprising a pair of opposed platens, a mould mounted on one of the platens, means for moving the opposed platens between a resting position, wherein the platens are spaced apart and a pressure forming position, wherein the platens are close together, means for holding the sheet in the machine, in use, means for heating

each side of the sheet, and pressure means for pushing the heated sheet onto the mould, characterised in that the heating means is a pair of heating units positioned to one side of the opposed platens, and in that the holding means is movable between a sheet loading position remote
5 from the opposed platens, a heating position between the pair of heating units and a moulding position between the opposed platens.

The positioning of the pair of heating units to one side of the platens together with the movement of the holding means has the advantage that the time between the heating of the sheet and the
10 contacting of the heated sheet with the mould is shortened in comparison with the prior art machine.

In the prior art machine it is the heating units, which move backwards and forwards, whereas in the machine according to the invention it is the sheet of thermoplastics material, which is moved. In
15 conventional machines the movable heating units can get damaged over time and thus, another advantage of the heating units being stationary is that they are less likely to be damaged in use.

Another benefit of this arrangement is that the machine will have less moving parts than the prior art machine, with an attendant reduction
20 in manufacturing and running costs.

Preferably, the holding means is an open frame, within which the sheet is held in use, the frame being suspended from a track along which it moves between the various holding positions.

An advantage of having an open frame is that it simplifies the loading and unloading of the thermoplastics sheet in the machine. The sheet also remains held in the open frame in the pressure forming position while the thermoplastics sheet is formed.

5 Another advantage is that the thermoplastics sheet can be moved quickly between the heating means and the pressure forming position so that the thermoplastics sheet has less opportunity to cool down before being formed and this prevents the attendant loss of quality of the formed product.

10 Further, preferably, one platen is fixed whereas the opposed platen is movable and the means for moving the opposed platens causes the sheet to be brought into contact with the mould as the platens are moved into the pressure forming position.

An advantage of this arrangement is that, since only one platen
15 moves, the machine, according to the invention, will have less moving parts than the prior art machine, with an attendant reduction in manufacturing costs.

In one embodiment of the machine according to the invention, the means for moving the opposed platens holds the sheet in sufficient
20 contact with the mould in the pressure forming position that a separate locking means is not required to keep the movable platen in place while the pressure means is pushing the sheet onto the mould.

The conventional method of locking the opposed platens together while pressure is being applied to the sheet, means that there is a further step in the process between the conveying of the heated sheet to the mould and the application of pressure to the sheet, with the attendant problems associated with any time delay. Thus, the machine, in accordance with the invention demonstrates a further advantage over a conventional machine in that a locking step is not required.

Preferably, the means for moving the opposed platens is driven by a hydraulic cylinder coupled to a pressure intensifier, which cuts in as the platens reach the pressure forming position and remains on during the operation of the pressure means.

The seal, thus created, will withstand air pressure up to 14 bar without any leakage of air. Thus, the pressure, which can be applied to the sheet of thermoplastics material is higher than that applied in conventional machines, resulting in an improved formed sheet.

This system of bringing the heated sheet into contact with the mould helps to minimise the time taken for this task and ensures that the opposed platens stay together while the pressure means is pushing the sheet onto the mould.

Furthermore, the addition of a number of inflatable airbags is not required to achieve the required sealing of the machine as the high pressure air is applied. This results in a further saving of time over the conventional machine.

Preferably, the pressure intensifier uses compressed air to provide the pressure intensification.

In a further aspect of the invention, the movable platen is counterbalanced to assist in the conveying of the heated sheet to the
5 mould.

It will be appreciated that the opposed platen has to be lifted up in order to bring the heated sheet into contact with the mould. Thus, by adding a counterbalance to the weight of the opposed platen, the force required to lift the platen is reduced.

10 Another advantage of the counterbalance is that the conveying action is fast yet smooth, which minimises any risk of distorting the heated sheet as it is conveyed to the mould.

The invention will be further illustrated by the following description of an embodiment thereof, given by way of example only
15 with reference to the accompanying drawings in which:

Fig. 1 is a side elevation in cross-section of a pressure forming machine for a sheet of thermoplastics material, according to the invention, with an open frame in a sheet loading position;

Fig. 2 is a side elevation in cross-section of the pressure forming
20 machine of Fig. 1, with the open frame in a heating position;

Fig. 3 is a side elevation in cross-section of the pressure forming machine of Fig. 1, with the open frame in a moulding position between two opposed platens;

Fig. 4 is a side elevation in cross-section of the pressure forming machine of Fig. 1, with the two opposed platens in a pressure forming position;

Fig. 5 is a front elevation of the pressure forming machine of Fig. 4; and

Fig. 6 is a side elevation in cross-section of the pressure forming machine of Fig. 1, following the pressure forming process.

Referring to the figures, there is illustrated generally at 10, a pressure forming machine, according to the invention, for a sheet of thermoplastics material and the sequence of steps in a pressure forming process using the machine 10.

Referring to Fig. 1, in particular, the machine 10 has an upper press structure 11, and a lower press structure 12. The machine is supported at each corner thereof by a leg 13 (see Fig. 5, these legs 13 have been removed from the remaining figures for the purposes of clarity). Two opposed platens 14, 15 are mounted on the upper press structure 11 and the lower press structure 12, respectively. A generally rectangular mould 16 is mounted on platen 15. A means for holding a sheet 17 of thermoplastics material, in the machine 10 is shown generally at 18, and takes the form of a rectangular open frame 19, having a plurality of

sheet-holding clamps 20, mounted thereon. The open frame 19 is suspended from a rail 21, by a pair of carriages 22, 22', the open frame 19 being free to move along the rail 21. The open frame 19 supports the sheet 17 of thermoplastics material, during the successive stages of the pressure forming process.

An upper heating unit, 23 and a lower heating unit 24 are positioned to the side of the upper press structure, 11 and the lower press structure, 12. To each side of the upper press structure, 11, a pair of hydraulic cylinders 25 and, 25' are mounted and are connected to the lower press structure 12 by a pair of connecting rods 26, 26', respectively, the rods 26, 26' being held thereto by nuts 27 and 27', respectively.

Referring to Fig 2, the machine 10 is illustrated with the holding means 18 in a heating position between the two opposed heating units 23 and 24. The sheet 17 is heated to the required temperature and once this is reached the holding means 18 moves along the rail 21, into the pressure forming position between the two opposed platens 14 and 15 (see Fig. 3).

Once the holding means 18 has moved to the forming position the hydraulic cylinders 25, 25' are activated and the lower press structure 12, is raised towards the upper press structure 11, and brings the sheet 17 with it.

As the lower press structure 12 is about to meet the upper press structure 11 a pressure intensifier (not shown), coupled to the pair of hydraulic cylinders 25, 25', cuts in with the effect of firmly closing the opposed platens 14 and 15 together during the application of high
5 pressure to the sheet 17. In the pressure forming position the sheet 17 is sandwiched between the mould 16 and a pressure box 28 mounted on the platen 14. The mould 16 abuts a pressure box 28 creating a tight seal.

Referring to Fig. 4, the machine 10 is illustrated with the opposed platens 14, 15 closed together in the pressure forming position. High-
10 pressure air has been applied to upper side 29 of the sheet 17, with the effect of pushing the sheet 17 onto the mould 16 to conform to the contoured shape thereof. The pressure intensifier (not shown) is forcing the opposed platens 14, 15 together during this forming step and at the same time a vacuum is being applied between the sheet 17 and the mould
15 16 to assist in the forming process.

Referring to Fig 5, the pressure forming machine 10 is viewed from the front with the platens in the pressure forming position. It can be seen that the pair of carriages 22, 22' are accommodated in respective recesses 30 and 30' in the lower platen 15. At the same time the open
20 frame 19 has slid up the carriages 22, 22'. In this figure two legs 13, of the set of four legs 13 can be seen. The legs 13 are attached to the upper press structure 11 by spacers 31.

Referring to Fig. 6, the machine 10 is illustrated following completion of the forming process. The lower press structure 12 has

been lowered away from the upper press structure 11 and the formed sheet 17 is awaiting retrieval from the machine 10. The pair of connecting rods 26, 26' have been removed for clarity in this illustration.

It will be appreciated that the known problems relating to the time
5 between the removal of heat from sheet 17 and the contacting of sheet 17
with the mould 16 are minimised by the arrangement and functioning of
the component parts of the machine 10. Also, since only the lower press
structure 12 has to be moved during the forming process and since the
mould 16 is carried on the lower press structure 12, the complexity of the
10 machine 10 is simplified and its weight reduced when compared to the
known machine.

Claims: -

1. A pressure forming machine for a sheet of thermoplastics material, comprising a pair of opposed platens, a mould mounted on one of the platens, means for moving the opposed platens between a resting
5 position, wherein the platens are spaced apart and a pressure forming position, wherein the platens are close together, means for holding the sheet in the machine, in use, means for heating each side of the sheet, and pressure means for pushing the heated sheet onto the mould, characterised in that the heating means is a pair of heating units
10 positioned to one side of the opposed platens, and in that the holding means is movable between a sheet loading position remote from the opposed platens, a heating position between the pair of heating units and a moulding position between the opposed platens.

2. A pressure forming machine according to Claim 1, wherein
15 the holding means is an open frame, within which the sheet is held in use, the frame being suspended from a track along which it moves between the various holding positions and wherein one platen is fixed, the opposed platen is movable and the means for moving the opposed platens causes the sheet to be brought into contact with the mould as the
20 platens are moved into the pressure forming position.

3. A pressure forming machine according to Claim 2, wherein the means for moving the opposed platens holds the sheet in sufficient contact with the mould in the pressure forming position that a separate

locking means is not required to keep the movable platen in place while the pressure means is pushing the sheet onto the mould.

4. A pressure forming machine according to any preceding claim, wherein the means for moving the opposed platens is driven by a
5 hydraulic cylinder coupled to a pressure intensifier, which cuts in as the platens reach the pressure forming position and remains on during the operation of the pressure means.

5. A pressure forming machine according to Claim 1,
substantially as hereinbefore described, with particular reference to and
10 as illustrated in the accompanying drawings.

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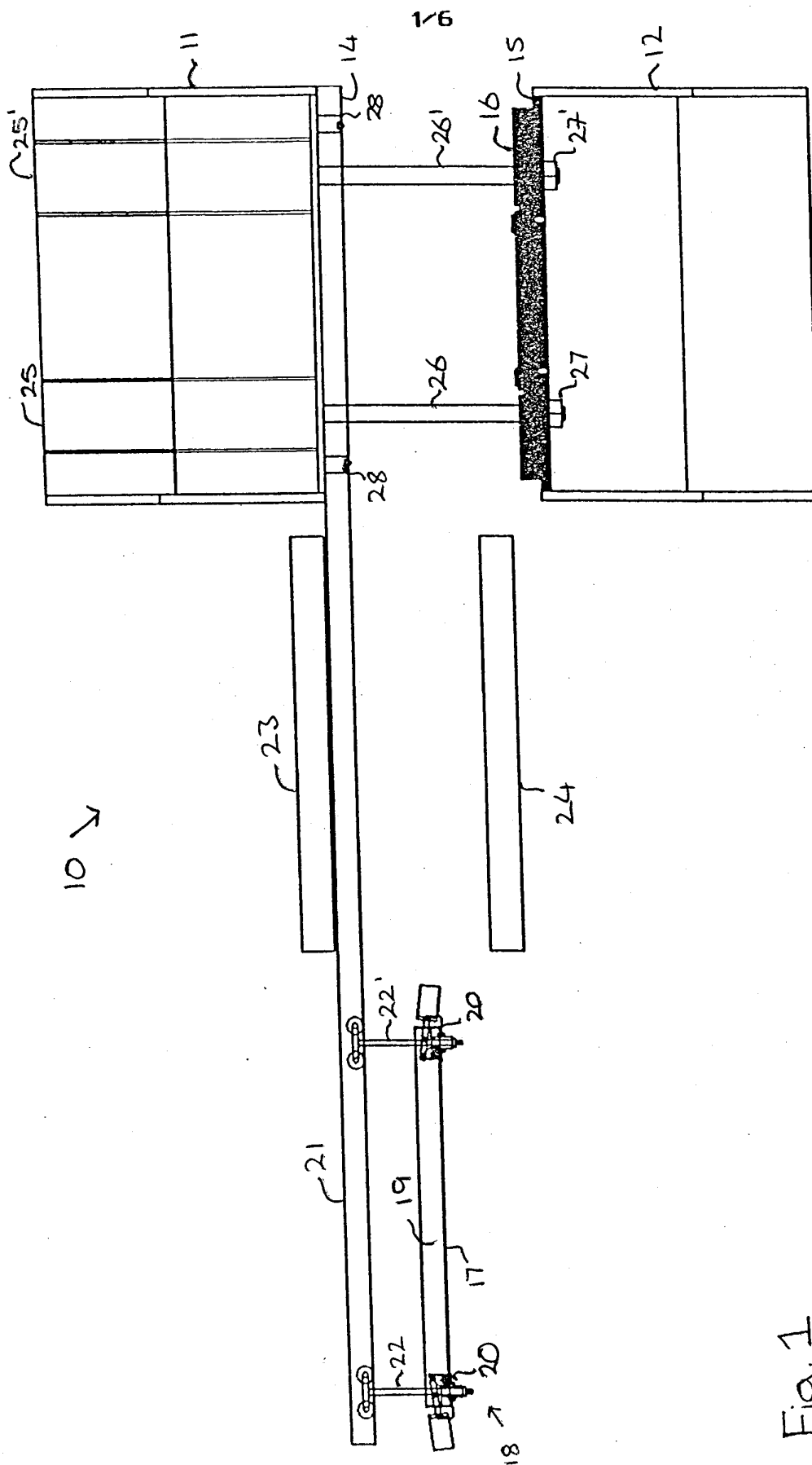


Fig. 1

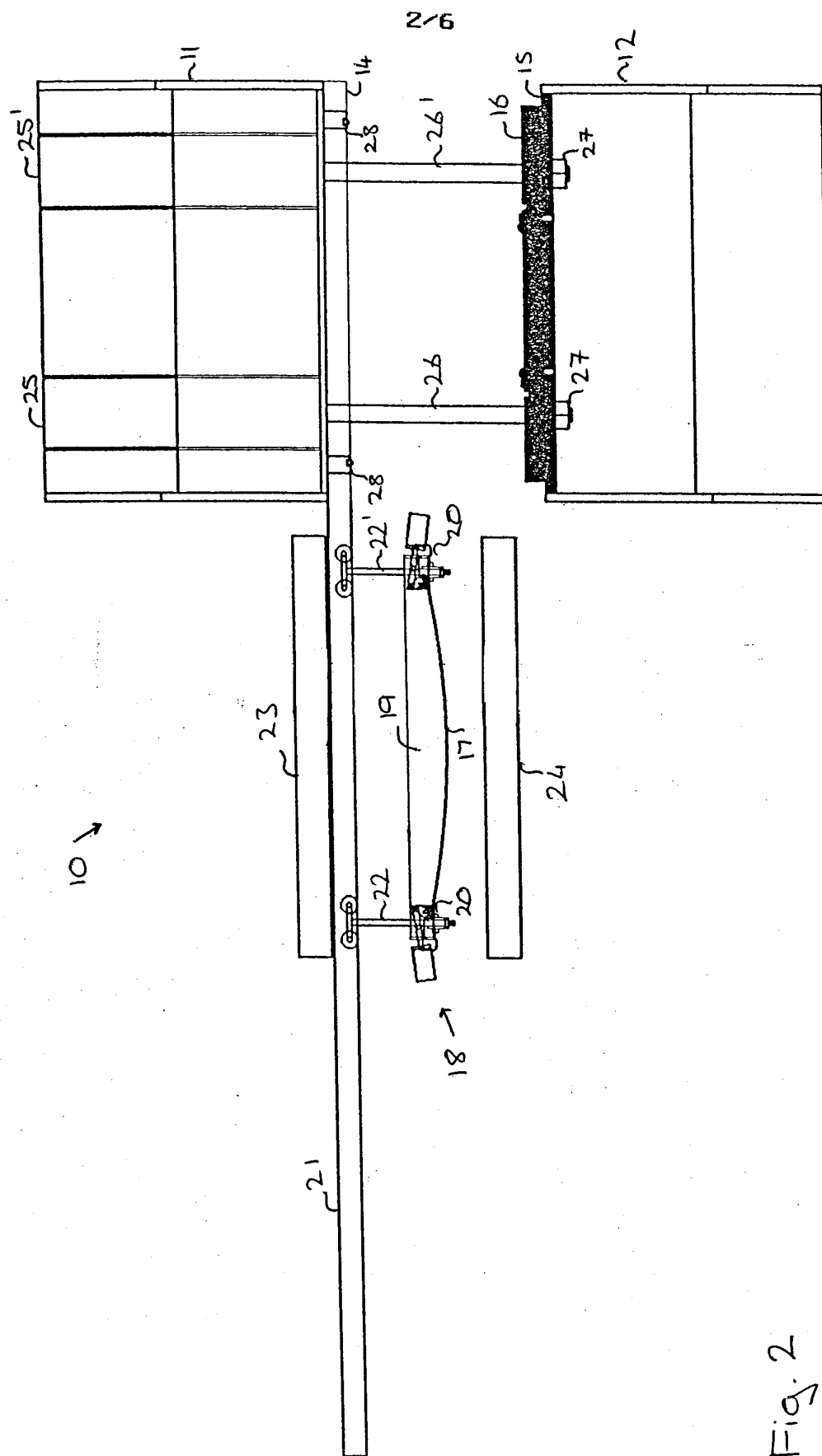
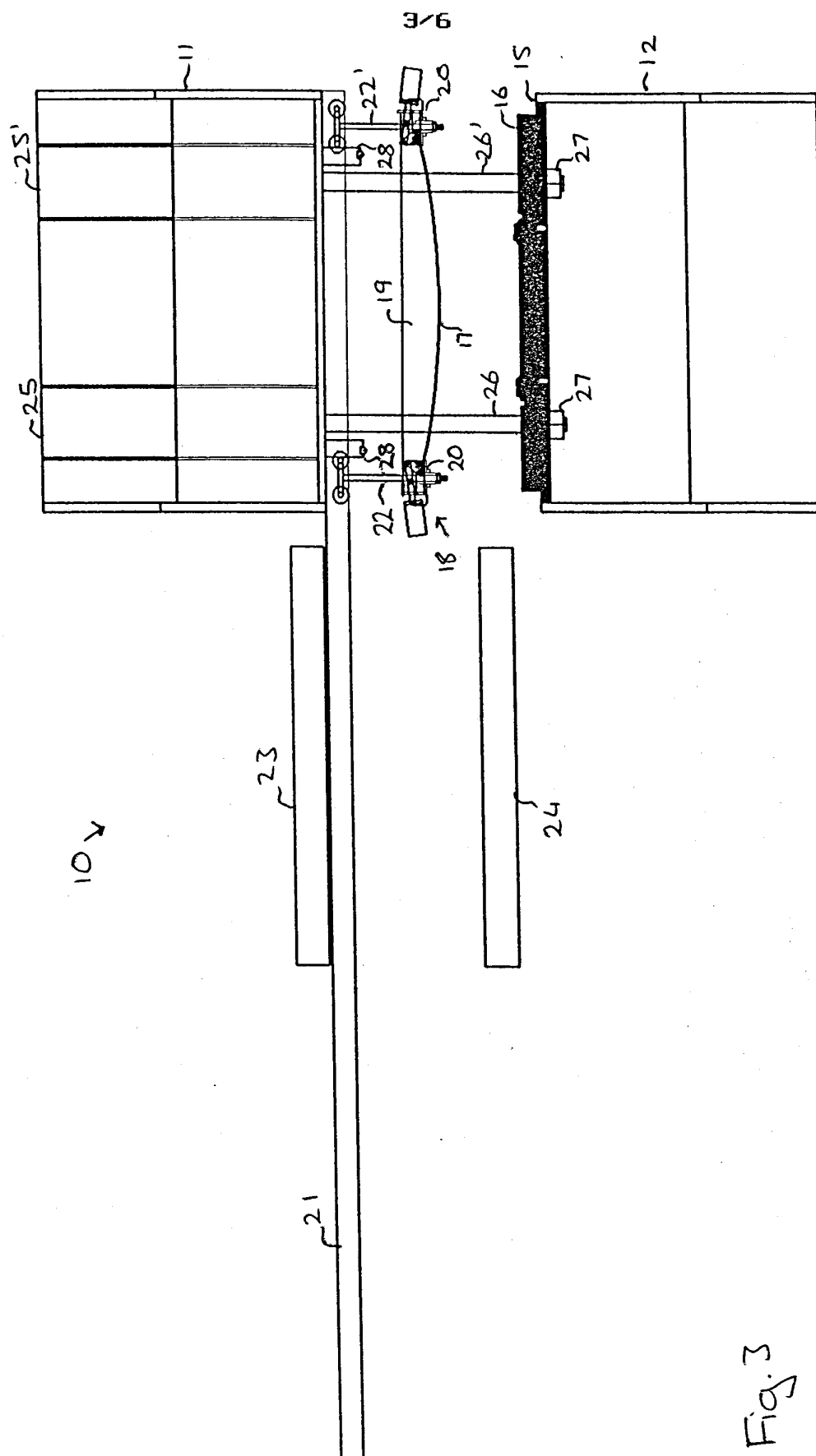


Fig. 2



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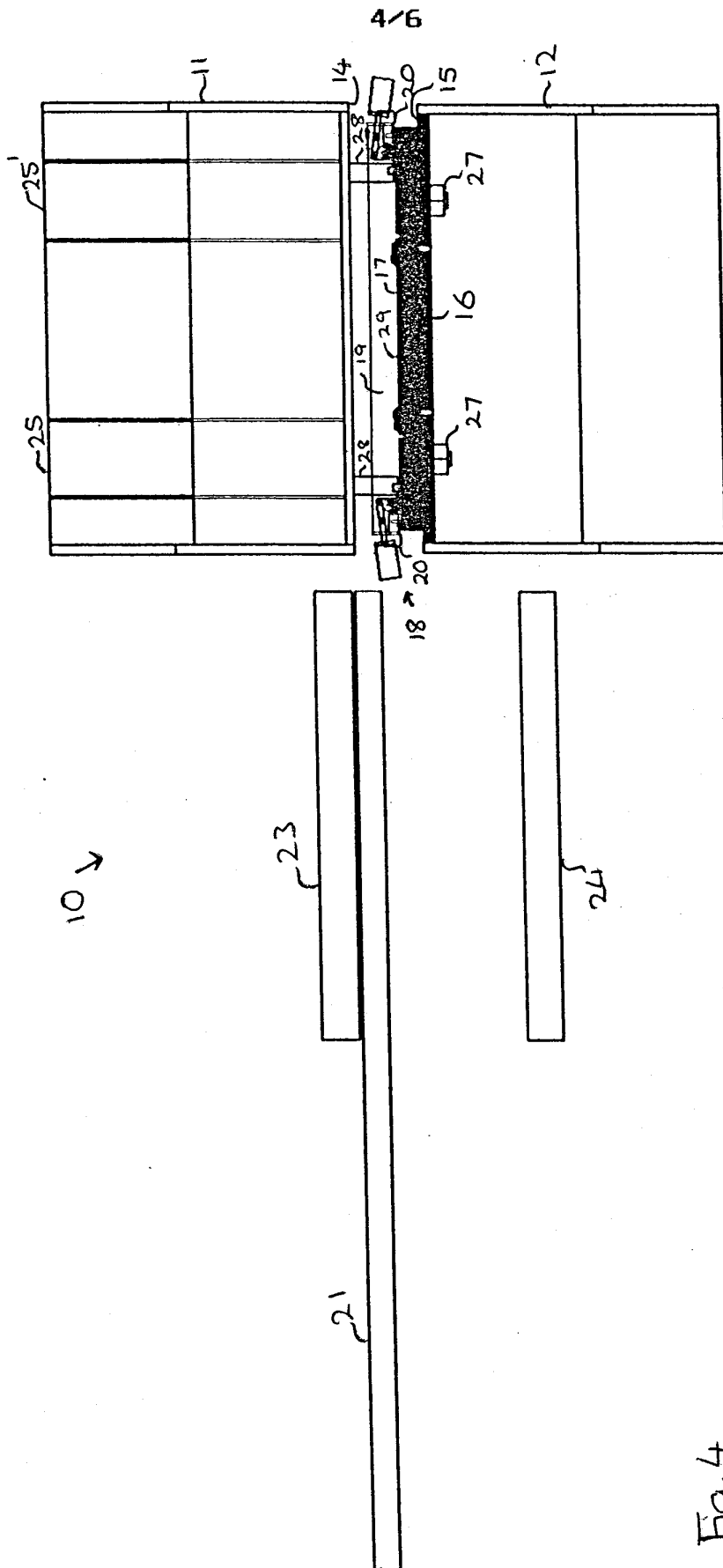


Fig. 4

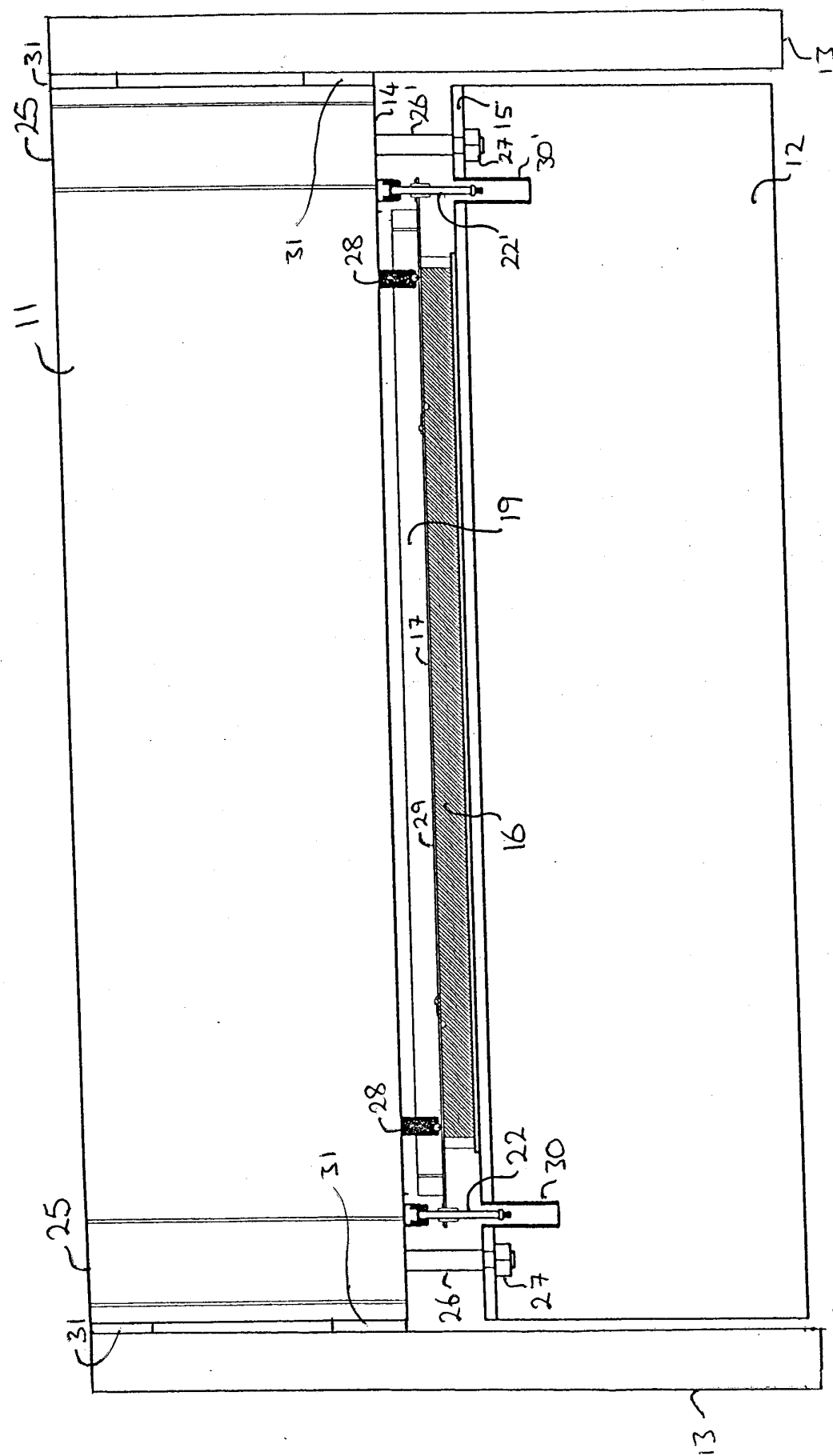
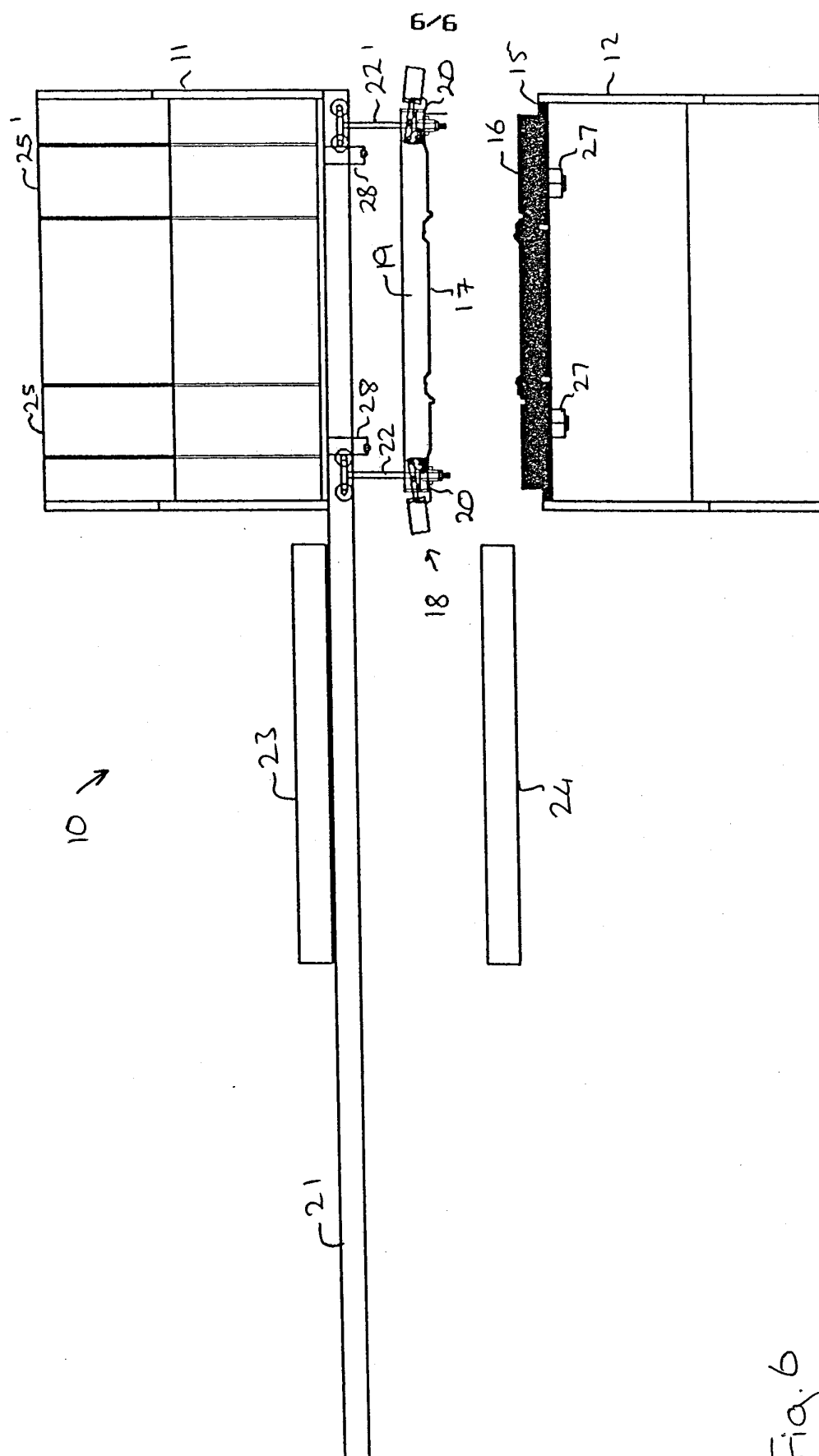


Fig. 5



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