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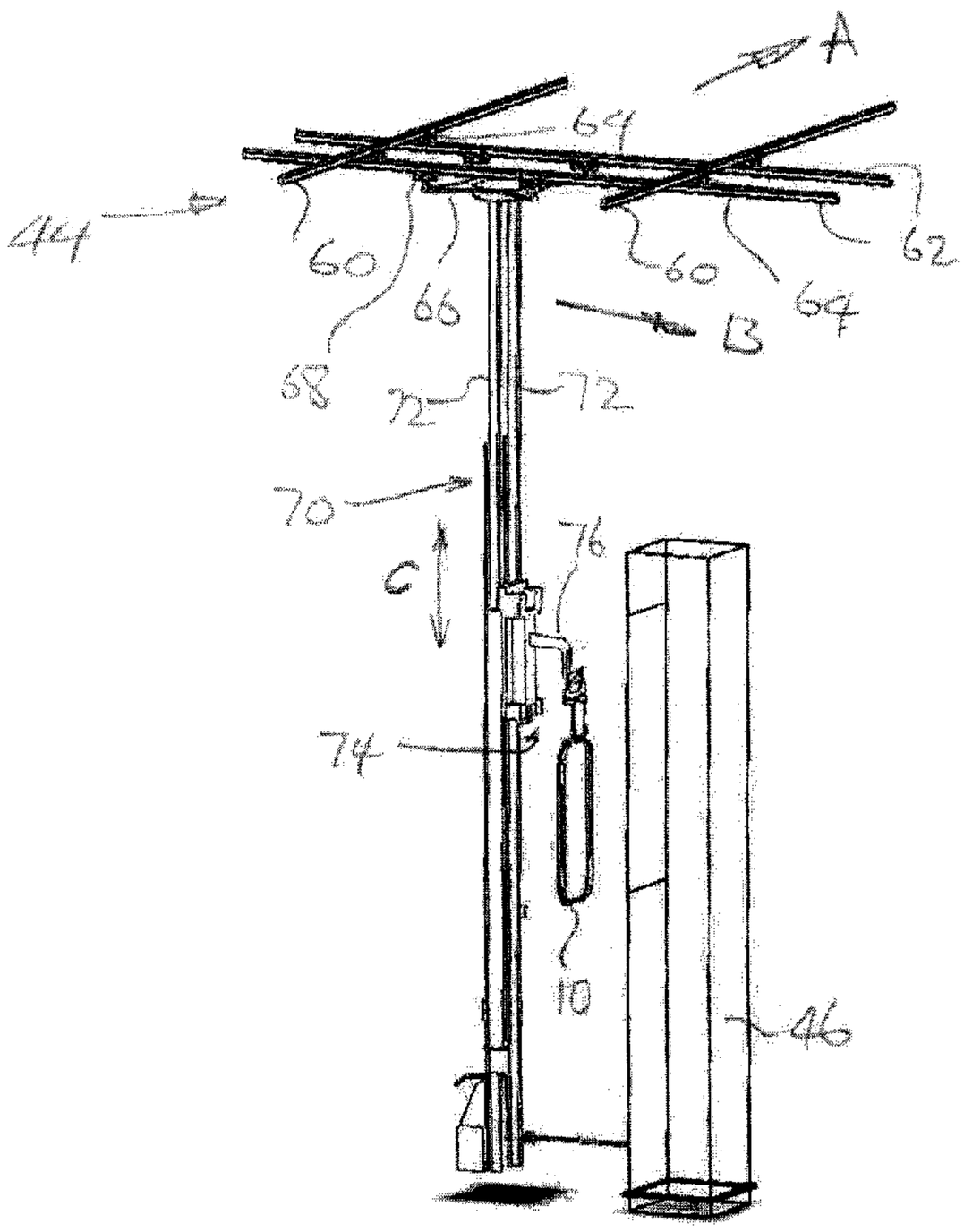
(72) **Inventeur/Inventor:**
BAMFORD, BRAD, CA

(73) **Propriétaire/Owner:**
AUTOMATIC COATING LIMITED, CA

(74) **Agent:** BLAKE, CASSELS & GRAYDON LLP

(54) **Titre : APPAREIL DE REVETEMENT**
(54) **Title: COATING APPARATUS**




(57) **Abrégé/Abstract:**
A component such as a door is coated by immersion in a fluidized bed. The component is supported by a hook assembly that moves the component within the fluidized bed during coating. The movement is cyclical and inhibits bridging of the coating material when applied to intricate articles.

**Abstract**

A component such as a door is coated by immersion in a fluidized bed. The component is supported by a hook assembly that moves the component within the fluidized bed during coating. The movement is cyclical and inhibits bridging of the coating material when applied to intricate articles.

# COATING APPARATUS

## FIELD OF THE INVENTION

**[0002]** The present invention relates to a method and apparatus for applying a coating to a component.

## SUMMARY OF THE INVENTION

**[0003]** Most fabricated articles require a coating to be applied to protect them against the environment in which they will operate. One of the most demanding environments is salt water, as encountered on seagoing vessels, in which mechanisms and components must be protected again the corrosive effects of the salt carried in the sea water. The maintenance of the components is an expensive and continuous process. Painting or coating of components is performed prior to exposure, but even then frequent replacement of intricate components where salt water may be trapped is necessary.

**[0004]** One particular application that has proven difficult to properly maintain is the sealing systems found on watertight doors used on seagoing vessels. The seals are contained within a channel formed from a lip of the door and a weldment to contain the seal. This construction provides various crevices in which protective coatings are difficult to apply and in which seawater tends to collect in use leading to rapid corrosion of the seal system and failure of the door.

**[0005]** It is known to apply coatings through the use of fluidized beds to components as shown for example in United States Patent No. US 6,444,032. The coating of a door assembly with a seal retention system does however pose further challenges, in particular because of the intricate nature of the seal retention system.

OBJECT OF THE INVENTION

**[0006]** It is therefore an object of the present invention to obviate or mitigate the disadvantages found in prior systems.

SUMMARY OF THE INVENTION

**[0007]** According to the present invention there is provided a method of applying a coating to a component which comprises steps of positioning said component adjacent to a fluidized bed, immersing the component into the fluidized bed to apply a coating thereto, moving the component within the fluidized bed during application of the coating, removing the component from the fluidized bed.

**[0008]** Embodiments of the invention will now be described by way of example only with reference to the accompanying drawings in which

**[0009]** Figure 1 is a schematic representation of a process flow for coating a component.

**[0010]** Figure 2 is a perspective view of a transfer and coating apparatus shown in figure 1.

**[0011]** Figure 3 is an enlarged perspective view of a portion of the apparatus shown in figure 2.

**[0012]** Figure 4 is a view on the line IV-IV of figure 3.

**[0013]** Figure 5 is a front view of the apparatus shown in figure 4.

**[0014]** Figure 6 is a top view of the apparatus shown in figure 4.

**[0015]** Figure 7 is a view similar to figure 1 of an alternative process.

**[0016]** Figure 8 is a perspective view of a component to be coated by the process of figures 1 or 7.

**[0017]** Figure 9 is a section on the line IX-IX of figure 8.

**[0018]** Figure 10 is a flow chart showing a sequence of steps performed in reconditioning a component.

**[0019]** Figure 11 is a view similar to figure 8 of another embodiment.

**[0020]** Referring firstly to figure 8, a component 10 that is to be coated is in the form of a door having an outer surface 12, and a frame 14. On the frame 14 there is provided a seal retainer 18 that carries a seal assembly (not shown) and cooperates with a door frame. The seal retainer 18 is formed as a channel in which a seal sits and has an overturned lip and a flange welded to the frame 14 to define the channel. The channel is of convoluted configuration and is therefore difficult to coat in a manner that fills the voids between the retainer 18 and the frame 14. It will be appreciated that the door is merely exemplary of the components that may be coated and is itself of known construction.

**[0021]** Referring to figure 1, a coating process for the component 10 is shown in which the component 10 is moved between different stations by an overhead conveyor indicated at 20. The conveyor 20 is a conventional chain conveyor with hangers that allow components to be suspended from the conveyor. The hanger is shown in figure 8 and has a body 22 with a pair of hooks 24 extending upwardly for engagement with the conveyor 20. The body 22 has central aperture 26 with a series of lower hooks 28 extending below a lower edge 30 of the body 22. The lower hooks 28 have upturned ends to engage a lip on the upper edge of the frame 14. The exact form of the hangers 22 will vary depending upon the nature of the component 10 but, as is standard practice, seek to minimise the footprint of the suspension system on the component 10.

**[0022]** Referring again to figure 1, the conveyor 20 moves the component 12 through an oven 40 to a transfer station 42. At the transfer station 42 the component 10 is transferred onto a lateral conveyor 44, to be described in more detail below so that it may be transferred into alignment with a fluidized bed 46. The lateral conveyor 44 positions the component within the fluidized bed for a predetermined time and then retracts the component and transfers it to an air blow off station 48. The purpose of the air blow off station is to remove surplus coating deposited by the fluidized bed. The component 10 is then transferred by the conveyor 44 back to the conveyor 20 which moves the component through an electrostatic coating station 50. A further coating is applied at coating station 50 to that applied in the fluidized bed and the conveyor carries the component through into a curing oven 52.

**[0023]** The lateral conveyor 42 can best be seen in figure 2 and comprises a pair of support rails 60 that extend between the transfer station 42 and the curing station 52. The support rails 60 carry a pair of tracks 62 on rollers 64 so that the tracks 62 can move along the rails 60 in unison as indicated by arrow A. A turntable 66 is mounted on the track 62 through rollers 68 that allow the carriage 66 to move along the axis of the tracks 62 as indicated by arrow B. The combination of the rails 60 and track 62 allow the carriage to move in orthogonal axes for positioning relative to the various stations involved in the processing of the component.

**[0024]** A mast 70 is rotatably coupled to the turntable 66 and comprises a pair of spaced columns 72 that have a channel cross section. The mast 70 supports a carriage assembly 74 for movement along the axis of the columns 72 as indicated by the arrow C. The carriage assembly 74 has a hook 76 that has a distal end arranged to engage the aperture 26 in the hanger 22.

**[0025]** Referring to the mast 70 in more detail in figures 3 to 6, the columns 72 provide guides for wheels 80. The wheels 80 are rotatably supported upon arms 82 disposed at opposite sides of a base plate 84. A housing 86 is secured to the base plate 84 and has a pair of oppositely directed guides 88 disposed parallel to the channels 72. The hook assembly 76 is slidably mounted within the guides 88 by wheels 91.

**[0026]** An air cylinder 92 is connected between the hook assembly 76 and the base plate 84 and may extend and retract along an axis parallel to the guides 88. A hose 94 supplies pressurised air to the cylinder 92. The hose 94 is connected to a compressor 95 through a valve 96 that can open and close repeatedly through solenoid 98.

**[0027]** Hook 76 extends perpendicular to the base plate 84 and has a downwardly depending body 97 that terminates with an outwardly extending foot 100. A notch 102 is formed on the upper surface of the foot 100 for engagement with the aperture 26 in the bracket 22.

**[0028]** A hoist 110 is located at the upper end of the mast 70 and is operable to raise or lower the carriage 74 through a chain 112. To reduce the load on the chain 112, the carriage 74 is counter balanced by a mass 114 that slides within a tube 116 secured to the outside of one of the channels 72. A cable 118 is connected between the mast 114 and the base plate 84 by

entrainment about a pulley 120. The mass 114 is chosen to be slightly less than the mass of the carriage 74 so that a tension is maintained in the chain 112.

**[0029]** The transverse conveyor 44 is used to transfer the components 10 to the fluidized bed 46. This is performed by engaging the notch 100 within the window 26 of the bracket 22 and operating the hoist to lift the bracket off the conveyor 20. The mast 70 is then moved laterally causing the tracks 62 to move along the rails 60 until the component 10 is aligned with the opening in the fluidized bed 46. The mast 70 is then advanced along the tracks 62 to position the component over the fluidized bed. The carriage 74 may then be lowered allowing the component 10 to become submerged in the fluidized bed of coating material.

**[0030]** To facilitate the uniform and through coating of the component, the actuator 92 is pulsed to oscillate the component 10 along a vertical axis within the fluidized bed and promote the uniform distribution of the coating material over the exterior surface of the component 10. The pulsing of the component 10 provides a cyclic bodily translation of the component within the fluidized bed that distributes the powder of the fluidized bed within the channel and at the same time prevents bridging the powder around the channel. An abrupt change of direction, or deceleration is preferred, that may be effected through the control of the solenoid 98. It has been found that a pulse rate of between 5 pulses per second and 0.5 pulses per second has provided satisfactory results. A pulse rate in the order of 2 pulses per second is preferred. In one embodiment, the component 10 is a door nominally 66" high by 26" wide that weighs in the order of 100 lbs. Vertical amplitude of between 1" and 4" has been attained.

**[0031]** After a designated time, typically in the order of 3 to 5 seconds, the component is lifted from the bed 46 and the mast 70 moved rearwardly along the track 62 away from the bed. Thereafter the surplus material can be removed from the component 10 at the station 48 and the component returned to the conveyor 20 where it can be reattached to the conveyor and the hook assembly 76 released.

**[0032]** With certain coatings, the flow of the coating over the surface of the component 10 can be promoted by vibrating the bracket 26 or hook assembly 76, which is transmitted in to the component. This is complementary to the translation of the component by the cylinder 92.

**[0033]** In an alternative process as shown in figure 7, a pair of fluidized beds 46(a), 46(b) are arranged side by side. Each bed 46(a)(b) has a separate coating component and the component may be initially immersed in the first bed, removed and transferred to the second bed through the operation of the tracks 62 and the rails 60 where the component 10 is again immersed. Thereafter, the component 10 can be positioned at the air blow off station 48 and returned to the conveyor for curing. In this arrangement, electrostatic coating is not performed but rather a double coating is applied to the component. Oscillation of the component through cylinder 92 may be performed at only the first step or at each step.

**[0034]** After curing, the component may be removed from the conveyor and the contact points with the hooks covered with coating material. It will however be noted that the contact points are on an upper edge of the surface of the component such that they would not be subjected to the same corrosive environment as on the lower edges where water may accumulate.

**[0035]** It has been found in practice that the provision of dipping of the component within the fluidized bed or beds enables a thorough coating to be provided on the retainer 18 and to ensure that all surfaces are coated to inhibit corrosion. The oscillation of the component whilst immersed inhibits bridging of the coating with the intricated configuration of the retainer 18 to ensure the surface is coated.

**[0036]** The hook assembly is mounted for movement independent of the mast, allowing the mast to perform the necessary translation and position with the hook providing the oscillation. Other forms of oscillation can be utilised, such as a mechanical cam drive or hydraulic drive. The frequency of oscillation and the vertical excursion will vary according to the component being coated. The oscillation should be of sufficient amplitude and frequency to inhibit bridging of the powder coating without removal of the component from the fluidized bed. Abrupt changes of direction are also preferred at the limits of the vertical movement.

**[0037]** The process of refurbishing a door that has been subject to corrosion is shown in figure 10. Initially the door is stripped of all mechanical components and the surface of the door blasted to remove corrosion. The door is immersed in a neutralising agent to deactivate the corrosion and holes and other defects are repaired.

**[0038]** All sharp edges are then deburred to ensure there are no edges that would prevent proper coating. The door is then blasted to remove contaminants and phosphated to provide a base coat. The door is then passed in to the oven 40 to be heated in preparation for immersion in the fluid bed 46. The first coating of epoxy is applied in the first bed, using the actuator 92 to agitate the door within the bed and ensure full encapsulation. The door is transferred to the second bed 46b where it is immersed in a polyester coating that offers high durability. After coating and curing the door is inspected and tested for fit, including the dimensions of the seal channel.

**[0039]** The primary coating applied in the fluid bed is preferably a fusion bond powder epoxy, such as grey zinc rich epoxy powder. The zinc content of the epoxy is preferably around sixty to-seventy percent by weight, which provides for resistance to undercreepage of the coating layer in corrosive environments. The presence of zinc in the coating also acts as a sacrificial element during the corrosion process. The secondary coating applied in the fluid bed 46b is a solid colour UV protectant layer for the zinc epoxy, such as Protec Z series polyester sold by Protec Chemicals, Montreal Canada. Other suitable coating mediums may be used in fluidized beds such as nylon, PVCS, polyolefins, and polyurethane.

**[0040]** A further embodiment is shown in figure 11 in which movement of the door within the bed is used to inhibit bridging of the coating. In the embodiment of figure 10, like reference numerals are used to denote like components with a suffix "a" added for clarity.

**[0041]** The bracket 22a has a pair of arms 28a that extend to either side of the door 10a. The arms 28a clamp to the midpoint of the door 10a through clamps 120 that can rotate relative to the arms 28a. A chain drive 122 is provided for one of the clamps 120 so that the door 10a can be rotated about a horizontal axis when immersed. The rotation may be continuous in one direction, may rotate a number of revolutions in one direction and the reverse, or may oscillate over partial revolutions. The bodily movement of the door 10a within the fluidized bed is sufficient to inhibit bridging of the powder coating and thereby ensure a cohesive coating of the door 10a.

**What is claimed is:**

1. A method of applying a coating to a component comprising the steps of supporting said component on a suspension system having a conveyor, a carriage moveable vertically relative to said conveyor and a hook assembly connected to said carriage and engaging said component, said method including moving said component along said conveyor to position said component above a fluid bed of coating material, moving said carriage relative to said conveyor to lower the component into said fluid bed to apply said coating thereto, moving said component within said fluid bed by applying pulses to said hook assembly to move the hook assembly vertically relative to the carriage and displace said component vertically relative to said carriage and conveyor, periodically reversing the direction of movement of said hook assembly relative to the carriage to produce cyclic bodily translation of said component in a vertical direction within said fluid bed during application of said coating, the application of said pulses producing an abrupt change of direction of movement in a vertical direction relative to said carriage to promote a uniform distribution of coating to an exterior surface of said component, and lifting the carriage relative to the conveyor to remove the component from the fluid bed.

2. The method of claim 1 wherein said cyclic bodily translation has a period of between 5 cycles per second and 0.5 cycles per second.

3. The method of claim 2 wherein said cyclic bodily translation has a period of 2 cycles per second.

4. The method of any one of claims 1 to 3 wherein a plurality of fluid beds are provided and said component is moved successively through said beds to apply a plurality of coatings thereto.

5. The method of any one of claims 1 to 4 wherein excessive coating material is removed upon removal of said component from said fluid bed.

6. The method of any one of claims 1 to 5 wherein said coating is fusion bond powder epoxy.

7. The method of any one of claims 1 to 6 wherein the component is heated prior to immersion in said fluid bed.

8. The method according to any one of claims 1 to 7 wherein said component remains in said bed for a period of between 3 and 5 seconds.

9. The method of any one of claims 1 to 8 wherein said component is subjected to vibration during cyclic bodily translation thereof.

10. The method of claim 1 wherein said cyclic bodily translation has an amplitude of between 1 inch and 4 inches.

11. A coating apparatus for coating a component comprising a fluidized bed of coating material, a conveyor to position a component above said fluidized bed, a carriage moveable vertically relative to said conveyor to lower said component into said fluidized bed, a hook assembly on said carriage to engage and carry said component, a drive acting on the hook assembly to move said hook assembly vertically relative to said carriage and a control to periodically reverse the direction of movement of said hook assembly relative to said carriage to cause cyclic bodily movement of said component in a vertical direction within said fluidized bed as coating is applied, said drive applying periodic pulses to said hook and thereby provide an abrupt change of direction of said hook in a vertical direction relative to said carriage to promote a uniform distribution of coating to an exterior surface of said component.

12. The apparatus of claim 11 wherein a mast connects said carriage to said conveyor and said carriage is moveable along said mast.

13. The apparatus of claim 12 wherein said mast is rotatably secured to said conveyor.

14. The apparatus of claim 12 or claim 13 wherein a hoist is mounted on said mast and operates on said carriage to move said carriage along said mast.

15. The apparatus of any one of claims 11 to 14 wherein said drive includes an extendable cylinder acting between said hook assembly and said carriage.

16. The apparatus of any one of claims 11 to 15 wherein a counterbalance is provided for said carriage.

17. The apparatus of any one of claims 15 to 17 wherein said hook assembly is slidably connected to said carriage and said extendible cylinder acts between said carriage and said hook assembly.

18. The apparatus of claim 17 wherein said drive provides a vertical displacement of between 1 inch and 4 inches.

19. The apparatus of any one of claims 11 to 18 wherein said drive provides a cyclic bodily translation that has a period of between 5 cycles per second and 0.5 cycles per second.

20. The apparatus of claim 19 wherein said cyclic bodily translation has a period of 2 cycles per second.

21. The apparatus of any one of claims 11 to 20 wherein a plurality of fluidized beds are provided to coat said component and said conveyor extends between said beds.

22. The apparatus of claim 21 wherein a material removal station is provided adjacent one of said fluidized beds.

23. The apparatus of any one of claims 11 to 22 including an oven to heat said component prior to transfer by said conveyor to said bath.

24. The apparatus of any one of claims 11 to 23 wherein said component is a door and said hook assembly holds said door in a vertical orientation.

25. The apparatus of claim 24 wherein said door has a seal retainer extending about one face of said door and said drive imparts an abrupt change of direction to inhibit bridging of said coating about said seal retainer.

| | |
|---|---|
| 1 | REMOVE HOT PART |
| 2 | FLUID BED COATING |
| 3 | AIR BLOW OFF |
| 4 | ELECTRO-STATIC COATING |
| 5 | REJECT PART FOR CURING |

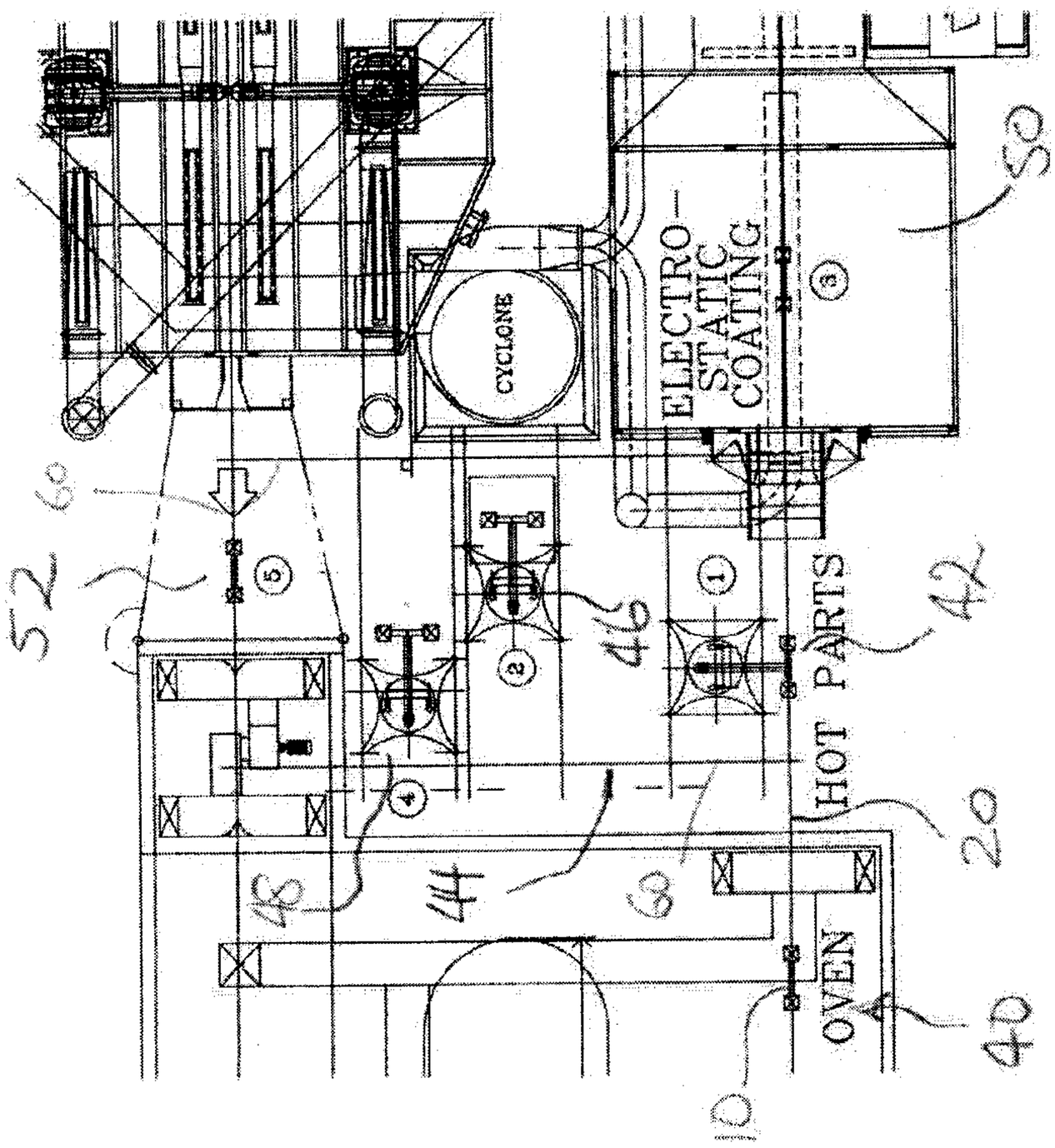



FIG. 1

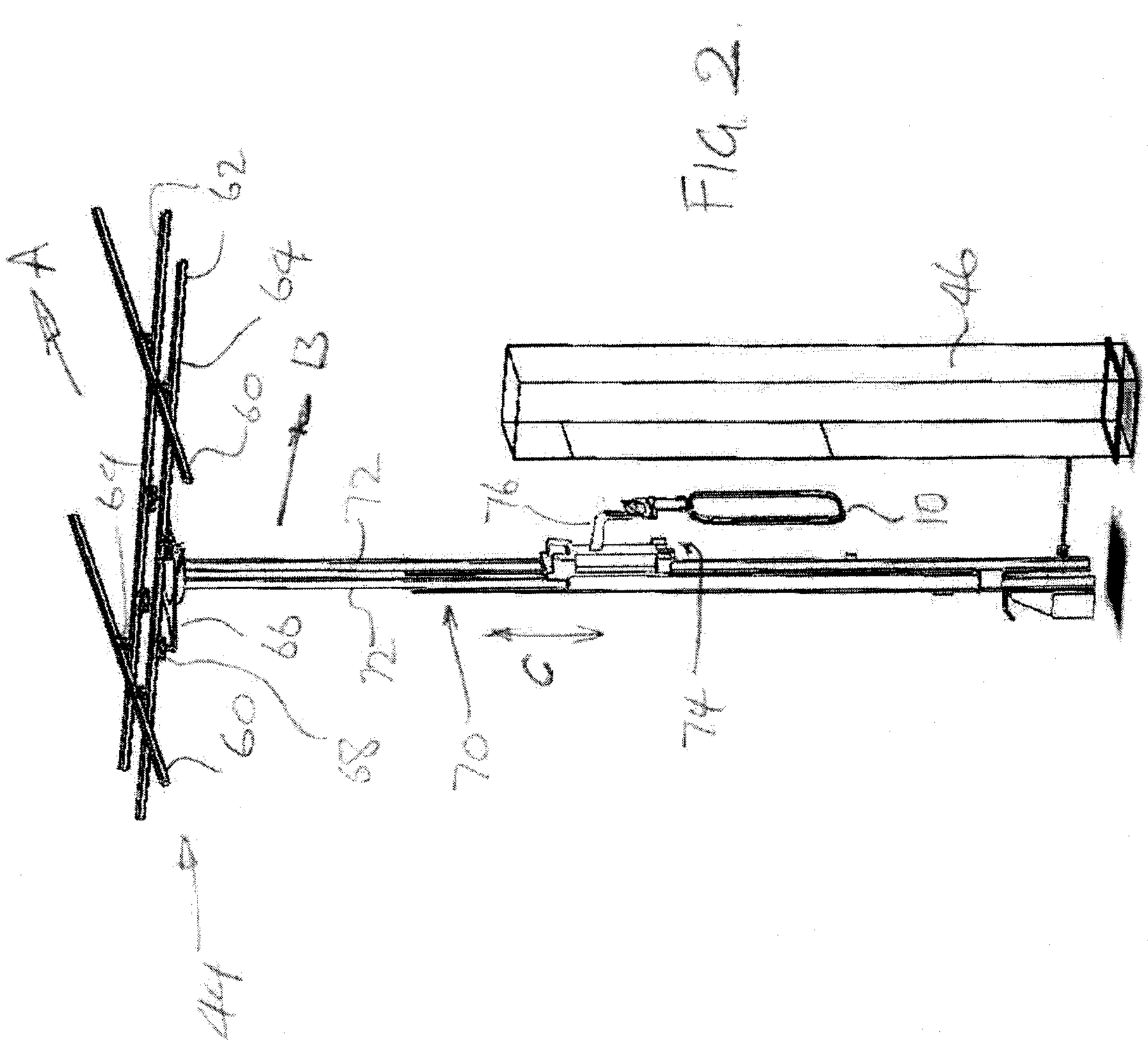



FIG. 2

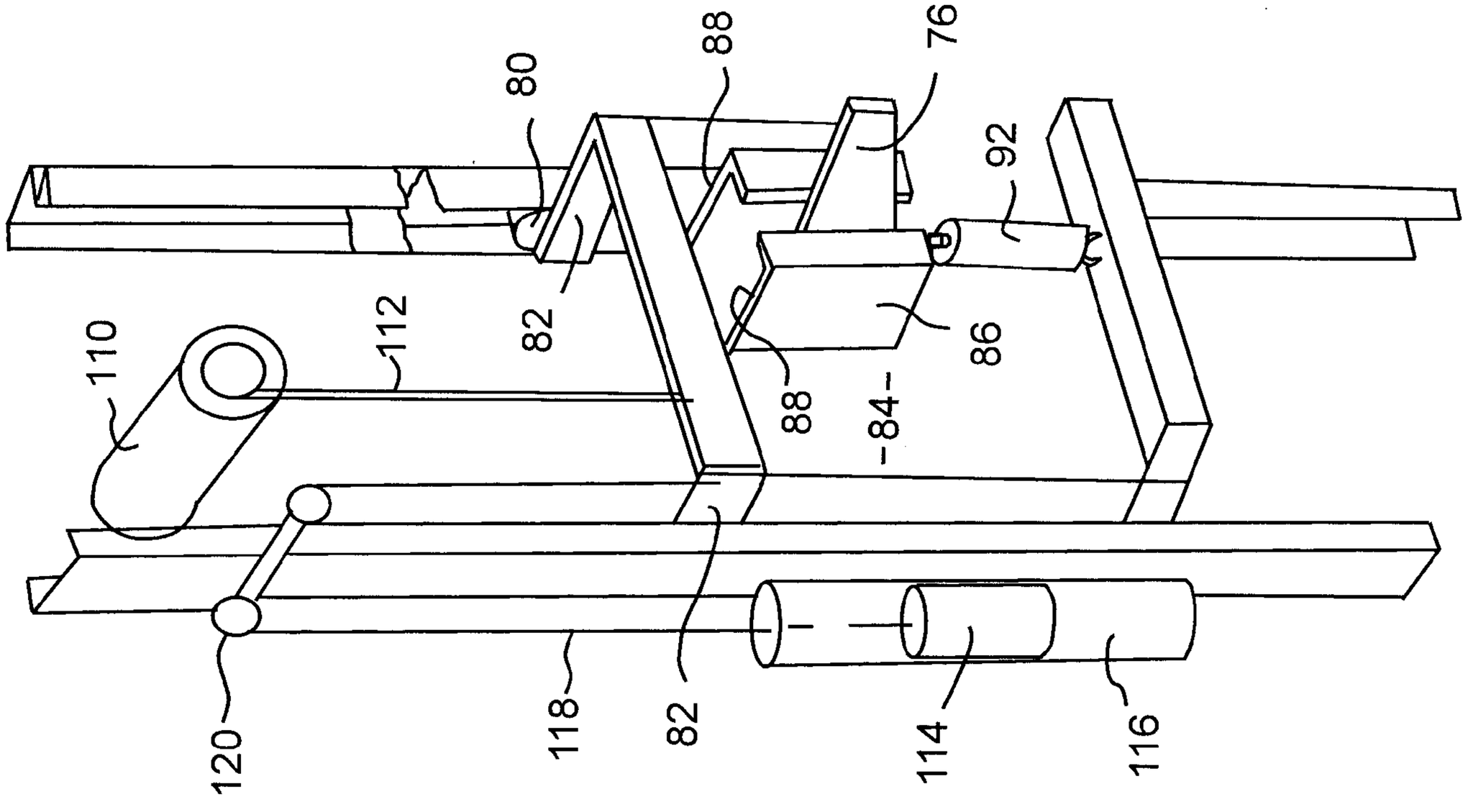



FIG. 3

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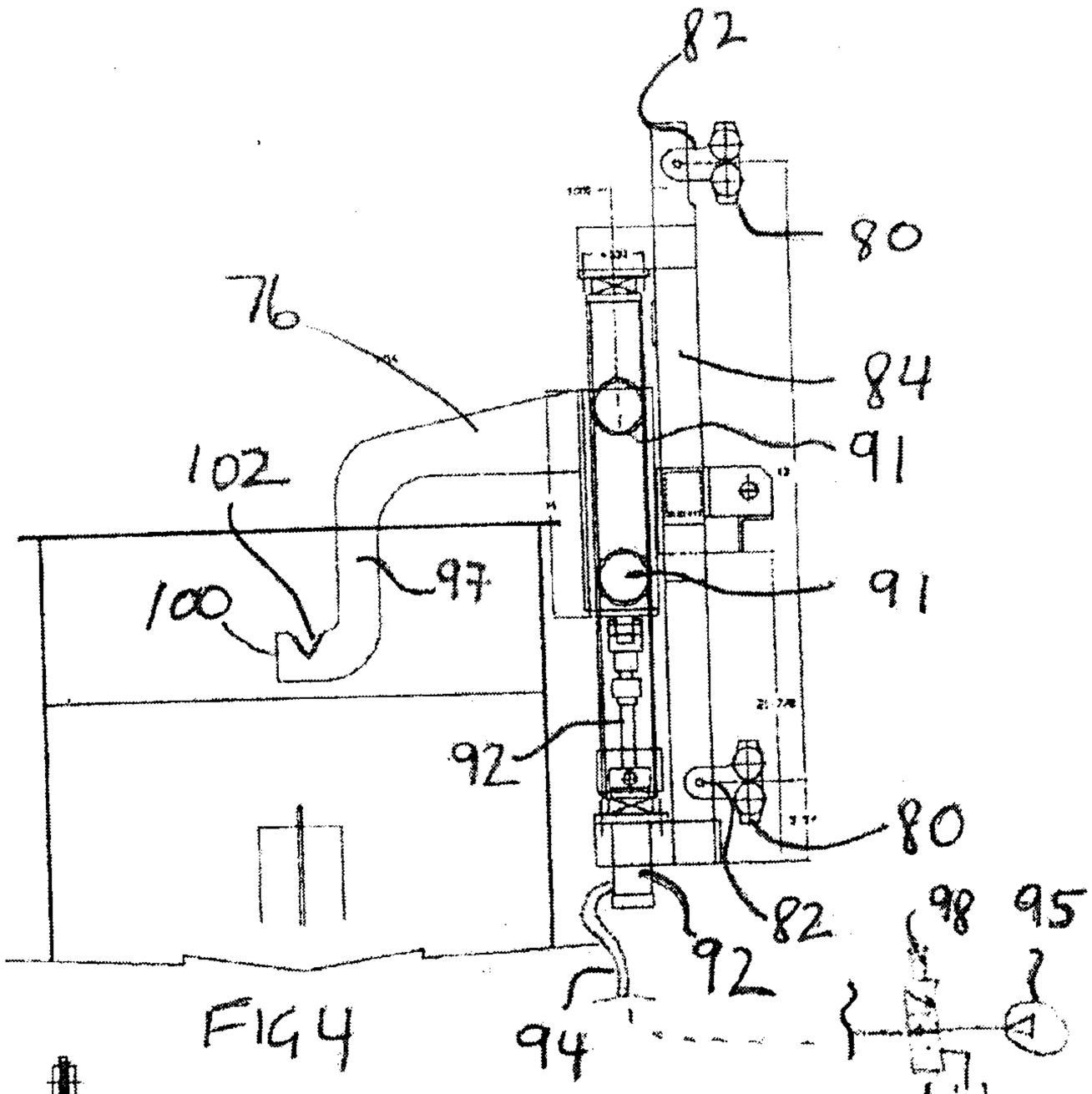



FIG 4

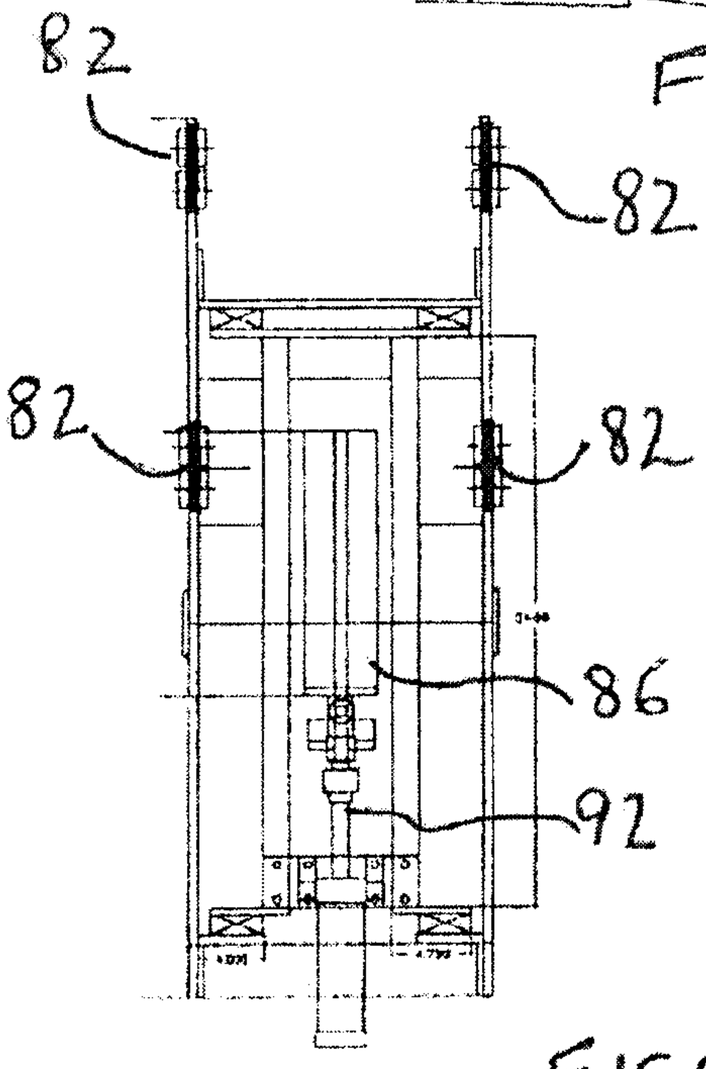



FIG 5

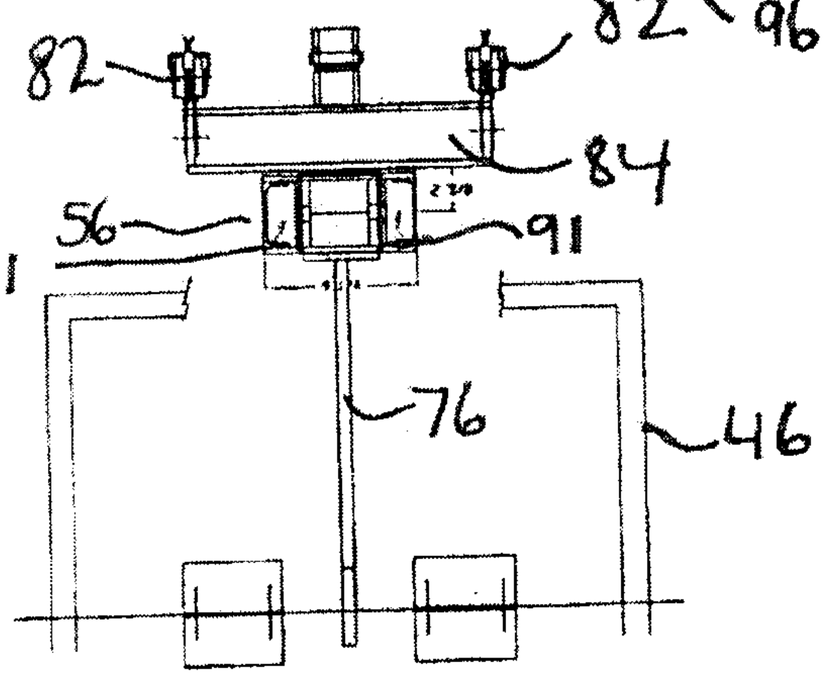



FIG 6

| | |
|---|---|
| 1 | REMOVE HOT PART |
| 2 | FLUID BED BASE COATING |
| 3 | FLUID BED TOP COATING |
| 4 | AIR BLOW OFF |
| 5 | REJECT PART FOR CURING |

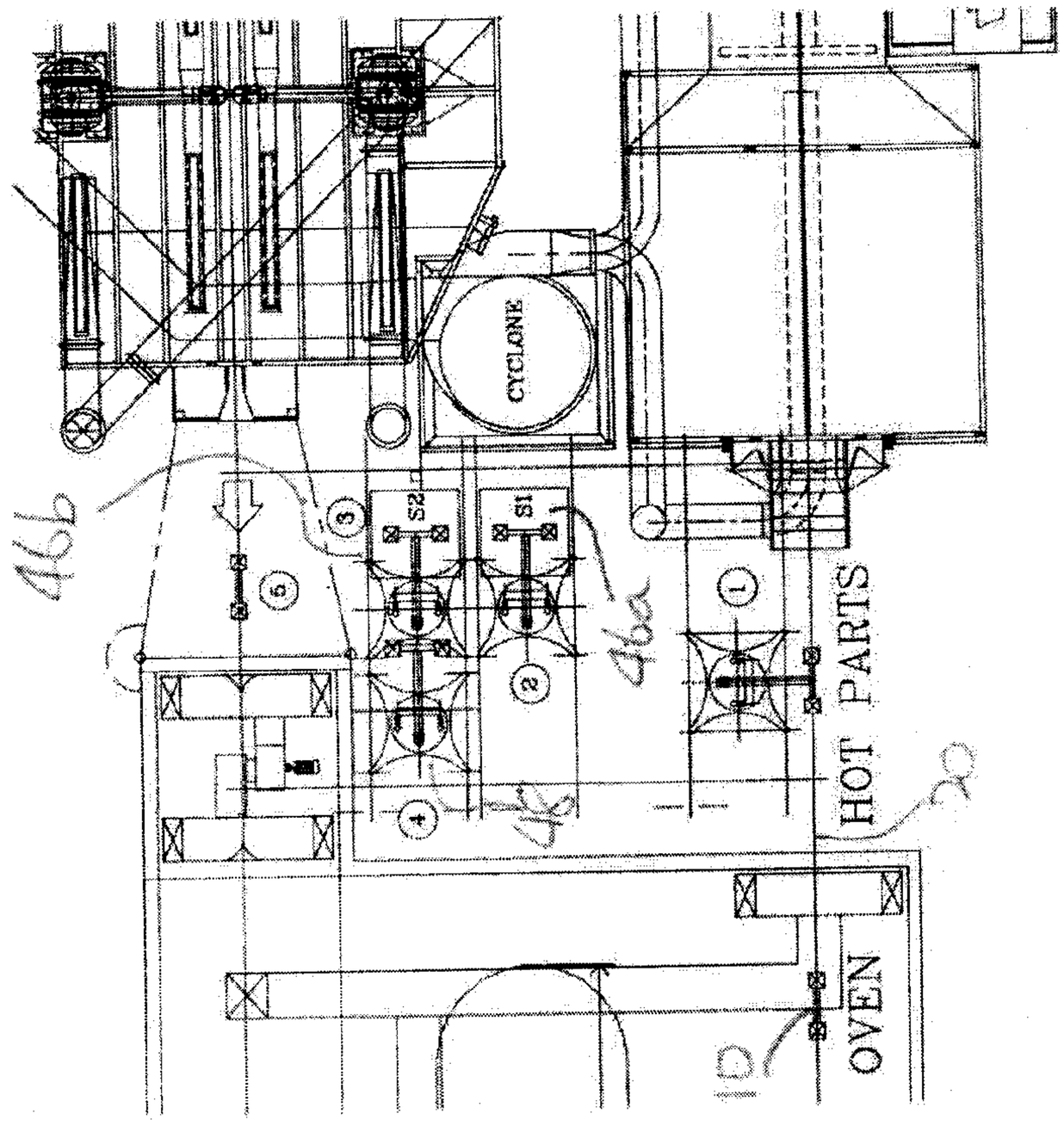



FIG 7

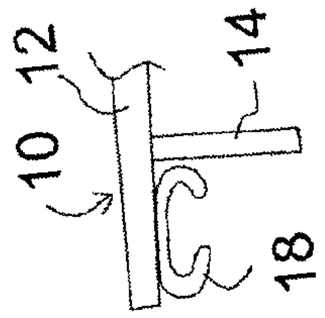



FIG. 9

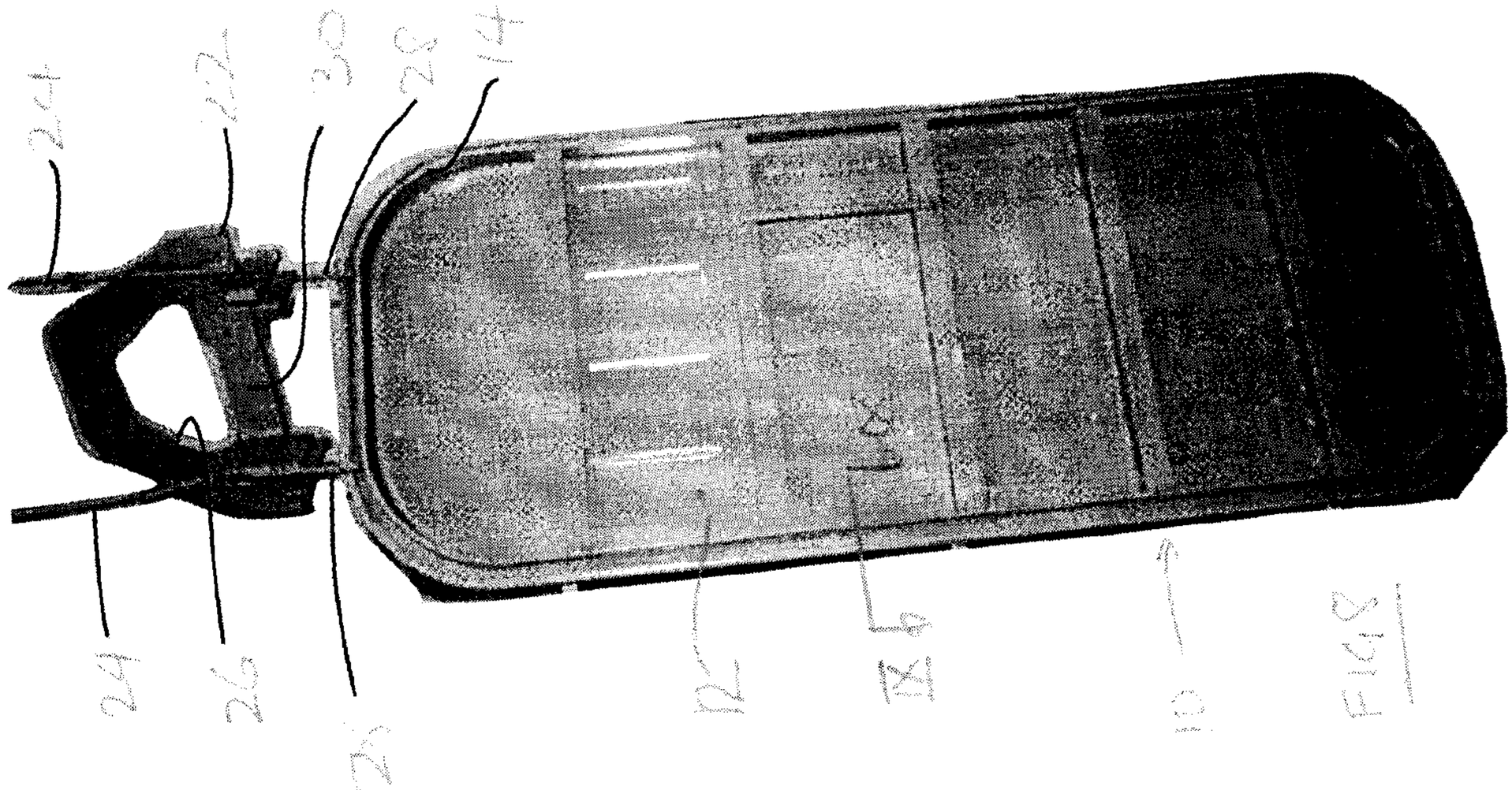



FIG. 10

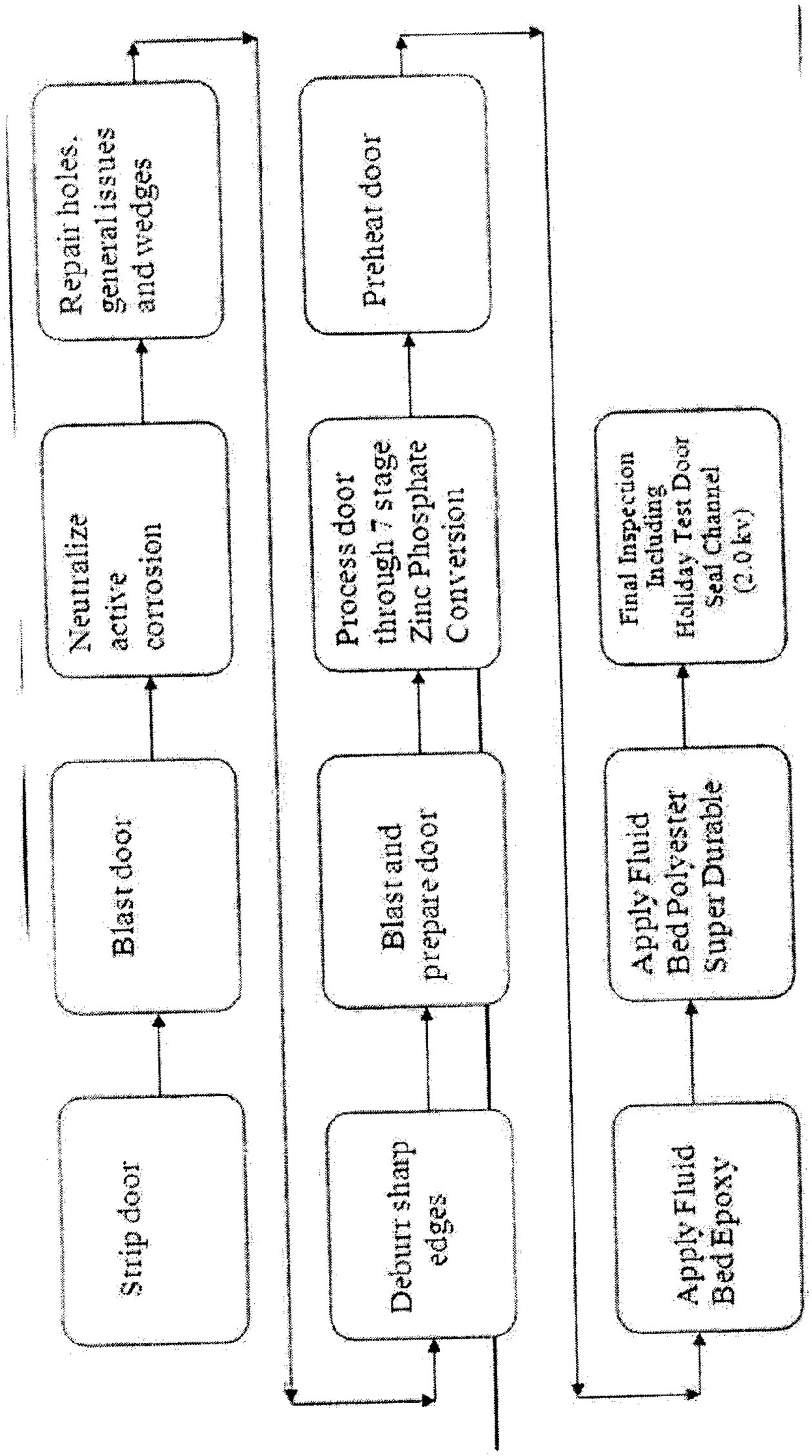

Repair holes, general issues and wedges
Neutralize active corrosion
Blast door
Strip door
Preheat door
Process door through 7 stage Zinc Phosphate Conversion
Blast and prepare door
Deburr sharp edges
Final Inspection Including Holiday Test Door Seal Channel (2.0 kv)
Apply Fluid Bed Polyester Super Durable
Apply Fluid Bed Epoxy

FIG 10

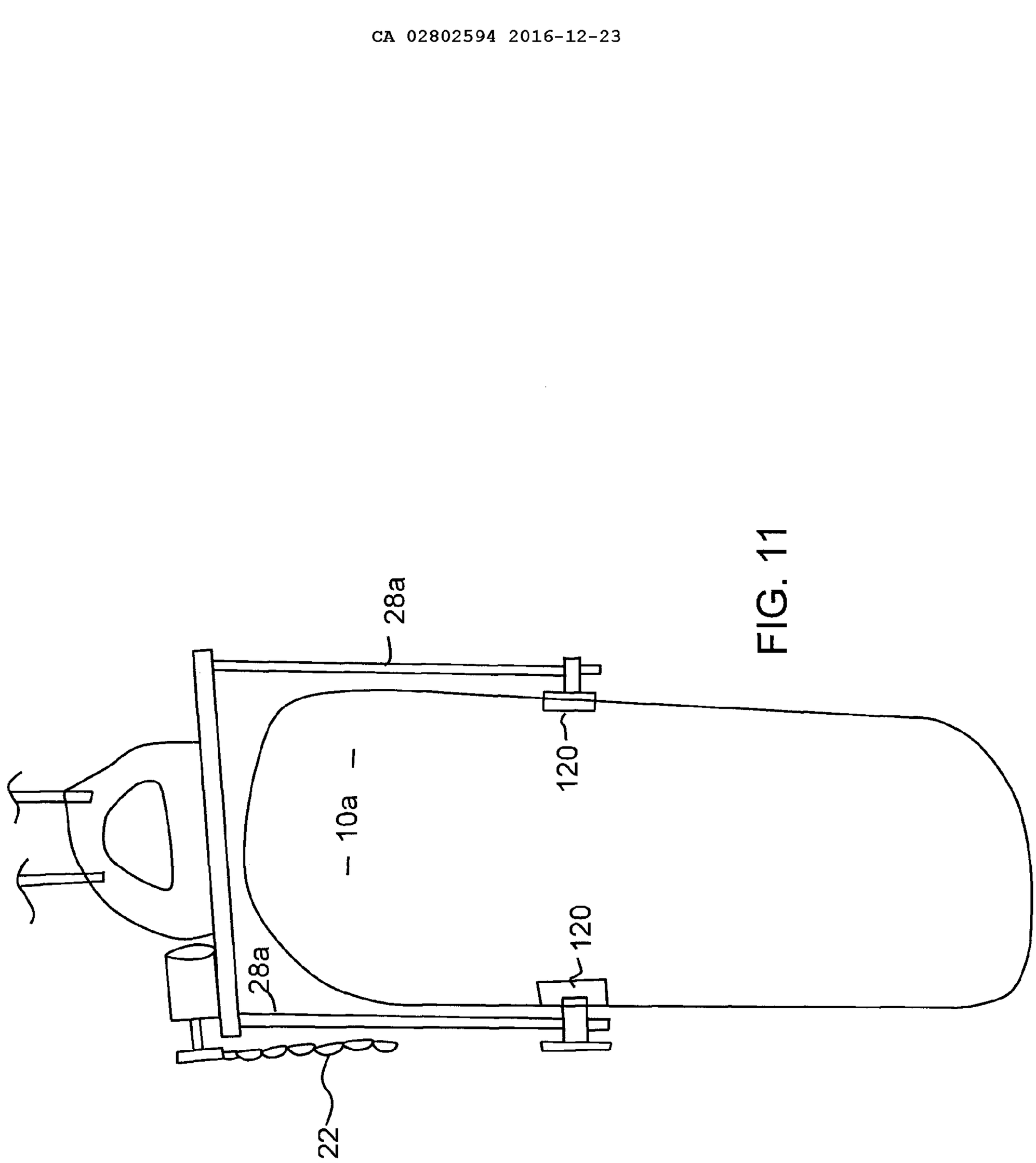
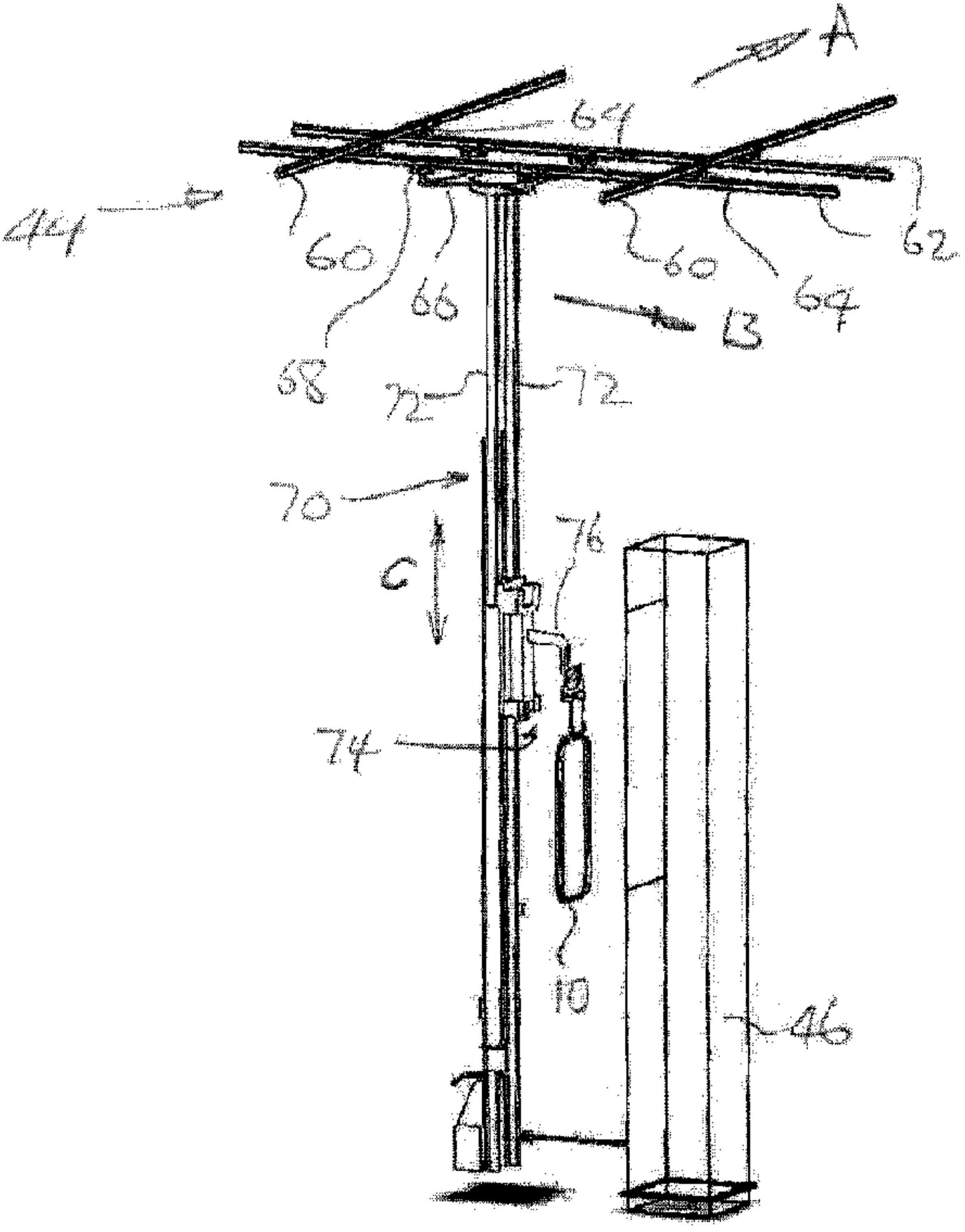



FIG. 11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