United States Patent [19]

Gilbert et al.

[11] **3,898,768**

[45] **Aug. 12, 1975**

[54] **SANDBLASTING APPARATUS**

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[73] Assignee: **Enviro-Blast International**, Los Angeles, Calif.

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[21] Appl. No.: **469,214**

[52] **U.S. Cl.** **51/15**

[51] **Int. Cl.** **B24c 3/12**

[58] **Field of Search** ..... 51/14, 15, 8 R

[56] **References Cited**

UNITED STATES PATENTS

1,953,311	4/1934	Peik	51/8 R
2,621,446	12/1952	Russell	51/14
3,055,150	9/1962	Greenberg	51/14

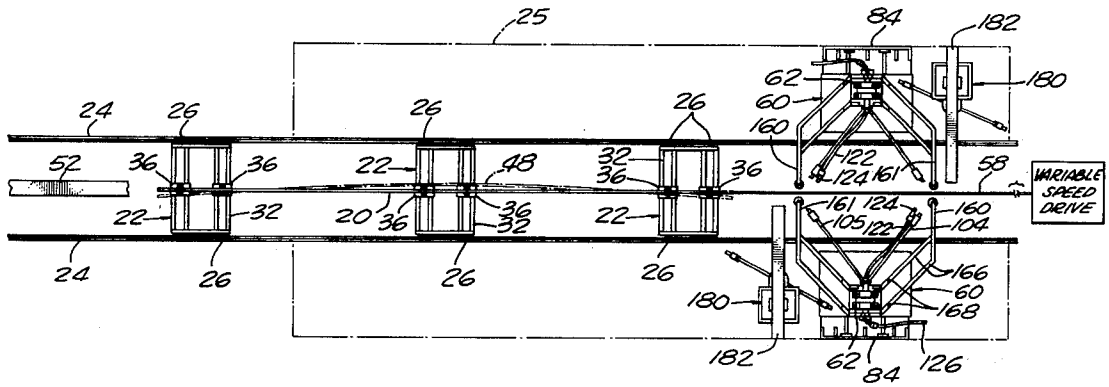
Primary Examiner—Donald G. Kelly

Attorney, Agent, or Firm—Paul A. Weilein

[57] **ABSTRACT**

A high production apparatus for sandblasting large flat plates for tank bottoms, large curved tank plates for tank walls, plates of odd shapes for tank tops and a wide range of sizes of pipes for connection to tanks. The flat and curved plates travel longitudinally in vertical position through a long booth past sandblast nozzles that move in circular orbits about horizontal axes. The orbiting nozzles are urged towards the travelling plates by springs and are equipped with pilot means to contact the plates to maintain the nozzles at predetermined spacing from the plates. Both sides of the plates are sandblasted simultaneously. The length of pipe rotate on their axes while traveling endwise past overhead downwardly directed vertical blasters with sandblast nozzles that move in orbits about vertical axes. The vertical blasters are moved to one side when the horizontal blasters are in use and the horizontal blasters are folded and moved to one side when the vertical blasters are in use.

28 Claims, 20 Drawing Figures



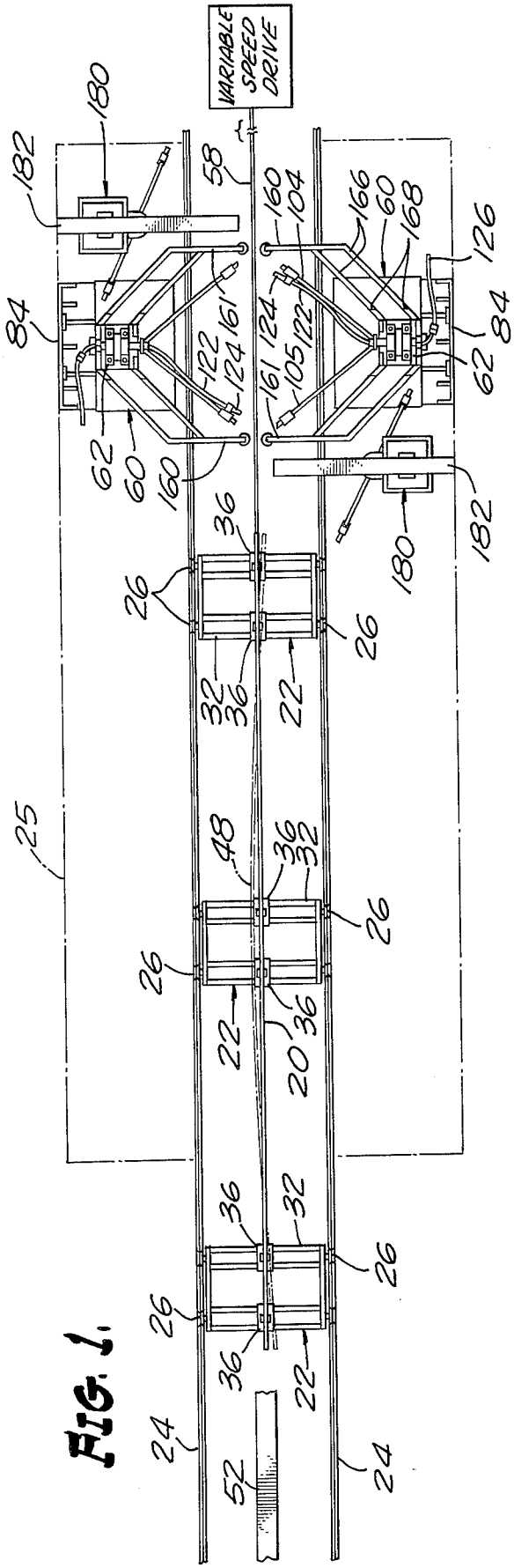

VARIABLE SPEED DRIVE
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FIG. 1.

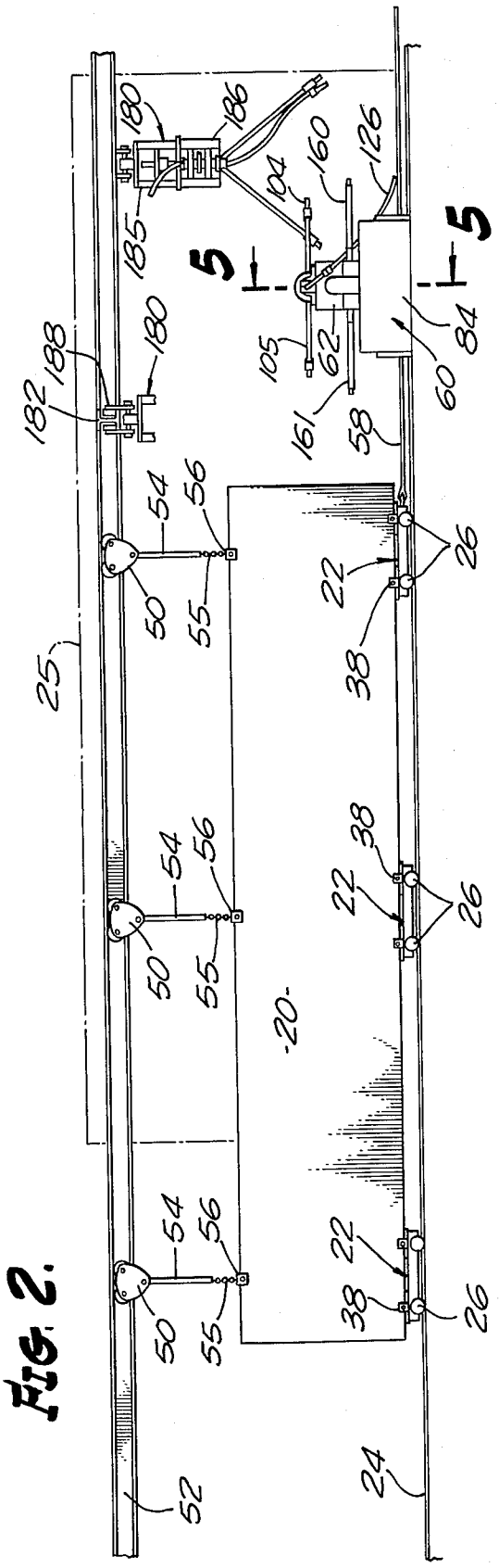

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FIG. 2.

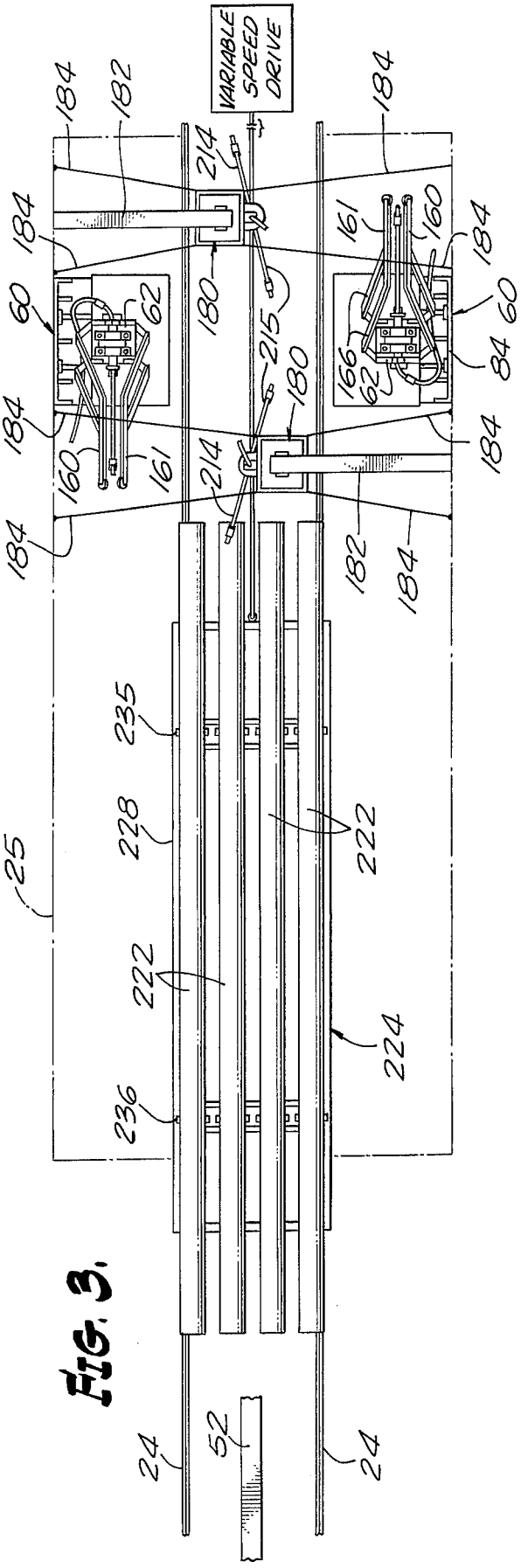

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Fig. 3.

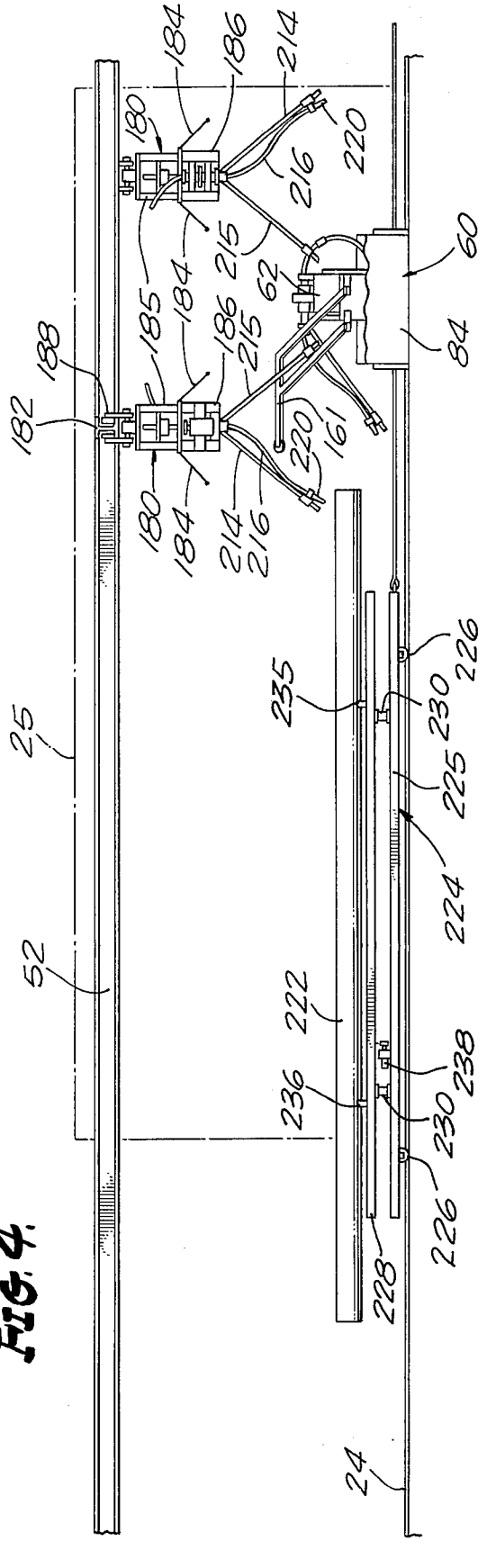
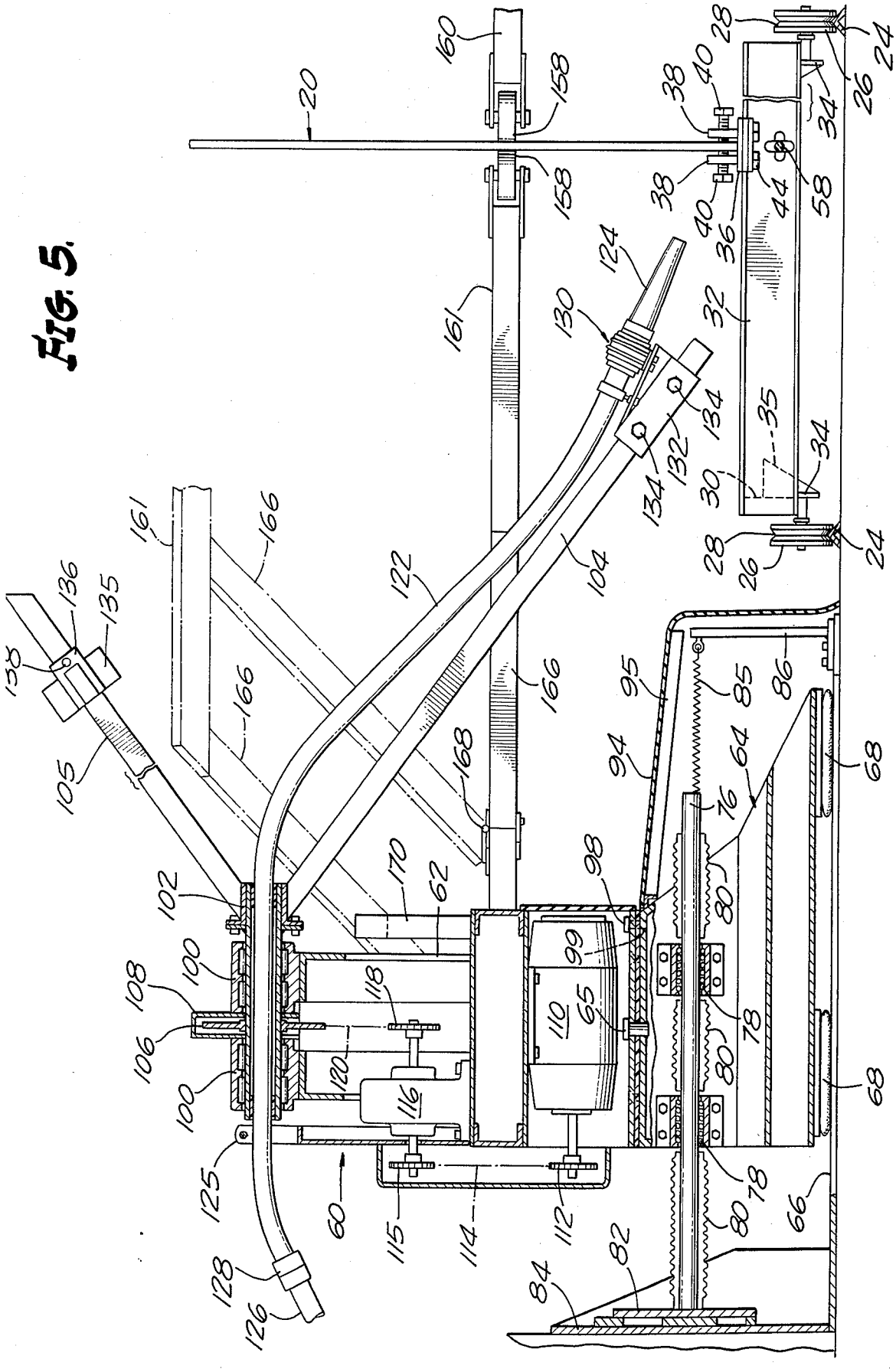
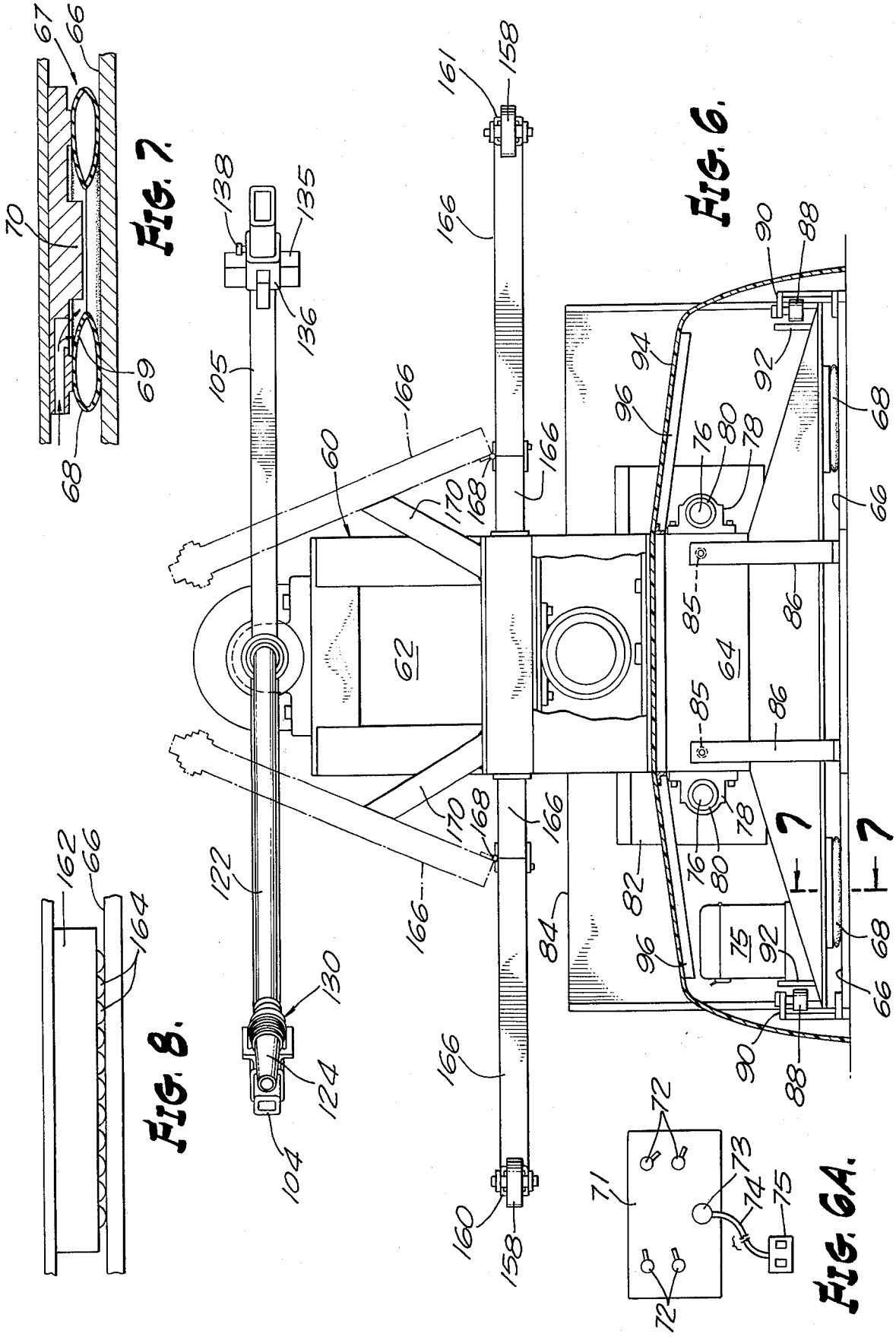

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Fig. 4.

FIG. 5.


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FIG. 6.
FIG. 7.
FIG. 8.
FIG. 6A.
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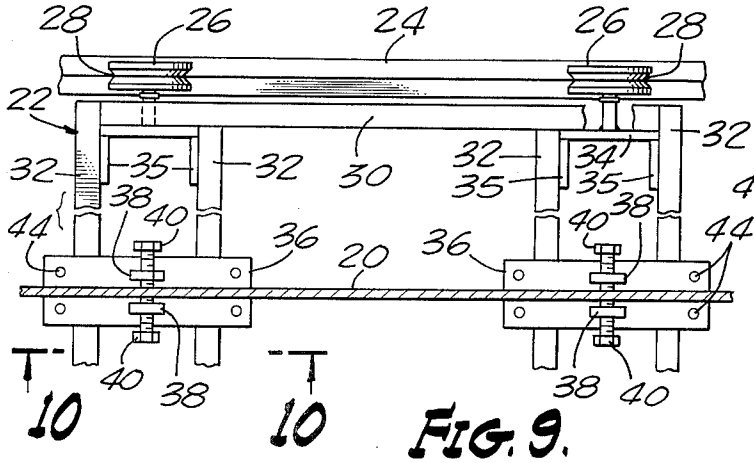


FIG. 9.

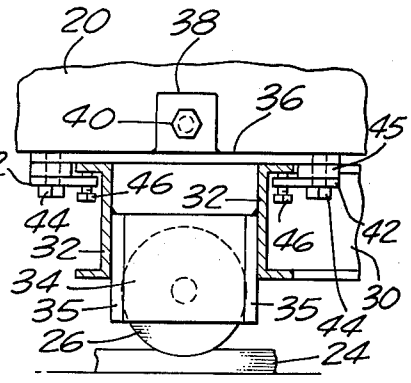


FIG. 10.

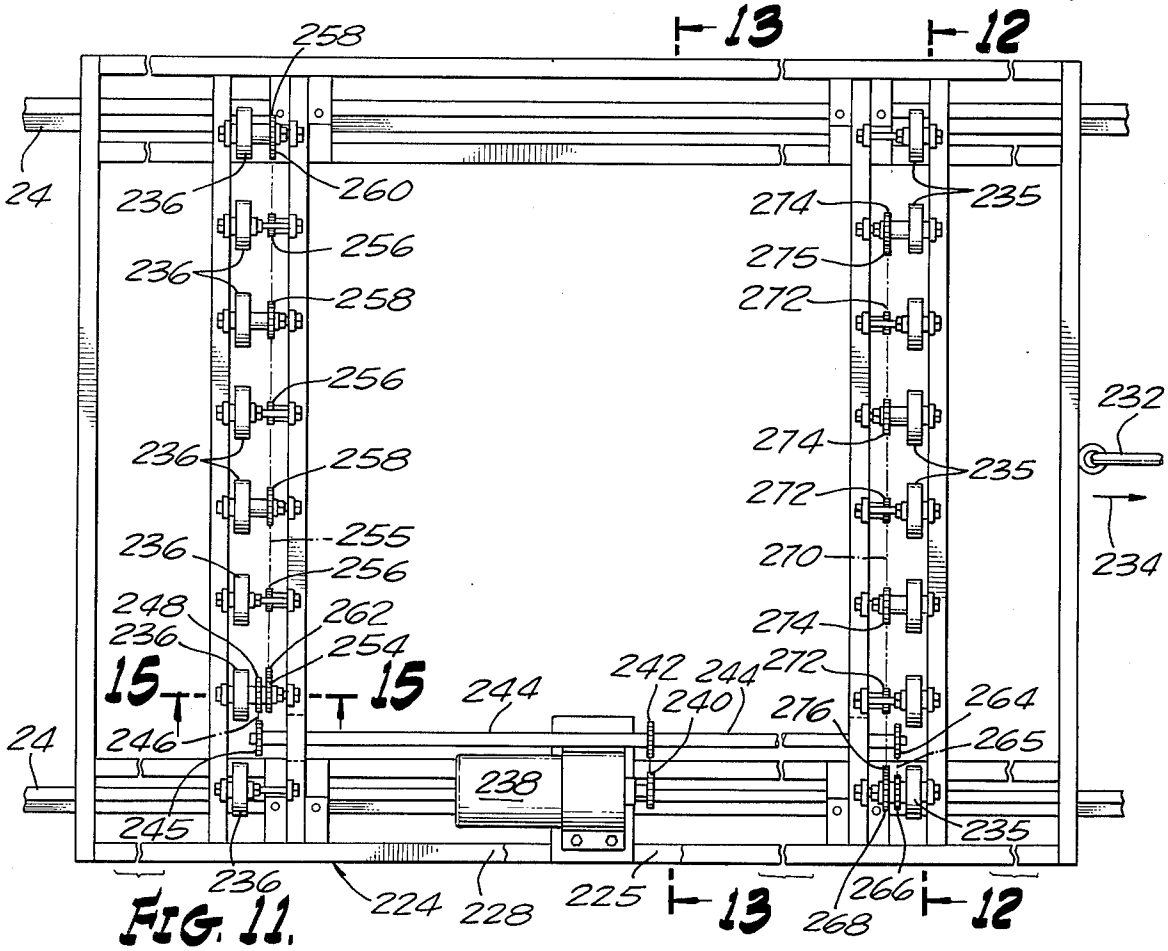


FIG. 11.

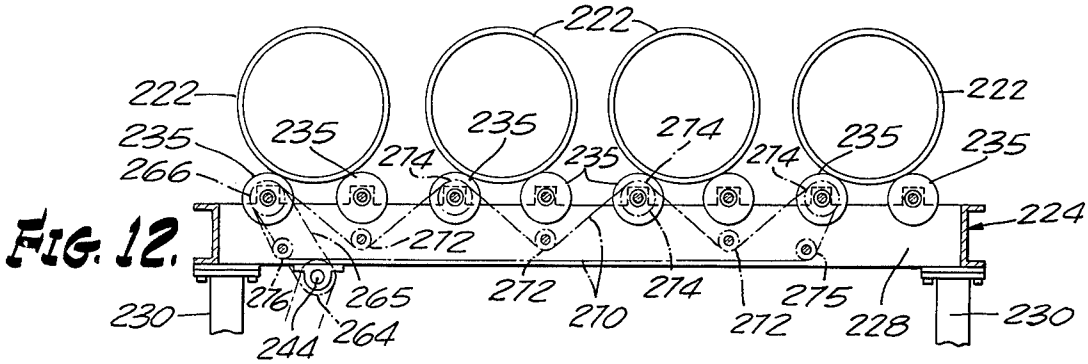


FIG. 12.

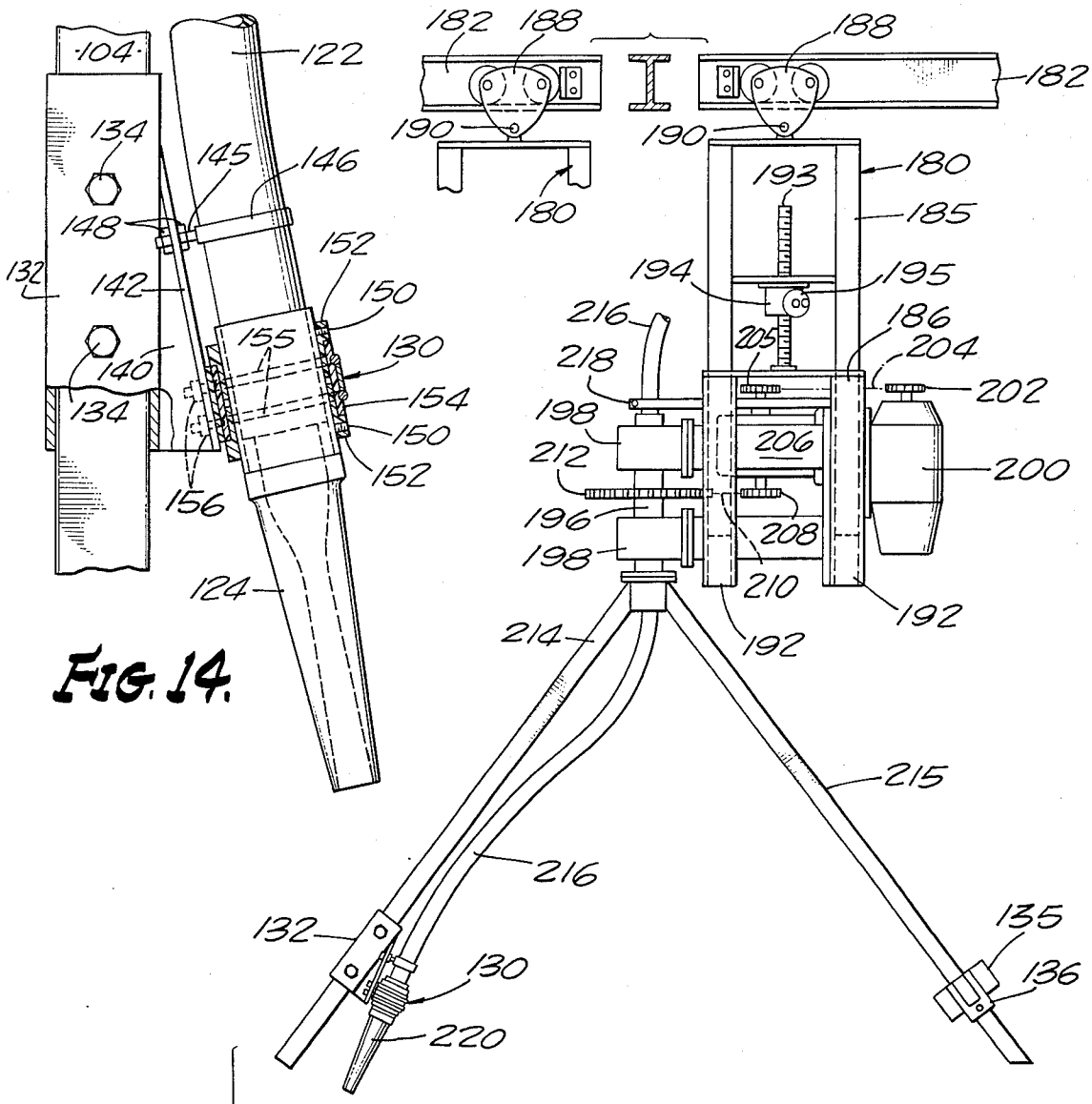
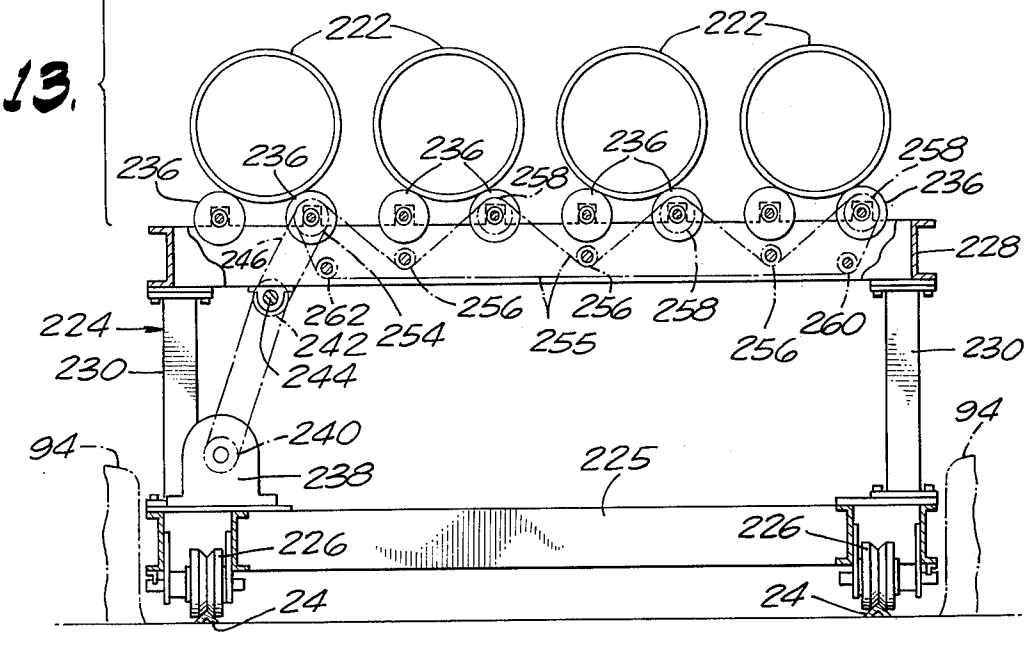

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FIG. 14.

FIG. 13.


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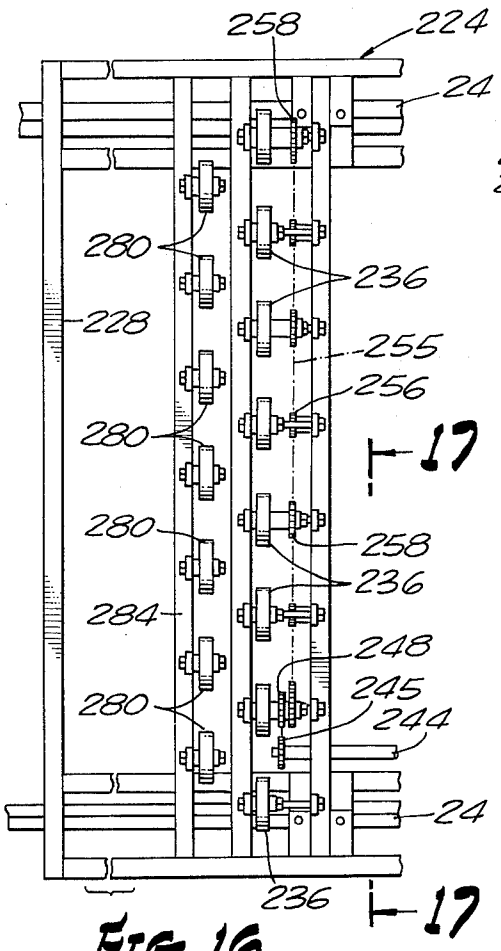


FIG. 16.

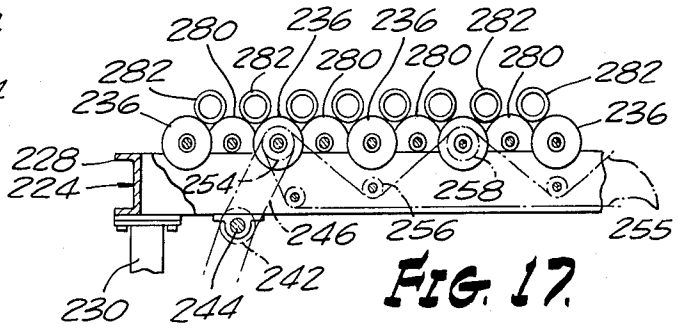


FIG. 17.

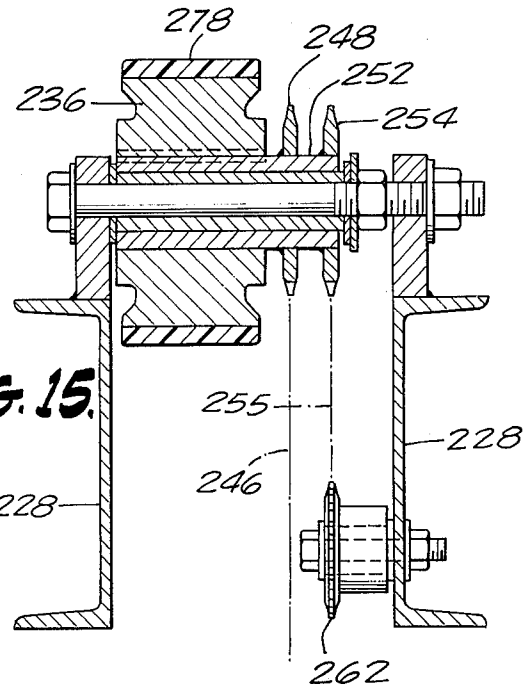


FIG. 15.

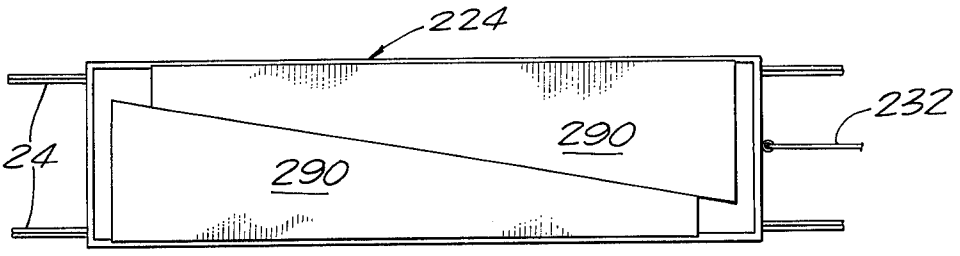


FIG. 18.

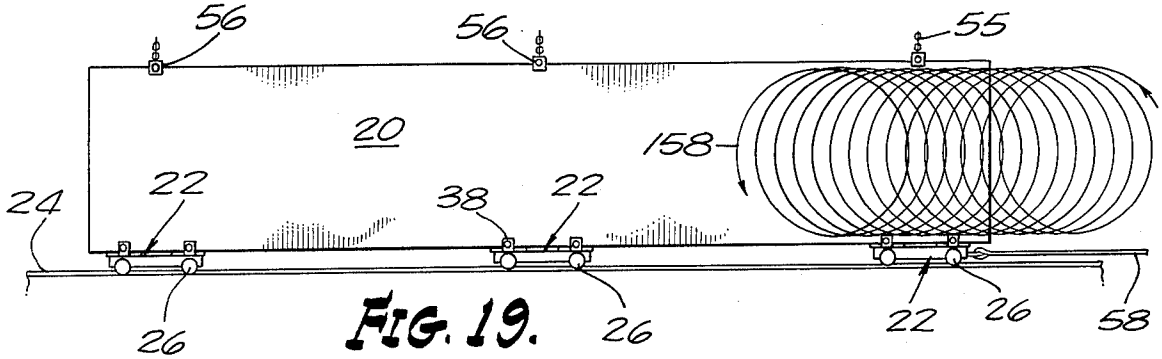


FIG. 19.

SANDBLASTING APPARATUS

BACKGROUND OF THE INVENTION

The fabrication of large multiple tank storage facilities requires that large tank plates be processed on both sides in preparation for protective coatings. The plates include flat plates **40** feet long and ¼ to 1¼ inch thick for tank bottoms and similar plates curved longitudinally for the cylindrical walls of tanks. Odd-shaped flat plates which may be of somewhat triangular configuration are employed to fabricate the top walls of the tanks. The pipes for a multiple tank installation may range in diameter from ¾ inch to **30** inches and are manufactured in **40** foot lengths. Such pipes must be thoroughly sandblasted in preparation for protective coatings or in preparation for protective wrappings.

It has been common practice for workmen to manipulate sandblast nozzles by hand for processing the plates and pipes required for tank installations. Such hand operation lacks quality control and is too slow. It may require, for example, six man years to process in this manner the plates and pipes for a typical multiple-tank installation.

SUMMARY OF THE INVENTION

A primary object of the invention is to reduce the time and labor required to sandblast the plates and pipes required for a multiple-tank installation. In accord with the teachings herein, it has been demonstrated that the man years of labor may be reduced by much more than two-thirds by employing sandblast nozzles that are moved orbitally at high speed and by providing power means to move the workpieces past the orbiting nozzles at controlled rates of travel.

Another object of the invention is to move the large tank plates edgewise through a processing zone for sandblasting both sides of the plates simultaneously and in doing so to maintain the orbiting sandblast nozzles at predetermined distances not only from the surfaces of flat plates but also from the surfaces of curved plates. A feature of the invention in this regard is the concept of providing blasters with orbiting nozzles, which blasters are urged towards the opposite faces respectively of the traveling plates and are provided with pilot rollers that contact the traveling surfaces of the plates and maintain the orbiting nozzles at predetermined spacing from the plates. When a **40** foot longitudinally curved plate moves edgewise between two confronting horizontal blasters the orbiting nozzle of the blaster on one side of the traveling plate is piloted to move inwardly and outwardly to follow the convex surface of the plate while the blaster on the other side of the plate is piloted inwardly and outwardly to follow the concave surface of the plate.

Still another object of the invention is to provide suitable pilot means for an orbitally moving nozzle of a horizontal blaster unit. The problem arises because a pilot roller for the horizontal blaster cannot be positioned within the area of the circular orbit of the nozzle and if the pilot roller is placed outside of the circle it will be out of alignment with the force that urges the blaster unit towards the traveling plate perpendicularly thereof with a consequent tendency for the blaster unit to react by turning away from the desired perpendicular alignment. This problem is solved in part by providing the horizontal blaster with a pair of pilot arms with pilot roller on the ends thereof straddling the orbit of the nozzle and the two pilot arms being diametrically opposite each other in a horizontal plane. The problem is solved in further part by mounting the horizontal blaster for movement in a substantially frictionless manner to minimize the thrust that is required for a pilot roller to maintain contact with a traveling plate. Finally, the solution is completed by providing effective but substantially frictionless means to confine the movement of the blaster to a path that is perpendicular to the traveling plates.

Another object of the invention is to provide suitable means for conveying the long plates edgewise in upright position past the pair of confronting horizontal blasters. For this purpose the lower longitudinal edges of the plates are supported by low lying carriages that travel on a track through the processing zone and the vertical plates are stabilized on the carriages by means of traveling clamps in engagement with the upper longitudinal edges of the plates. The upper traveling clamps are suspended from overhead trolleys on a monorail that extends through the processing zone.

Since the longitudinally traveling lengths of pipe vary widely in diameter the problem arises of providing means for adjusting the vertical distance between the orbiting nozzles of the overhead vertical blasters and the upper surfaces of the traveling lengths of pipe. This problem is solved by supporting the lengths of pipes on carriages that are variable in height and by suspending the overhead vertical blasters in a manner that permits a limited range of vertical adjustment of the blaster nozzles.

Carriages for moving the **40** foot lengths of pipe longitudinally through the processing zone are equipped with a forward pair of rollers and a rearward pair of rollers for nesting each length of pipe with one roller of each pair power actuated to cause the length of pipe to rotate on its axis at a desired rate. The problem arises of minimizing the number of types of carriages required to accommodate the wide range of pipe diameters. The problem is to reduce the required number of carriages by making each carriage adaptable for a number of pipe sizes.

Each carriage has a forward transverse row of rollers to act in pairs to nest the forward ends of the lengths of pipe and a rearward transverse row of rollers to act in pairs to nest the trailing ends of the lengths of pipe. These two rows of rollers are capable of nesting only a small range of pipe sizes. The invention teaches, however, that a forward auxiliary transverse row of idler rollers and a rearward auxiliary transverse row of idler rollers may be added to enable the carriage to accommodate an additional range of smaller pipe diameters, the auxiliary idler rollers being staggered relative to the main rollers. With reference to the forward and rearward rows of main rollers, the odd numbered rollers of one row and the even numbered rollers of the other row are power driven for cooperation with the auxiliary idler rollers. The invention further teaches that every other roller of the transverse rows of main rollers may be omitted to space the main rollers farther apart for the purpose of nesting and rotating pipes of relatively large diameters. These concepts make it possible to require only four different carriages to accommodate all of the pipe sizes that range from ¾ inch to **30** inch diameter.

A still further object of the invention is to provide a sandblasting apparatus of this character that is semi-

portable in the sense that it may be set up for operation at a succession of installations adjacent geographically scattered sites for new tank facilities. The sandblasting machines are readily portable and it is a simple matter to assemble knockdown sandblasting booths.

The features and advantages of the invention may be understood from the following detailed description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which are to be regarded as merely illustrative:

FIG. 1 is a simplified plan view of an elongated sandblasting booth showing a tank plate supported in upright position for movement into a processing zone that is provided by a pair of confronting horizontal blasters;

FIG. 2 is a simplified side elevation showing how the upright path is mounted on lower carriages and is stabilized by upper trolleys;

FIG. 3 is a simplified plan view showing parallel lengths of pipe mounted on a carriage for movement through a processing zone that is provided by two successive overhead vertical blasters;

FIG. 4 is a simplified elevational view of the pipes and blasters shown in FIG. 3;

FIG. 5 is an enlarged transverse section along the line 5—5 of FIG. 2 showing in side elevation and partly in section a horizontal blaster positioned to abrade one face of a traveling upright plate;

FIG. 6 is a front elevation of the horizontal blaster shown in FIG. 5;

FIG. 6A is a diagrammatic view of a control panel on the horizontal blaster;

FIG. 7 is a fragmentary sectional view along the line 7—7 of FIG. 6 showing the construction of an air caster that is incorporated in the structure of the horizontal blaster;

FIG. 8 is an elevational view of a type of linear ball bearing that may be substituted for the air casters;

FIG. 9 is an enlarged fragmentary plan view of a carriage for supporting the lower longitudinal edge of a traveling upright plate;

FIG. 10 is a fragmentary section as seen along the line 10—10 of FIG. 9;

FIG. 11 is a somewhat diagrammatic plan view of a carriage for conveying a row of parallel pipes through a sandblasting zone with the pipes rotating on their axes;

FIG. 12 is a transverse section along the line 12—12 of FIG. 11 showing how alternate rollers of the forward transverse row of rollers of the carriage are power actuated;

FIG. 13 is a similar view along the line 13—13 of FIG. 11 showing how alternate rollers of the rearward transverse row of rollers are power actuated, the view further showing an overhead vertical blaster positioned above the pipes on the carriage;

FIG. 14 is an enlarged fragmentary elevational view, partly in section, showing how a nozzle of a horizontal blaster is mounted by a bearing on an orbitally moving support arm;

FIG. 15 is an enlarged fragmentary sectional view along the line 15—15 of FIG. 11 showing a portion of the means for actuating the pipe supporting rollers on the carriage;

FIG. 16 is a fragmentary plan view similar to FIG. 11 showing how an auxiliary transverse row of idler rollers may be added to a carriage adjacent the rearward transverse row of rollers to accommodate a range of pipes of relatively small diameter;

FIG. 17 is a fragmentary diagrammatic view as seen along the line 17—17 of FIG. 16 showing how the auxiliary rollers cooperate with the main rollers to nest the small diameter pipes;

FIG. 18 is a simplified plan view showing how a pipe carriage may be employed to move odd shaped tank plates past the pair of overhead vertical blasters; and

FIG. 19 is a diagrammatic elevational view showing how an orbitally moving nozzle of a horizontal blaster traces a helical pattern on a face of an upright traveling plate.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

FIGS. 1 and 2 show an upright steel plate 20 40 feet in length supported by its bottom edge on three carriages 22 that travel along a pair of rails 24 through an elongated sandblasting booth that is indicated in phantom at 25. Preferably, the sandblasting medium is steel grit which drops through the floor of the booth for recycling in a well known manner. As shown in FIG. 5 the rails 24 are of triangular cross sectional configuration to shed sandblast particles and the wheels 26 of the carriages 22 have circumferential grooves 28 of V-shaped cross section for accurate guidance by the rails. As shown in FIGS. 5, 9 and 10 each of the carriages 22 comprises a frame made of heavy steel channels, the frame having opposite side channels 30 that are interconnected by forward and rearward pairs of transverse channels 32. Each of the four wheels 26 is mounted on a plate 34 that is braced by a pair of gussets 35, the plate and gussets being welded to a pair of the transverse channels 32.

For the purpose of engaging the bottom longitudinal edge of a plate 20, each of the three carriages 22 is provided with a pair of brackets 36 each of which has a pair of upstanding ears 38 equipped with corresponding cap screws 40 that are tightened to clamp the plate. Each of the brackets 36 lies across a pair of the transverse channels 32 and engages the top flanges of the channels from their undersides. As indicated in FIGS. 9 and 10, small plates 42 are attached to the undersides of the opposite ends of each bracket 36 by a pair of screws 44 with an intervening spacer 45 and at least one cap screw 46 in each of the plates 42 may be tightened upward against the corresponding channel iron flange. To carry a flat plate 20, the various brackets 36 are aligned with the center line of the track 24. If an upright plate on the three carriages 22 is curved longitudinally as indicated in phantom at 48 in FIG. 1, the brackets 36 are positioned off center to accommodate the curvature of the plate.

As shown in FIG. 2, an upright plate 20 on three carriages 22 is stabilized from above by three corresponding trolleys on a central overhead monorail 52. Each trolley 50 has a pivotally mounted downwardly extending arm 54 which is adjustably connected by a chain 55 to a corresponding clamp 56 that grips the upper edge of the upright plate. The plate 20 is towed by a cable 58 which is actuated by a variable speed drive and is connected to the leading carriage 22. The other two carriages together with the three overhead trollyes 50 are pulled along by the travelling plate.

FIG. 1 shows the leading edge of the plate 20 approaching a pair of confronting horizontal blasters 60 that lie on opposite sides of the center line of the pair of rails 24 to process the two opposite faces of the plate simultaneously. The preferred embodiment of a horizontal blaster 60 is best shown in FIGS. 5–7.

Each horizontal blaster 60 has an upright housing 62 mounted on a supporting carriage 64 by a pivot 65 which permits the housing to turn 90° out of the way when the blaster is not needed for processing upright tank plates. The carriage 64 rides on a flat polished floor plate 66 of a base structure and is supported thereon in a nearly frictionless manner by four inflatable air casters 67 which may be of the construction shown in FIG. 7. Each air caster 67 has a toroidal flexible envelope 68 which may be inflated to elevate the carriage and to confine an air cushion in a well known manner for floating the carriage.

In the construction shown in FIG. 7, compressed air is introduced as indicated by the arrows to form the supporting air cushion and the envelope 68 has a port 69 for inflation of the envelope by diverting a portion of the compressed air stream. The toroidal envelope 68 surrounds a downwardly extending foot-piece 70, the four foot-pieces supporting the carriage on the floor plate 66 when the envelopes are deflated.

A small control cabinet 71 on the carriage 64 has a control panel of the character shown in FIG. 6A providing four individual valves 72 for the four air casters respectively to permit the air pressure of the four air cushions to be adjusted in accord with the location of the center of gravity of the unit to level the unit. With the pressures of the four air cushions adjusted to level the horizontal blaster 60, the blaster, weighing as much as 6000 lbs., may be moved freely by a lateral manual force of only 6 pounds. The control panel also includes a master solenoid valve 73 connected by a cable 74 to a remote control 75 having buttons to start and stop air flow to inflate and deflate the air casters 67.

Any suitable guide means may be employed to confine the movement of a horizontal blaster 60 to a path that is perpendicular to the rails 24 on which the carriages 22 travel. For this purpose a pair of spaced polished horizontal guide rods 76 are positioned perpendicular to the track 24 and the two guide rods are embraced by a pair of ball bushings 78 on the opposite sides respectively of the carriage 64. Extending forwardly and rearwardly from the ball bushings 78 are suitable sleeves 80 of corrugated elastomer that embrace and protect the guide rods. The two guide rods 76 are supported by a back plate 82 that has a limited range of vertical movement on a back wall 84 of the base structure to accommodate the changes in elevation of the carriage 64 by inflation and deflation of the air casters 67. The carriage 64 is yieldingly urged forward by a pair of coiled tension springs 85 which are connected at their forward ends to a corresponding pair of upright posts 86 of the base structure. An additional safeguard against disorientation of the carriage 64 is provided by rollers 88 mounted on fixed brackets 90 adjacent vertical plates 92 that extend longitudinally on opposite sides of the lower portion of the carriage 64.

A protective apron 94 of flexible rubber-like material extends forward from the carriage 64 and is draped over a front wall 95 of the base structure as shown in FIG. 5. As indicated in FIG. 6 the apron 94 also covers the top of the carriage 64 and is draped over opposite side walls 96 of the base structure.

Any suitable means may be provided to latch the rotatable housing 62 either in its normal operating orientation shown in FIGS. 5 and 6 or in its stowed orientation shown in FIG. 3. As shown in FIG. 5 this purpose may be served by a latch pin 98 for engagement selectively with two holes 99 spaced 90° apart in the top wall of the carriage 64.

Rotatably mounted by spaced bearings 100 on the top of the blaster housing 62 is a hub 102 that carries a forward pair of diametrically opposite divergent arms 104 and 105. The hub 102 is unitary with a sprocket wheel 106 in a protective cover 108 and is driven by a variable speed motor 110. In the construction shown, a sprocket 112 on the shaft of the motor 110 is connected by a sprocket chain 114 to a sprocket 115 of a reduction gear box 116 and an output sprocket 118 of the gear box is connected by a sprocket chain 120 with the sprocket wheel 106 of the rotary hub.

A flexible hose 122 extends through the rotary hub 102 to a sandblast nozzle 124 and is held against rotation on its axis by a clamp 125 on the housing 62. A supply hose 126 for highly compressed air entraining sandblasting particles is connected to the flexible hose 122 by a suitable releasable coupling 128. The base end of the blaster nozzle 124 is embraced by a bearing 130 that is anchored to a sleeve 132 that is releasably secured to the arm 104 by a pair of screws 134 and may be adjusted along the length of the arm. A counterweight 135 for the sandblast nozzle 124 is mounted on a sleeve 136 that is slidable along the second arm 105 and is releasably secured by a suitable screw 138.

The manner in which the sandblast nozzle 124 is mounted on the arm 104 is shown more specifically in FIG. 14. The sleeve 132 that is slidable along the arm 104 has a triangular wing 140 with two opposite flanges 142 and the hose 122 extends loosely through a U-bolt 145 that is covered by a plastic sheath 146. The two ends of the U-bolt 145 are clamped to the two flanges 142 respectively by pairs of nuts 148. Embracing the cylindrical base portion of the nozzle 124 and secured thereto by set screws 150 is a pair of spaced Teflon collars 152 that are of stepped cross sectional configuration to seat the opposite ends of a Teflon cylinder 154. The Teflon cylinder 154 is clamped to the flanges 142 of the wing 140 by means of a pair of U-bolts 155 that are secured by nuts 156. The cylinder 154 remains fixed relative to the arm 104 but rotates relative to the two Teflon collars 52 that are anchored to the nozzle 124. Any substantial rotation of the nozzle 124 on its own axis is prevented by the previously mentioned hose clamp 125 although the nozzle may rotate slightly by stressing the hose 122 in torsion.

The orbitally moving sandblast nozzle 124 traces a helical path on the moving plate 120, the general character of the pattern being indicated at 158 in FIG. 19. The spacing of the successive convolutions of the pattern 158 is determined by the rate of orbital rotation of the nozzle 124 relative to the rate of linear travel by the upright plate 20. The width of the helical path varies with the distance of the nozzle from the plate and, of course, the severity of the abrading action varies inversely with the spacing of the nozzle from the plate. To remove relatively light mill scale from the steel plate the sandblast nozzle may be at substantial distance from the plate. On the other hand, if the steel plate is

heavily corroded, the nozzle may be positioned relatively close to the plate. It is also to be noted that the depth of abrasion decreases with the speed of orbital rotation of the nozzle. In practice it is not difficult to set the distance of the nozzle from the plate and to adjust the rate of travel of the plate and the rate of orbital rotation of the nozzle to obtain any desired sandblast effect.

An important feature of the invention is the concept of continuously urging the orbitally moving nozzle **124** towards the traveling plate **20** to permit the distance of the orbitally moving nozzle from the plate to be determined by pilot means in rotating contact with the plate. A further feature is the concept of employing pilot rollers **158** on two corresponding diametrically opposite divergent pilot arms **160** and **161** that straddle the orbit of the nozzle **124** and therefore lie outside of the sandblasting zone. In reducing frictional resistance to movement of the horizontal blaster, the air casters **67** make the horizontal blaster highly responsive to the tension springs **85** and a further important fact is that the ball bushings **78** embracing the polished guide rods **76** keep the orientation of the horizontal blaster perpendicular to the traveling plate **20.** Since only one of the two pilot arms **160,161** is usually stressed to follow the surface of a curved plate with a resultant strong tendency for rotation of the horizontal blaster out of its normal perpendicular alignment, the importance of the parallel guide rods **76** may be appreciated.

In preparation of the arrival of the leading edge of a steel plate **20** at the operating zone of a horizontal blaster **60,** an operator manually retracts the horizontal blaster from the path of travel of the plate and then releases the blaster to make pilot contact with the plate as soon as the leading edge of the plate comes within the range of the pilot arms **160, 161.** A feature of the inventin in this regard is that it is merely necessary to cut off flow of compressed air to the four air casters **67** to immobilize the retracted horizontal blaster in opposition to the tension springs **85.** Deflating the air casters **67** permits the four foot-pieces **70** of the horizontal blaster to drop into contact with the floor plates **66.** Subsequently, when the leading edge of an upright plate **20** reaches the processing zone, the operator merely turns on the compressed air to the air casters **67** to permit the horizontal blaster to float forward until piloting contact is made with the traveling plate by the roller **158** on the pilot arms **160,161.** Thus, the use of the air casters **67** makes it unnecessary to provide any kind of mechanical latch to restrain a retracted horizontal blaster in opposition to the force of the two tension springs **85.**

Initially only the leading pilot arms **160** and **161** space the horizontal blaster **60** from the traveling plate **20.** Finally, as the plate moves out of the processing zone, only the following pilot arms **160** and **161** make contact with the plate.

FIG. **8** shows in side elevation a well known type of ball bearing caster **162** that may be substituted for the air casters **67.** The caster **162** has a plurality of steel balls **164** protruding from its underside for rolling contact with the floor **66.** If such a ball bearing caster is employed, it is desirable to provide a mechanical latch (not shown) to restrain a retracted horizontal blaster.

When **40** foot lengths of pipe are processed in the booth **25,** the two horizontal blasters **60** are stowed compactly against opposite sides of the booth as best shown in FIG. **3.** To permit such compact storage not only must the housing **62** be rotatable relative to the carriage **64** as heretofore described, but also the two pilot arms **160, 161** must be foldable. As best shown in FIG. **1,** each of the two pilot arms **160, 161** is mounted on a pair of parallel arms **166** that are in turn mounted on the housing **62** of the horizontal blaster. Each of the two parallel arms **166** is made in two sections which are joined together by a suitable hinge **168** and the two hinges **168** of a pair of the parallel arms **166** are coaxial to permit the pair of parallel arms to be folded upward against two corresponding inclined stop posts **170** on the housing **62** as indicated in phantom in FIG. **6.** With the two pilot arms **160, 161** folded out of the way in this manner, it is a simple matter to rotate the housing **62** of the horizontal blaster **90°** to swing the folded pilot arms out of the way as shown in FIG. **3.**

Lengths of pipe, usually **40** feet long, are processed by two successive overhead vertical blasters **180** which are mounted on two corresponding transverse overhead booms **182.** When the two horizontal blasters **60** are in use, the two vertical blasters **180** are retracted on the booms **182** to the opposite side walls of the booth **25** as shown in FIG. **1.** To put the two vertical blasters **180** into service they are moved outward on the booms **82** to the longitudinal center line of the booth and then each vertical blaster is stabilized by four releasable guy wires **184** as shown in FIGS. **3** and **4.**

As best shown in FIG. **13,** each vertical blaster **180** has a frame comprising an upper section **185** and a lower section **186,** the upper section being suspended from a dolly **188** on a boom **182** by means of pivot pin **190.** The upper frame section **185** has four downwardly extending legs which telescope into corresponding tubular members **192** of the lower frame section **186** to make the frame as a whole vertically expandable and contractible. The degree to which the frame is expanded is controlled by a manually operable screw jack that comprises a vertical screw **193** mounted on the lower frame section **186** and nut means (not shown) in a casing **194** that is carried by the upper frame section **185,** the nut means being rotatable by a crank **195.**

Mounted on one side of the lower frame section **186** is a rotary hub **196** of the previously described construction in a pair of speced bearings **198** for actuation by a variable speed motor **200.** A sprocket **202** on the shaft of the motor **200** is connected by a sprocket chain **204** to a sprocket **205** on the input shaft of a reduction gear box **206** and a sprocket **208** on the output shaft of the gear box is connected by a sprocket chain to a sprocket wheel **212** that is unitary with the rotary hub **196.**

In a previously described manner the rotary hub **196** carries a pair of downwardly extending diverging arms **214** and **215.** A flexible hose **216** is secured against rotation by a clamp **218** on the lower frame section **186** and extends through the tubular hub **196** to a sandblast nozzle **220.** In a previously described manner the nozzle **220** is secured by a bearing **130** to an adjustable sleeve **132** on the arm **214** and a counterweight **135** is carried by a sleeve **136** that is adjustable along the other arm **215.**

FIGS. **3** and **4** show how parallel **40** foot lengths of pipe **222** may be mounted on a pipe carriage, generally designated **224,** for movement along the rails **24** into

the sandblast zone produced by the two overhead vertical units **180.**

As best shown in FIG. **13** the pipe carriage **224** has a lower frame **225** equipped with grooved wheels **226** and has an upper frame **228** to carry the pipe **222,** the upper frame being supported by upright posts **230** on the lower frame. Interchangeable sets of posts **230** of different vertical dimensions make it possible to adjust the elevation of the upper frame **228** as required to bring pipes of different diameters to a desired spacing below the two orbiting nozzles **220.** It is apparent that gross adjustments of the vertical spacing between the pipes and the nozzles **220** may be provided by the interchangeable sets of posts **230** and then finer final adjustment of the spacing may be accomplished by operating the screw jacks on the vertical blasters **180.**

FIGS. **3** and **4** show how a cable **232** actuated by a variable speed drive may be connected to the front end of the pipe carriage **224.** FIG. **11** is an enlarged plan view indicating that the pipe carriage **224** moves forward in the direction of the arrow **234** along the rails **24.** The upper frame **228** of the pipe carriage has a forward transverse row of spaced rollers **235** to nest the front ends of the lengths of pipe and has a rearward transverse row of rollers **236** to nest the trailing ends of the lengths of pipes, there being eight rollers in each row to act in pairs to nest the four pipes. Viewing the carriage **224** in the direction of the arrow **234** in FIG. **11** and numbering the rollers of each of the two rows beginning at the left side of the carriage, the even numbered rollers of the forward row of rollers **235** are power driven, the odd numbered rollers being idler rollers. On the other hand, in the rear row the odd numbered rollers **236** are power actuated and the even numbered rollers are idler rollers.

The power actuated rollers of the two rows are driven by a variable speed motor **238** (FIG. **13**) on the lower frame **225** which motor has a drive sprocket **240** connected by a sprocket chain to a driven sprocket **242** on a countershaft **244** that, as shown in FIG. **11,** extends longitudinally of the pipe carriage. A sprocket **245** on the rear end of the countershaft is connected by a sprocket chain **246** (FIG. **13**) to a sprocket **248** which is on the hub of the seventh roller in the rear row of eight rollers **236.** As best shown in FIG. **15,** a second sprocket **254** on the hub **252** is provided to actuate the rest of the odd numbered rollers **236** of the rear row. For this purpose a continuous sprocket chain **255** is of the pattern shown in FIG. **13** where the sprocket chain goes under idler sprockets **256** positioned beneath even numbered rollers **236** (in this view the rollers are numbered from the right) and passes over sprockets **258** on the hubs of the fifth, third and first rollers **236.** The return run of the sprocket chain **255** extends from an idler sprocket **260** to an idler sprocket **262.**

At the forward end of the countershaft **244,** a sprocket **264** (FIGS. **11** and **12**) drives the even numbered rollers (again counting from the right) of the forward row of rollers **235.** As shown in FIG. **12** the sprocket **264** on the countershaft is connected by a sprocket chain **265** to a sprocket **266** on the hub of the eighth roller **235** of the row and a second sprocket **268** is connected to an endless sprocket chain **270** of the pattern shown. In FIG. **12** the endless sprocket chain **270** passes under idler sprockets **272** that are positioned below the seventh, fifth and third rollers **235** of the row. The endless sprocket chain **270** passes over sprockets **274** on the hubs of the sixth, fourth and second rollers **235** to actuate these rollers. The return run of the sprocket chain extends from an idler sprocket **275** to an idler sprocket **276.**

It is apparent that each length of pipe **222** nests at its forward end on odd and even numbered rollers of the forward row of rollers **235** with the even numbered rollers of the row power actuated and that the length of pipe nests at its rear end on odd and even numbered rollers of the rear row of rollers **236** with the odd numbered rollers of the rearward row power actuated. As indicated in FIG. **15,** each of the various rollers **235** and **236** is embraced by a cylindrical casing **278** of rubber-like material which not only provides traction on the pipe but also protects the roller from the abrasive effect of the sandblasting.

FIGS. **16** and **17** show how the pipe carriage **224** of FIGS. **11–13** may be provided with two auxiliary rows of idler rollers **280** to enable the pipe carriage to handle multiple lengths of pipe **282** shown in section in FIG. **17** that are of too small diameter to be nested by the previously mentioned forward and rearward rows of rollers **235, 236.** Only the rearward auxiliary row of rollers **280** is shown in FIGS. **16** and **17.**

In FIG. **16,** a transverse auxiliary channel iron **284** which is removably placed across the upper carriage frame **228** near the rearward transverse row of rollers **236** carries a rearward auxiliary row of seven idler rollers that are staggered relative to the adjacent eight rollers **236.** In like manner, a second similar transverse channel iron (not shown) is positioned adjacent the forward transverse row of rollers **235** and carries another auxiliary row of seven idler rollers that ar staggered with respect to the forward rollers **235.**

FIG. **17** shows how the rear end of each pipe **282** is nested by a rearward auxiliary roller **280** and an idler roller of the rearward auxiliary row of idler rollers **236.** In like manner the forward end of each pipe **282** is nested by an idler roller of a forward auxiliary row of idler rollers **280** and by a roller of the forward row of rollers **235.**

The pipe carriage shown in FIGS. **11–13** can also be modified to carry pipes that are substantially larger in diameter than the pipes **222** by simply omitting alternate forward rollers **235** and alternate rearward rollers **236.** For example, if the odd numbered rollers of the forward row of rollers **235** and the odd numbered rollers of the rearward row of rollers **236** are removed, the remaining set of four forward rollers **235** and the remaining set of four rearward rollers **236** will handle two lengths of pipe that are of substantially greater diameter than the pipes **222** shown in FIGS. **12** and **13.**

In accord with these teachings it has been found to be practical to employ only four different pipe carriages to handle the whole range of pipe sizes from ½ inch diameter to **42** inch diameter. One pipe carriage handles **2** inch through **6** inch pipe; a second pipe carriage handles pipe from **8** inches diameter to **14** inches diameter; a third pipe carriage handles pipe from **16** inches diameter to **24** inches diameter; and the fourth pipe carriage is capable of handling pipe of **30** inches and **42** inches diameter.

Referring to FIGS. **3** and **4,** with grit-laden compressed air supplied to the two vertical blasters **180** at a given rate, the intensity of the blasting action on the lengths of pipe **222** may be varied as desired by varying the rate of travel of the pipe carriages, the rate of rota-

tion of the overhead nozzles **220** and the vertical distance between the pipes on the carriage and the two overhead orbiting nozzles **220.**

FIG. **18** shows how odd shaped plates may be mounted on a pipe carriage **224** to be processed by the two overhead vertical blasters **180.** The two plates **290** shown in FIG. **18** are plates of tapered plan configuration for use in fabricating a conical top wall of a storage tank.

The description herein in specific detail of the presently preferred practice of the invention will suggest various changes, substitutions and other departures from our disclosure within the spirit and scope of the appended claims. For example, instead of the plates and pipes moving on carriages through a processing zone with the blasters at fixed locations in the processing zone, the plates and pipes may be at fixed locations with the blasters mounted on carriages to traverse the fixed plates and pipes.

We claim:

1. In an apparatus for sandblasting surface areas of elongate structural members having different configurations, the combination of:

means to move the members longitudinally along a path through a sandblasting zone;

at least one horizontal blaster unit in said zone with laterally directed nozzle means movable in an upright orbit to sandblast the surface area of a member of one configuration;

at least one overhead vertical blaster unit in said zone with downwardly directed nozzle means movable in a substantially horizontal orbit to sandblast the surface area of a member of another configuration; and

means respectively supporting said blaster units for independent movement laterally of said path between a position of non-use and an operating position of use,

whereby the horizontal blaster unit and the vertical blaster unit may be selectively utilized to sandblast the surface areas of members having different configurations.

2. A combination as set forth in claim **1,**

which includes two horizontal blaster units on opposite sides respectively of said path, and means to urge said horizontal blaster units towards said path;

and which includes pilot means on the horizontal blaster units to contact the members of one configuration to limit the movement of the blaster units by said urging means to maintain predetermined spacing between the contacted members and said nozzle means of the horizontal blaster units.

3. A combination as set forth in claim **1** which includes a track with rails extending along said path;

which includes carriage means to support the members for movement along said track;

in which the rails of said track are of inverted V-shaped configuration to shed sandblast particles falling thereon;

and in which the carriages are mounted on wheels to traverse said rails, the wheels having circumferential grooves for engagement with the rails.

4. A combination as set forth in claim **1** in which the members are plate members, and including carriage means movable along said path to support the plate members by their lower edges;

and which includes means separate from the carriage means to releasably engage upper portions of the plate members to stabilize the plate members in upright position on said carriage means.

5. A combination as set forth in claim **4** in which said stabilizing means comprises:

an overhead track extending along said path;

clamp means to releasably engage the upper edges of the plate members; and

trolley means on said overhead track connected to said clamp means.

6. A combination as set forth in claim **1** in which the means for supporting the vertical blasting unit includes overhead track means extending transversely of said path in said zone; and

trolley means on said overhead transverse track means carrying said vertical blaster unit for movement between an operating position above said path and a retracted position out of the way to avoid interference with the processing of members by the horizontal blaster unit.

7. A combination as set forth in claim **6** which includes releasable guy means to stabilize the vertical blaster unit at its operating position.

8. A combination as set forth in claim **1** in which the members are pipe members, and including carriage means to move a plurality of lengths of said pipe members longitudinally along said path through said processing zone with the pipe members positioned side by side in a substantially horizontal row;

which includes at least two spaced transverse rows of rollers on said carriage means to support the opposite ends of the pipe members;

and which includes power means on said carriage means to actuate at least some of said rollers to rotate the pipe members on their axes as they travel through the processing zone.

9. A combination as set forth in claim **8** in which said carriage means for the plurality of said pipe members are variable in height for coarse adjustment of the vertical spacing between the pipe members and the vertical blaster unit;

and in which the vertical blaster unit is vertically extensible and contractible by small increments for fine adjustment of said vertical spacing.

10. In an apparatus for sandblasting large plates for the fabrication of large storage tanks, the combination of:

means for holding a plate in upright position in a sandblasting zone;

a horizontal blaster in said zone on one side of the plate to sandblast one face of the plate, said blaster having blaster nozzle means power actuated to move in an upright circular orbit;

means to yieldingly urge the horizontal blaster towards the plane of the plate;

means to cause relative movement between the plate and the blaster longitudinally of the plate to cause the orbitally moving nozzle to blast a helical path along the length of the plate; and

pilot means on the horizontal blaster to contact the plate to limit the movement of the blaster towards the plate to maintain predetermined spacing between the plate and the orbiting nozzle means.

11. In an apparatus for sandblasting large plates for the fabrication of large storage tanks, the combination of:

means for holding a plate in upright position in a sandblasting zone;

a horizontal blaster in said zone on one side of the plate to sandblast one face of the plate, said blaster having blaster nozzle means power actuated to move in an upright circular orbit;

means to yieldingly urge the horizontal blaster towards the plane of the plate;

means to cause relative movement between the plate and the blaster longitudinally of the plate to cause the orbitally moving nozzle to blast a helical path along the length of the plate; and

pilot means on the horizontal blaster to contact the plate to limit the movement of the blaster towards the plate to maintain predetermined spacing between the plate and the orbiting nozzle means,

said pilot means including pilot roller means for rolling contact with the face of the plate.

12. In an apparatus for sandblasting large plates for the fabrication of large storage tanks, the combination of:

means for holding a plate in upright position in a sandblasting zone;

a horizontal blaster in said zone on one side of the plate to sandblast one face of the plate, said blaster having blaster nozzle means power actuated to move in an upright circular orbit;

means to cause edgewise movement of the upright plate along a path past the horizontal blaster to cause the orbitally moving nozzle to blast a helical path along the length of the plate;

a base with a flat level surface;

low friction means to movably support the horizontal blaster on said flat surface to permit free movement of the horizontal blaster towards and away from said path;

spring means to urge the horizontal blaster towards said path;

guide means to maintain a given orientation of the horizontal blaster relative to said path and to guide the horizontal blaster along a linear path in the movements of the horizontal blaster towards and away from said path; and

pilot means on the horizontal blaster to contact the plate to limit the movement of the blaster towards the plate to maintain predetermined spacing between the plate and the orbiting nozzle means.

13. A combination as set forth in claim **12** which includes releasable means to maintain the horizontal blaster retracted from the path to await the arrival of a leading edge of a plate to the region of the horizontal blaster, whereby releasing the retracted horizontal blaster permits said spring means to move the horizontal blaster into position to sandblast the plate.

14. A combination as set forth in claim **12** in which the means for supporting the horizontal blaster on said level surface comprises a plurality of air casters to float the horizontal blaster above the level surface on a corresponding number of air cushions.

15. A combination as set forth in claim **14** which includes control means to cut off air to said air casters when the horizontal blaster is retracted from said path through the processing zone thereby to lower the horizontal blaster onto said level surface to immobilize the blaster against the resistance of said spring means,

whereby with the horizontal blaster retracted and resting on the level surface said control means may be manipulated to supply compressed air to said casters when a traveling plate reaches the region of the horizontal blaster thereby to permit the spring means to move the horizontal blaster towards the traveling plate until said pilot means makes contact with the plate.

16. A combination as set forth in claim **12** in which said guide means includes:

at least one horizontal guide rod that is anchored against longitudinal movement; and

low friction bushing means on the horizontal blaster slidingly embracing said guide rod.

17. A combination as set forth in claim **12** in which the horizontal blaster rides on a flat surface and is provided with air cushion means to float over the flat surface, inflation of the air caster means raising the horizontal blaster and deflation of the air caster means lowering the horizontal blaster,

said guide rod being free for vertical translation to follow the changes in level of the horizontal blaster.

18. A combination as set forth in claim **12** in which said pilot means comprises a pair of arms straddling the orbit of the nozzle means,

one of the arms being positioned for initial contact with the leading end of a traveling plate,

the other arm being positioned for terminal contact with the trailing end of the plate.

19. A combination as set forth in claim **18** in which the two guide arms are foldable to retract out of the way when the horizontal blaster is not in use.

20. A combination as set forth in claim **18** in which said horizontal blaster has a lower section and an upper section with the upper section rotatable about a vertical axis relative to the lower section;

and in which said two arms are mounted on said upper section whereby the upper section may be rotated to swing the two arms out of the way when the horizontal blaster is not in use.

21. A combination as set forth in claim **18** in which the two pilot arms are foldable to fold out of the way when the horizontal blaster is not in use.

22. A combination as set forth in claim **12** in which the horizontal blaster has a predetermined range of movement transversely of said path;

and in which the horizontal blaster is at an intermediate point in said range when the pilot means is at the center line of said path,

whereby the horizontal blaster has freedom for movement to follow the moving surface of a curved plate that lies on both sides of the center line of the path.

23. In an apparatus for sandblasting lengths of pipe, the combination of:

means to support a plurality of the pipes side by side in a processing zone;

blaster means in said processing zone to sandblast the plurality of pipes from above, said blaster means having a nozzle moving in a substantially horizontal orbit;

means to rotate the pipes on their axes while they are in the processing zone;

means to cause relative movement between the plurality of pipes and the blaster means longitudinally of the plurality of pipes to cause the orbitally moving nozzle to blast a helical path along the plurality of pipes,

said support means having a first forward transverse row of spaced rollers with their axes parallel to the pipes to permit the forward ends of the pipes to rest on pairs of the rollers of the first row,

said support means having a second rearward transverse row of spaced rollers with their axes parallel to the pipes to permit the trailing ends of the pipes to rest on the pairs of rollers of the second row; and

means on the support means to actuate at least some of said rollers to cause the pipes to rotate on their axes as they pass through the processing zone,

some of the rollers of each of the two transverse rows being removable to increase the spacing between the rollers in the two rows to permit the rollers to support and rotate pipes of increased diameter.

24. In an apparatus for sandblasting lengths of pipe, the combination of:

means to support a plurality of the pipes side by side in a processing zone;

blaster means in said processing zone to sandblast the plurality of pipes from above, said blaster means having a nozzle moving in a substantially horizontal orbit;

means to rotate the pipes on their axes while they are in the processing zone;

means to cause relative movement between the plurality of pipes and the blaster means longitudinally of the plurality of pipes to cause the orbitally moving nozzle to blast a helical path along the plurality of pipes,

said support means having a first forward transverse row of spaced rollers with their axes parallel to the pipes to permit the forward ends of the pipes to rest on pairs of the rollers of the first row,

said support means having a second rearward transverse row of spaced rollers with their axes parallel to the pipes to permit the trailing ends of the pipes to rest on the pairs of rollers of the second row; and

means on the support means to actuate at least some of said rollers to cause the pipes to rotate on their axes as they pass through the processing zone,

said support means having a removable third transverse row of idler rollers near said forward row and a removable fourth transverse row of idler rollers near said rearward row, the axes of said idler rollers being parallel with the pipes,

the auxiliary idler rollers being offset laterally from the rollers of said forward and rearward rows to permit pipes of reduced diameter to be transported by the carriage with the forward end of each pipe resting on an auxiliary roller and a roller of the forward row and with the trailing end of each pipe resting on an auxiliary roller and a roller of said rearward row.

25. In an apparatus for sandblasting different work pieces of different configurations with surfaces facing in different directions, the combination of:

means to move the workpieces along a path through a sandblasting zone;

a plurality of blaster units having blaster nozzles to process the workpieces; and

a corresponding plurality of supports for the blaster units each movable laterally of said path from a retracted position away from said path to an advanced operating position to blast workpieces on the path,

different blaster units of said plurality having nozzles facing the path from different directions to process the surfaces of workpieces of different configurations,

whereby the blaster units may be advanced selectively from their retracted positions to their operating positions to sandblast the different configurations of workpieces.

26. A combination as set forth in claim **25** in which said plurality of blaster units include a first kind of blaster unit having a downwardly directed blaster nozzle and a second kind of blaster unit having a blaster nozzle directed towards said path from one side of the path.

27. A combination as set forth in claim **26** in which said first kind of blaster is mounted on an overhead trolley and the second kind of blaster is mounted on a lower carriage.

28. A combination as set forth in claim **27**,

which includes means to urge the second kind of blaster units towards said path;

and which includes pilot means on the second kind of blaster unit to contact the traveling workpieces to limit the movement of the second kind of blaster by said urging means to maintain predetermined spacing between the workpieces and the nozzle means of the second kind of blaster unit.

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