Nov. 1, 1960 D. J. BORODIN 2,958,331

AUTOMATIC PLATING MACHINE

Filed July 9, 1956 9 Sheets-Sheet 1

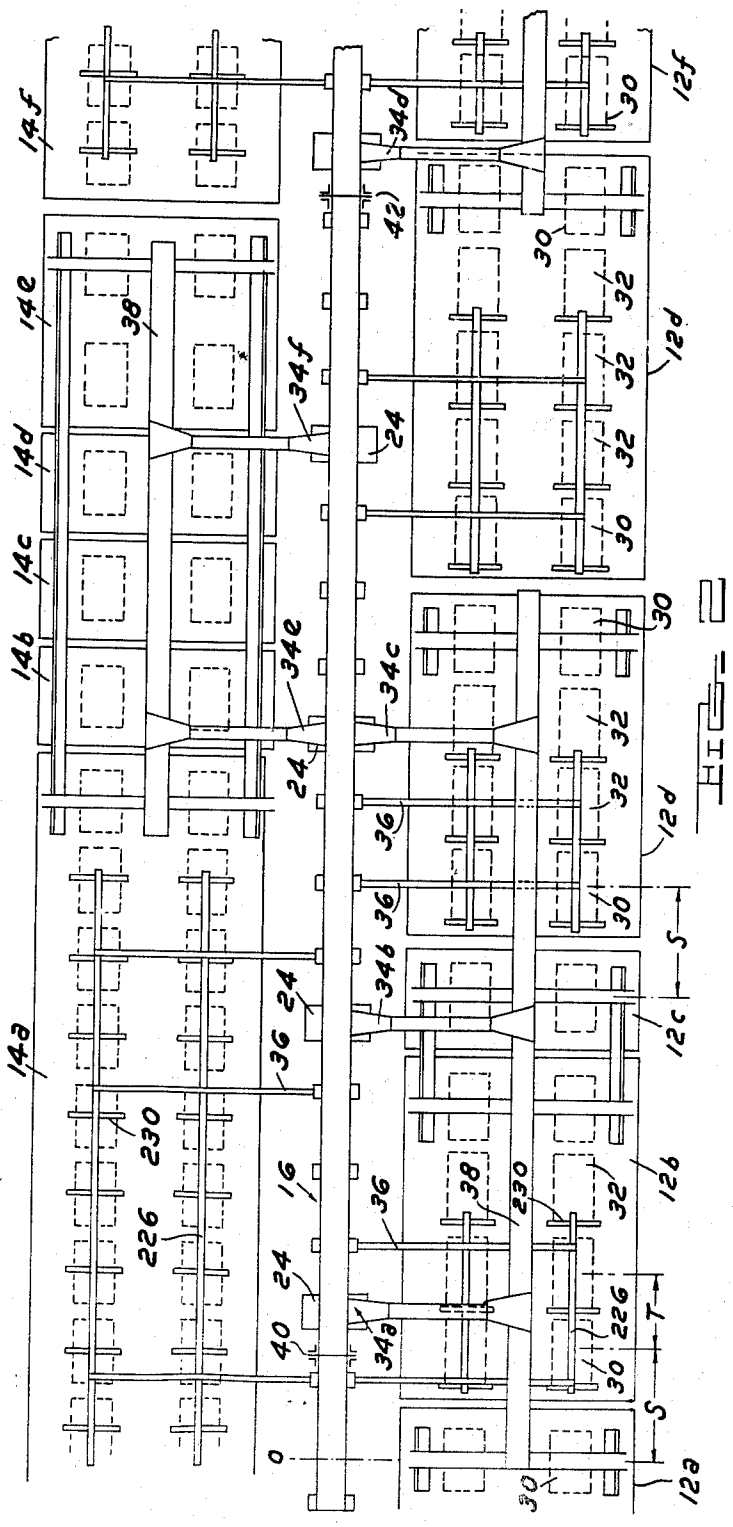

FIG. 2

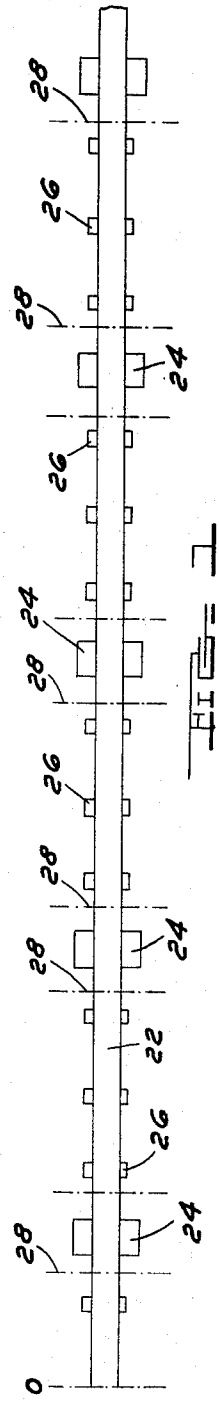

FIG. 1

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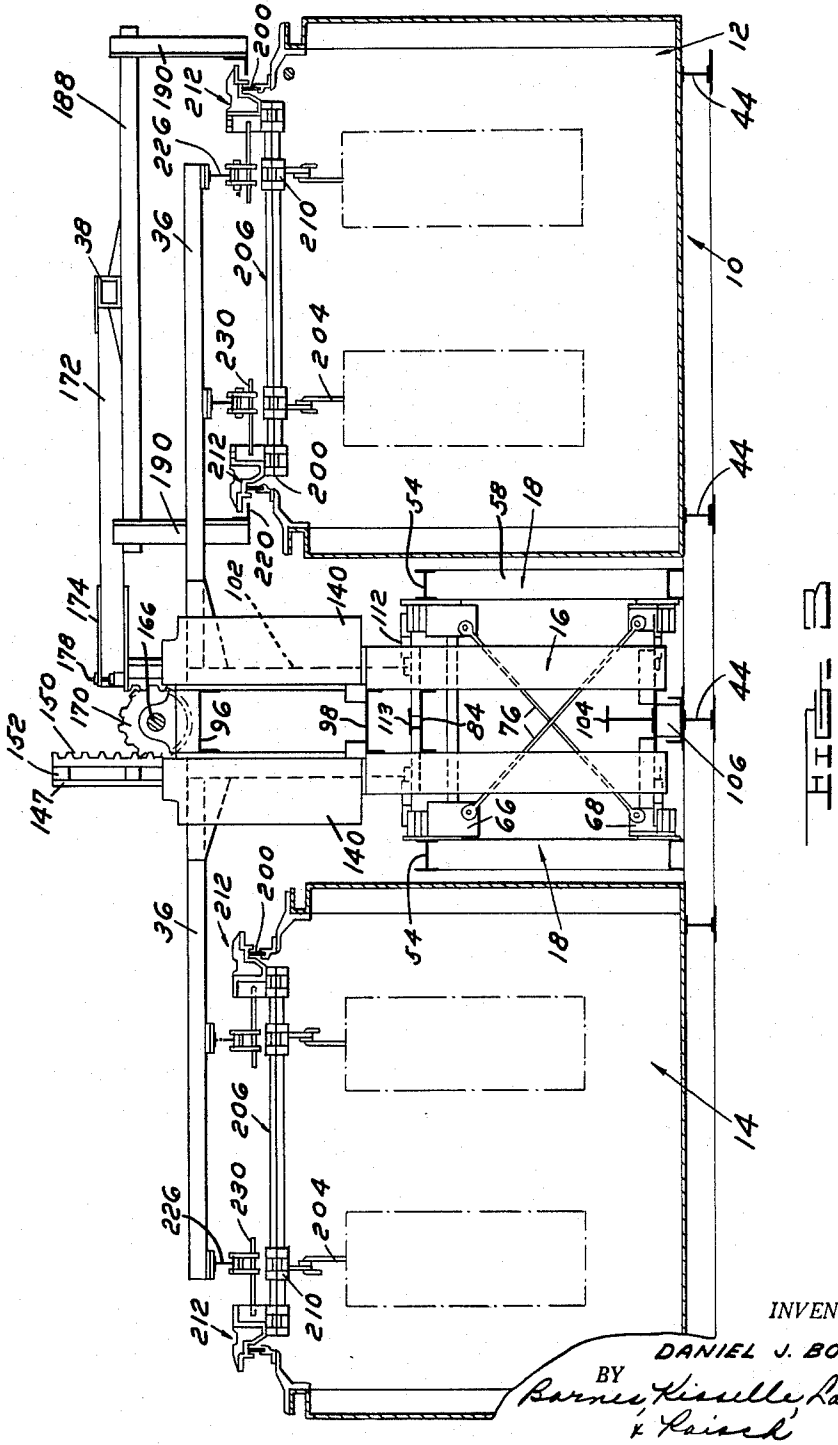

FIG. 5

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Filed July 9, 1956 9 Sheets-Sheet 3

FIG. 3

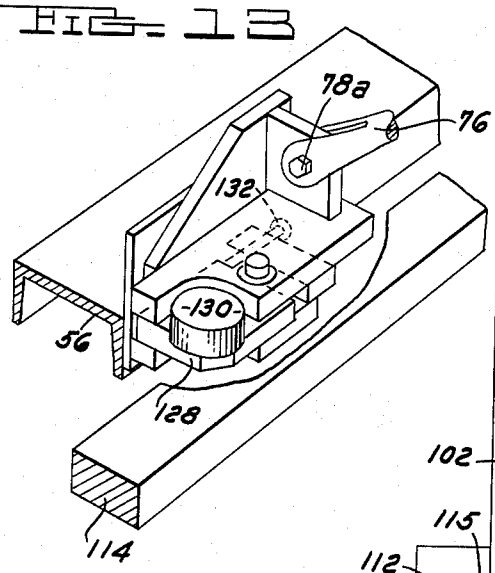

FIG. 4

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AUTOMATIC PLATING MACHINE

Filed July 9, 1956 9 Sheets-Sheet 4

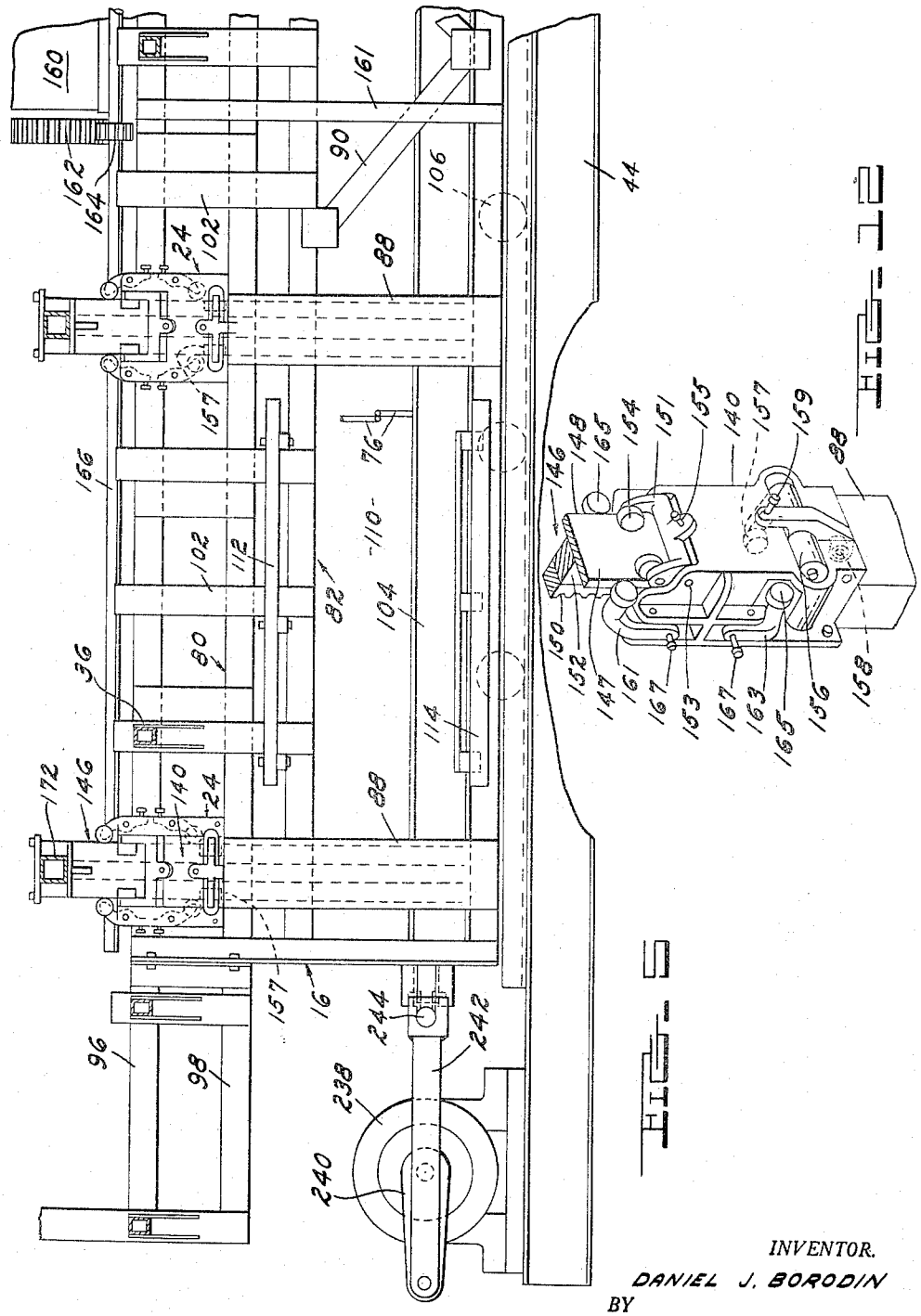

FIG. 12

FIG. 5

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AUTOMATIC PLATING MACHINE

Filed July 9, 1956 9 Sheets-Sheet 5

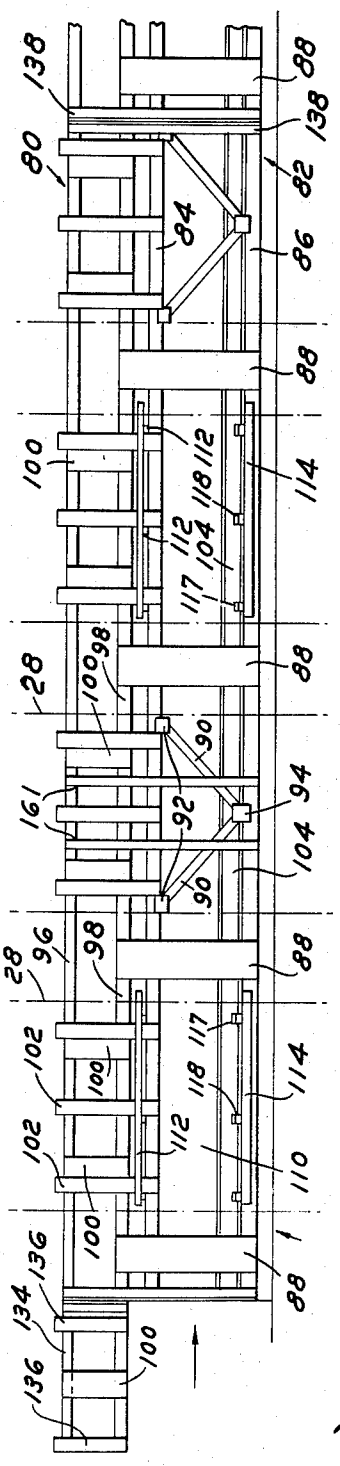

FIG. 6

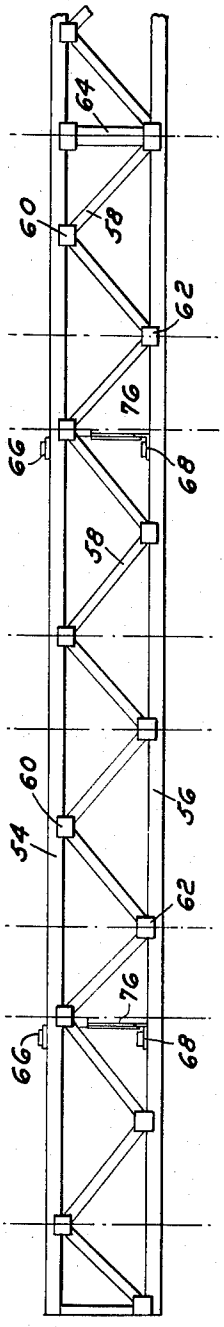

FIG. 7

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Filed July 9, 1956 9 Sheets-Sheet 6

FIG. 8

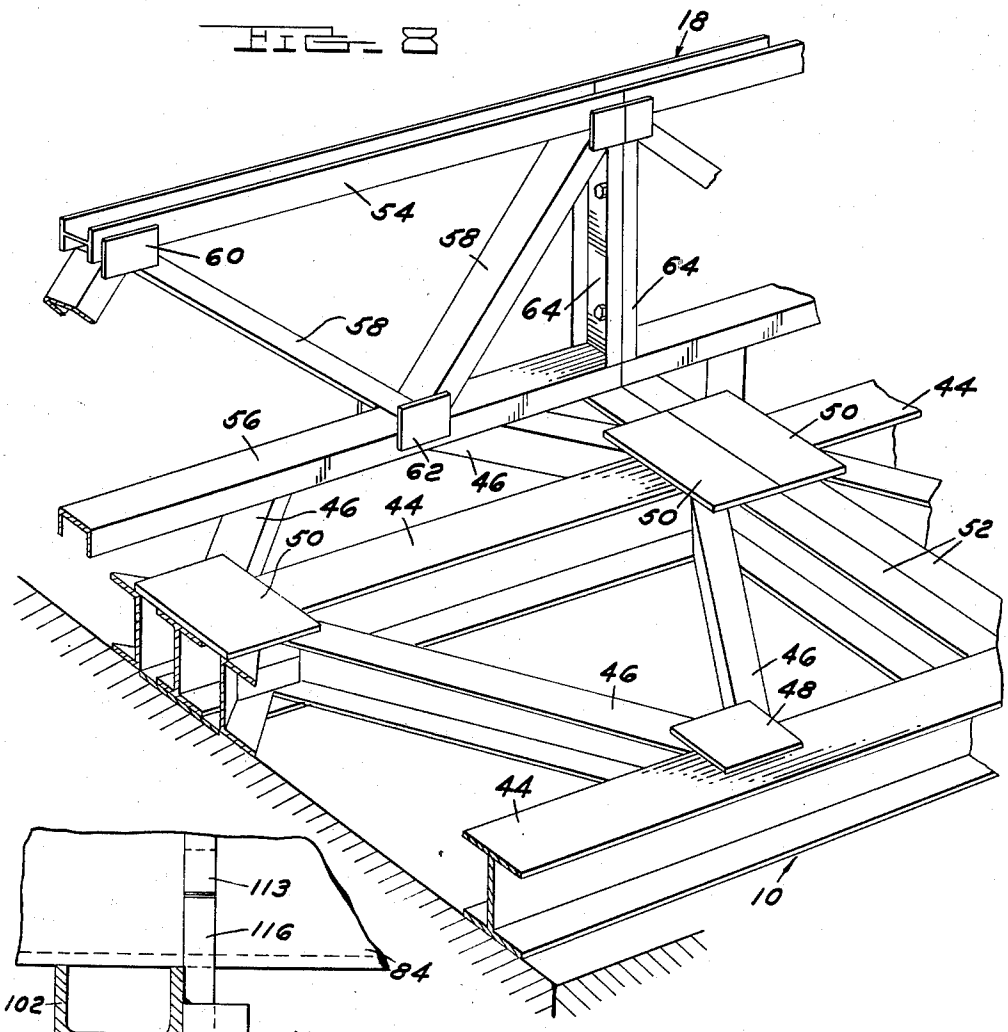
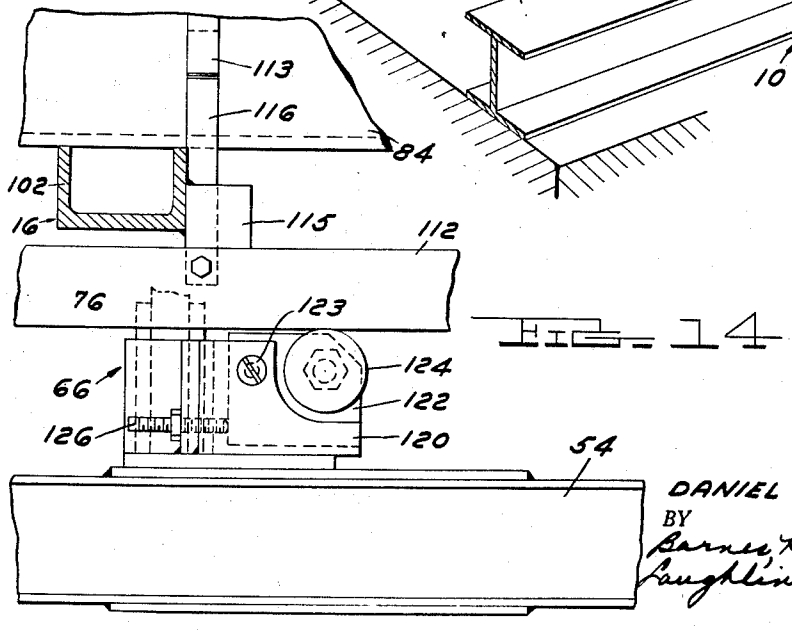


FIG. 14



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AUTOMATIC PLATING MACHINE

Filed July 9, 1956 9 Sheets-Sheet 7

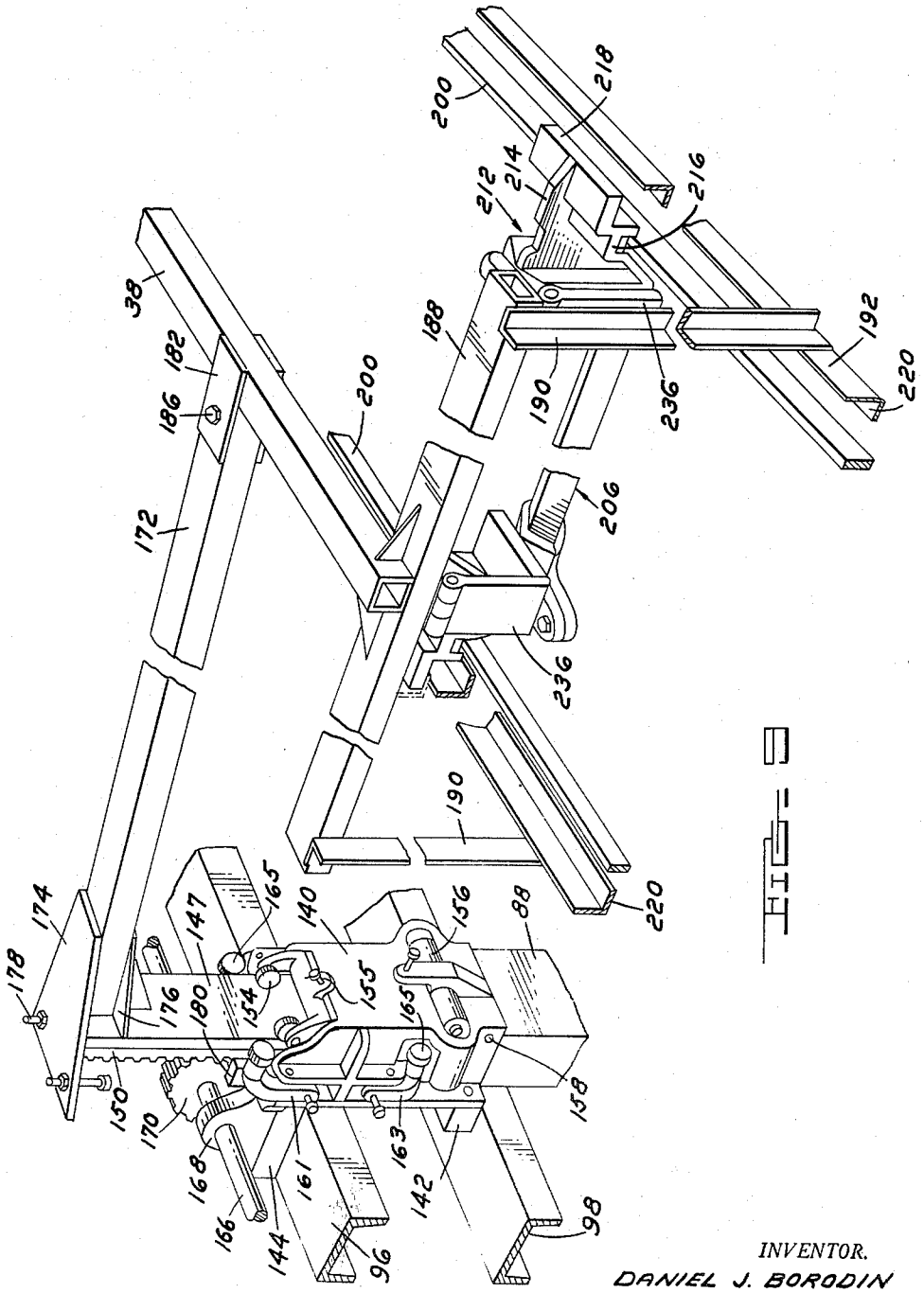

FIG. 5

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AUTOMATIC PLATING MACHINE

Filed July 9, 1956 9 Sheets-Sheet 8

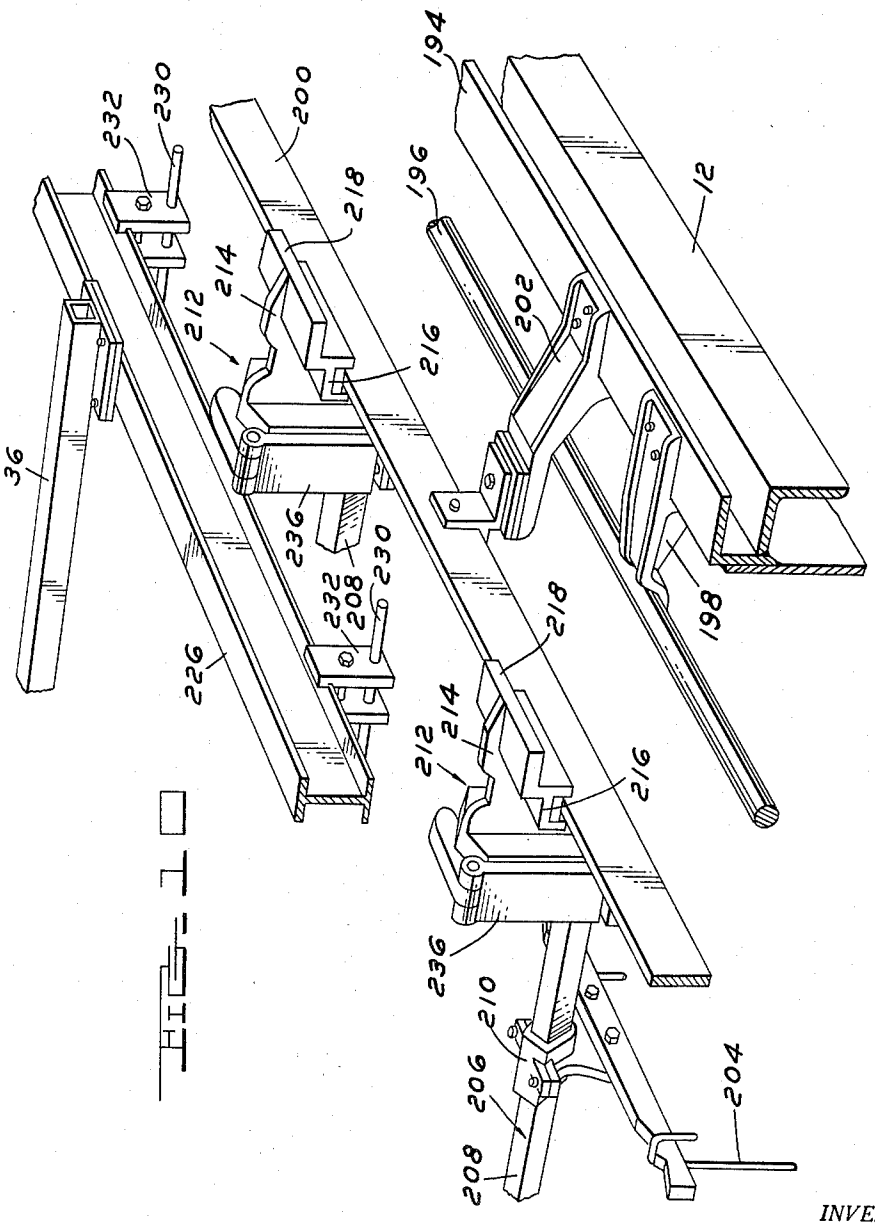

FIG. 10

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AUTOMATIC PLATING MACHINE

Filed July 9, 1956 9 Sheets-Sheet 9

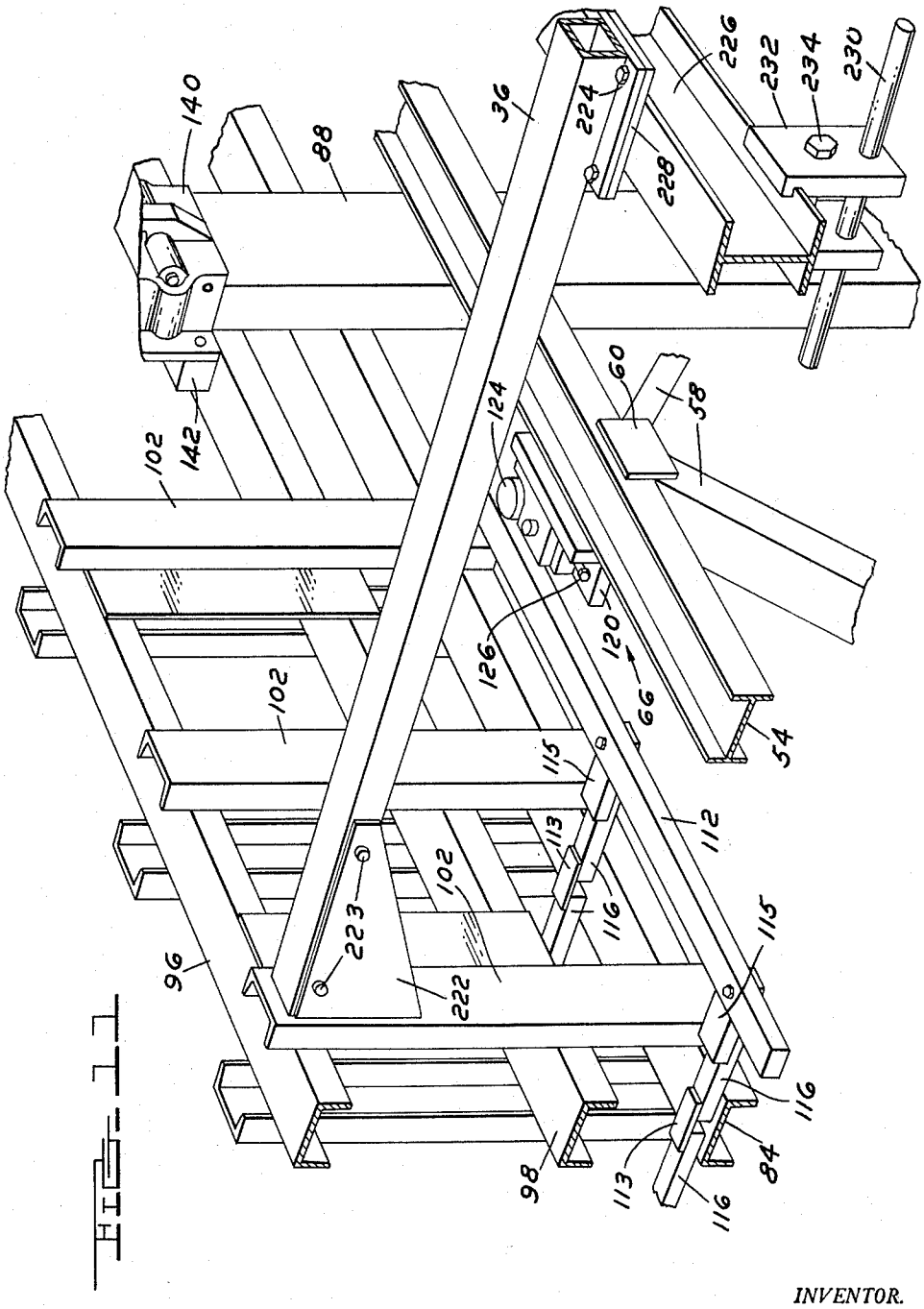

FIG. 11

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United States Patent Office

2,958,331

Patented Nov. 1, 1960

2,958,331

AUTOMATIC PLATING MACHINE

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Filed July 9, 1956, Ser. No. 596,712

32 Claims. (Cl. 134—76)

This invention relates to an automatic plating machine.

Automatic plating machines are quite often relatively large structures reaching sometimes 300 or 400 feet in length. Usually, these plating machines incorporate two rows of tanks side by side and a semi-circular tank at either one or both ends connecting the tanks in the two rows. A mechanism is provided for conveying the work pieces, usually supported on work racks, successively through the tanks along one side of the machine then around the end and back through the tanks along the other side of the machine. In some tanks, the work pieces are retained for a relatively short period of time and in other tanks for a relatively long period of time. Thus, the tanks vary considerably in length. The shorter tanks may be designed to serve as a single work rack station, while the longer tanks may have a plurality of stations. The conveying mechanism is usually arranged to pick up the work rack from one tank and deposit it in another tank; and in those tanks that provide for a plurality of rack stations, the conveying mechanism is designed to convey the work rack intermittently from one end of the tank to the other. Thus, the conveying mechanism includes elevators for picking up a work rack from one tank and depositing it in the next adjacent tank and also includes pushers for moving the work racks horizontally from one end of the multiple station tanks to the other end. The supporting structures for the tanks and the conveying mechanism for plating machines of this type must necessarily be of very rigid construction; and therefore, it has been the practice in the past to custom design each machine according to the requirements of the process which the machine is to perform.

One type of prior art machine with which I am familiar employs a central upright frame, referred to as a carriage, which reciprocates along the line of tanks. The carriage supports the pusher members as well as the elevators. The pushers are very accurately located on the carriage to meet the requirements of the tank arrangement employed, and the elevators are likewise very accurately located on the carriage so that their carrying capacity would correspond to the location of the transfer stations at the end of the adjacent tanks. Thus, in accordance with prior practice, each machine is custom designed to the process specifications; and each machine is thus necessarily custom built.

It is an object of the present invention to provide a novel automatic plating machine which is designed for modular construction; that is, the structural sections of the machine, such as the base, the carriage and the side panels on the base which provide lateral stability for the carriage are provided with a repetitive pattern. The patterns of these structural sections are designed such as to lend themselves readily to practically any required plating process. For example, the carriage is provided with regularly spaced elevator stations throughout its length. Likewise, the carriage is fashioned with regularly spaced supports for mounting pushers thereon. An elevator station may or may not be equipped with

an elevator, depending on whether an elevator is required at that location for the particular tank arrangement employed; and pusher arms are mounted or omitted from the supports therefor as required by the tank arrangement. The spacing of the elevator stations is such that a pair of elevators fixedly positioned on the carriage can accommodate any transfer station midway between these elevators and the next adjacent elevators on either side thereof.

It is a further object of the invention to provide a construction for an automatic plating machine which enables the machine to be built up from a plurality of standard prefabricated sections of repetitive pattern. This enables construction of the individual sections from standard fixtures on a production basis and eliminates the considerable time and expense involved in custom designing and custom building each machine.

Another object of the invention resides in a construction for an automatic plating machine wherein the structural sections lend themselves readily to modular construction and at the same time produce a very rigid structure as a whole.

A further object of the invention resides in a novel arrangement for providing lateral stability to the reciprocating carriage.

Other advantages and improvements of the plating machine of this invention will become apparent from the following description taken in conjunction with the drawings in which:

Fig. 1 is the basic grid layout of an automatic plating machine constructed in accordance with the present invention.

Fig. 2 is a master drawing of a typical machine showing the elevators and pusher bars arranged thereon at locations determined by the tank arrangement and the grid layout shown in Fig. 1.

Fig. 3 is a vertical transverse sectional view of the machine.

Fig. 4 is a fragmentary transverse vertical sectional view of the machine showing the internal bracing of the side panels.

Fig. 5 is a fragmentary longitudinal sectional view of the machine showing primarily the carriage construction at the drive end thereof.

Figs. 6 and 7 are fragmentary side elevational views showing the modular construction of the carriage and side panels, respectively.

Fig. 8 is a fragmentary perspective view showing the arrangement of the base of the machine and the side panels thereon.

Fig. 9 is a fragmentary perspective view showing the elevator arrangement.

Fig. 10 is a fragmentary perspective view showing the pusher arrangement.

Fig. 11 is a fragmentary perspective view illustrating the manner in which the carriage is laterally supported by the side panels of the machine.

Fig. 12 is a fragmentary perspective view of one of the elevator assemblies.

Fig. 13 is a fragmentary perspective view showing the means for providing lateral stability to the lower end of the carriage.

Fig. 14 is a fragmentary sectional view on an enlarged scale of a portion of the internal bracing arrangement shown in Fig. 4.

Referring to Fig. 3, the machine illustrated comprises a base 10 on which two rows of tanks 12 and 14 are supported. A carriage 16 is mounted on base 10 for longitudinal reciprocable movement. At each side thereof, carriage 16 is laterally supported by panels 18. The specific construction of these various sections and the relation therebetween will be fully described hereinafter.

Referring now to Figs. 1 and 2, there is illustrated a grid layout and a master drawing which enables the modular construction of the present invention to be employed in the design and construction of an automatic plating machine to meet the requirements of most any process that has to be performed by a machine of this type. In the grid layout which is shown in Fig. 1, there is drawn at one end thereof a datum line O. All the dimensions of the machine in a longitudinal direction are in effect measured from this datum line O. The datum line is located at one end of an elongated box section **22**, which, for the purposes of design, corresponds to the carriage **16** of the machine. At regularly spaced intervals, there is provided a plurality of elevator stations **24** and pusher stations **26**. For reasons which will be explained more fully hereinafter, the first elevator station **24** is located from the datum line O a distance equal to one-half the distance between the successive elevator stations **24**. It is preferred to have the elevator stations **24** located on 80-inch centers. I have arrived at this dimension from numerous considerations. Steel mill lengths for structural members run on an average of 40 feet. The maximum shipping length of a structure is also usually 40 feet. Thus, the structural members employed in constructing a plating machine of the present invention may be 40 feet in length; and this is an even multiple of 80 inches. The selection of 80-inch centers between successive stations was also arrived at as a suitable dimension considering the maximum loads which the elevators of the machine are designed to sustain and the space within which the elevator columns have to be confined without unduly widening the machine. The grid pattern illustrated in Fig. 1 also includes at each side of each elevator station **24** a broken line **28** which corresponds to a break plane; that is a plane which may be cut transversely through the various structural sections of the machine such as the base **10**, the panels **18** and the carriage **16** at a very convenient point. As will be explained hereinafter, at these break planes, the structural sections are so designed as to permit terminating these sections along these break lines without creating assembly problems, sacrificing strength and rigidity or having to utilize structural members of odd lengths and shapes. The grid illustrated in Fig. 1 is basic in the sense that it remains unchanged and is employed for locating pushers and elevators on any tank arrangement that may have to be used.

One such tank arrangement is illustrated in Fig. 2, which shows a master layout for a portion of the machine. The tanks at one side of the machine are designated **12***a*, **12***b*, **12***c*, **12***d*, **12***e* and **12***f*. The tanks along the opposite side of the machine are designated **14***a*, **14***b*, **14***c*, **14***d*, **14***e* and **14***f*. Tanks **12***c*, **14***b*, **14***c* and **14***d* are single station tanks; that is, tanks in which the work is simply deposited and then lifted from the tank and deposited in the next adjacent tank without being moved longitudinally through the single station tank. The remaining tanks illustrated are multiple station tanks; that is, tanks in which the work is deposited and then moved longitudinally through the tank. The particular arrangement of the tanks will, of course, vary with different machines and will depend upon the particular plating process that is to be performed.

In designing a machine in accordance with the present invention, first the tank arrangement required is drawn as illustrated in Fig. 2 to the scale on which the grid pattern shown in Fig. 1 is based. After the arrangement of tanks is established, the locations of the work rack stations and the outlines of the various tanks are drawn in. The transfer stations are indicated by broken lines **30**; and in multiple station tanks, the stations intermediate the transfer stations **30** at each end thereof are designated **32**. The broken lines which designate these stations actually represent the size of the work rack that is specified by the purchaser of the machine. The stroke of the carriage **16** corresponds to the distance S which is the distance between transfer stations **30**. The number of stations in each tank will, of course, depend upon the cycle time, more specifically, to the length of time that a work piece must remain in each tank. For reasons which will be explained more fully hereinafter, the distance between successive stations in a single tank, that is, the distance T, is less than the distance S.

After the various tanks and the stations within each tank are drawn to scale on the master layout, then in order to arrive at the proper locations of the various elements which will enable the machine to be of modular construction, the tank layout is superimposed on the grid pattern that is shown in Fig. 1, with the datum line O coinciding with the center line of the first transfer station **30** at one side of the machine. In this arrangement, this station is illustrated at **30** in tank **12***a*. Thereafter, it is a relatively simple matter to locate the elevators **34** and the pusher arms **36** wherever necessary in positions governed by the location of the elevator stations **24** and the pusher stations **26** of the grid layout.

In the arrangement shown, since the work racks have to be elevated at the transfer stations between the adjacent ends of tanks **12***a* and **12***b*, **12***d* and **12***c*, **12***c* and **12***d*, and **12***d* and **12***e*, a series of three elevators **34***a*, **34***b* and **34***c* are provided at the first three elevator stations **24**; and these elevators are connected by a single boom **38**. At each of the transfer stations, suitable lifting devices are provided as illustrated. These devices will be described more fully hereinafter. An elevator is also provided at **34***d* for the transfer stations between tanks **12***e* and **12***f*. These four elevators take care of all the transfer stations shown for the tanks illustrated along the lower side of Fig. 2. It will be observed that the elevator station **24** between elevators **34***c* and **34***d* does not have an elevator mounted thereon. On the opposite side of the machine, there is arranged elevators **34***e* and **34***f*. The latter two elevators are likewise connected by a boom **38** and take care of all the transfer stations shown on the other side of the machine. The elevator arrangement illustrated is, of course, not the only elevator arrangement that may be adopted. For example, boom **38**, which is shown connecting elevators **34***a*, **34***b* and **34***c*, might be terminated right after elevator **34***b* and elevator **34***c* might be connected by a boom with elevator **34***d*. As a matter of fact, depending on the load that is to be lifted, elevator **34***b* might even be eliminated, in which case the boom **38** would extend directly from elevator **34***a to* elevator **34***c*.

At each of the multiple station tanks, pusher arms **36** are provided for advancing the work racks from the transfer station **32** at one end of the tank to the transfer station at the opposite end of the tank. In Fig. 2, carriage **16** is shown at the very beginning of its stroke; that is, in the extreme left position. From the position shown, the carriage **16** moves to the right through its stroke length, a distance sufficient to move the work racks from the end transfer station **30** in one tank to the transfer station **30** of the next adjacent tank.

In the layout of Fig. 2, it will be observed that the carriage **16** has a break at **40** and another at **42**. These breaks in carriage **16** correspond with a pair of break lines **28** in the grid layout of Fig. 1. In the arrangement shown, breaks **40** and **42** are spaced apart 320 inches. The arrangement has been shown in this manner because of lack of space. In actual practice, the break lines **40** and **42** would usually be spaced apart 480 inches, a length including six elevator stations rather than four, so as to utilize both the maximum shipping length and the mill length of the structural steel members that are employed for fabricating these sections.

Referring now to Figs. 3, 7 and 8, the general layout of base **10** and panels **18** are illustrated. Base **10** includes a plurality of longitudinally extending I-beams **44** which are spaced apart transversely of the machine and are connected together by diagonally arranged braces **46** which

are in the form of I-beam or channels. The diagonal braces 46 form a zig-zag regular pattern throughout the length of base 10, and these braces are connected with the I-beams 44 by gusset plates 48 and 50. At the breaks 40 and 42 shown in Fig. 2, the I-beams 44 of base 10 are interconnected by perpendicularly arranged channels 52. Thus, when the machine is assembled at the customer's plant, the various sections of base 10, each of which might be 40 feet in length except for the sections at each end of the machine, are secured together end to end in any suitable manner such as by passing bolts through the webs of channels 52 or by simply welding these channels together. However, channels 52 are arranged in base 10 so as to not interfere with the regularity of the repetitive pattern provided by the diagonal braces 46. In other words, the spacing between the apices of the triangles formed by the diagonal braces 46 and the I-beams 44 is identical throughout the length of base 10.

The panels 18 have a pattern somewhat similar to that of base 10. Each panel comprises an upper longitudinal stringer 54 and a lower longitudinal stringer 56 in the form of an I-beam and channel, respectively, that are interconnected by channel-shaped diagonal braces 58. The connections between braces 58 and stringers 54, 56 may be in the form of gusset plates 60 and 62. The zig-zag pattern formed by diagonal braces 58 corresponds exactly in dimensions, longitudinally of the machine, with the zig-zag pattern formed by diagonal braces 46 on base 10. In other words, the apices of the triangles formed by stringers 54, 56 and braces 58 lie in the same transverse plane as the apices of the triangles formed by I-beams 44 and braces 46. At the break planes, the panels 18 are provided with upright channel braces 64, which, in assembly, may be bolted together back to back as shown in Fig. 8 so that the break plane between channels 52 on base 10 coincides exactly with the break plane between channels 64 on panels 18. Braces 52 and 64 are always located at the apices of the triangular pattern.

Referring now to Figs. 4, 13 and 14, the manner in which the two panels 18 are interconnected is illustrated. The lower stringers 56 of each panel are welded to the top faces of the diagonal braces 46 on base 10. At regularly spaced points, which, in the arrangement illustrated, amounts to every 160 inches, there is welded to gusset plates on the innerside of upper stringer 54 of each panel 18 at the apices of triangles formed by diagonal braces 58, a bracket 66. Directly below each bracket 66, a bracket 68 is welded to a gusset plate on the inner face of the lower stringer 56. A spacer sleeve 70 is arranged between the brackets 66 at the upper sides of panels 18. A long bolt 72 passes through spacer sleeve 70 and clamps the panels together in fixed spaced relation along their upper side. Diagonally extending rods 76 provided with turnbuckles 74 are pivotally connected at their opposite ends to brackets 66 as at 78 and to brackets 68 as at 78*a*. It will be observed that this internal cross bracing arrangement provides a very rigid assembly for the two panels.

The general construction of the carriage 16 is shown in Figs. 4, 5 and 6. The carriage is divided into an upper panel section 80 and a lower panel section 82. The lower panel section 82 comprises upper and lower longitudinal stringers 84 and 86 which are in the form of channels. These stringers are interconnected by regularly spaced uprights 88. Uprights 88 are C-shaped channel members and are located on carriage 16 at each elevator station 24. Within the alternate spaces between uprights 88, the carriage is further reinforced by the provision of diagonal braces 90, the upper spaced apart ends of which are secured to the upper stringer 84 by gusset plates 92 at points adjacent the break planes 28. The lower ends of these braces 90 form the apex of a triangle and are secured to the lower stringer 86 by means of gusset plates 94 on opposite sides of the stringers.

The upper panel section 80 of the carriage comprises upper and lower longitudinal stringers 96 and 98, respectively, which are formed by the same size channels as stringers 84 and 86. Stringers 96 and 98 may be interconnected by short vertical braces 100. In the process of construction, upper panel section 80 and lower panel section 82 may be formed as assemblies; and thereafter connected into an integral carriage unit by welding the upper ends of uprights 88 to the outer faces of the lower stringers 98 of upper panel section 80 and by providing upright supports 102 arranged in pairs at each of the pusher stations 26. The upright supports 102 are welded at their lower ends to the side faces of the upper stringer 84 of the lower panel section of the carriage. Uprights 88 and the upright supports 102 may be provided in a plurality of standard lengths so that while the upper and lower stringers of each panel of the carriage are spaced apart a fixed distance for every machine, these two panel sections may be spaced apart one of several standard spacings, depending upon the size of the work rack.

The lower edge of carriage 16 is reinforced in a longitudinal direction by means of an I-beam 104 which is welded to the top face of lower stringer 86. Carriage 16 is mounted for rolling movement on base 10 by means of a plurality of rollers 106 (Fig. 4) which are arranged between lower stringer 86 and an inverted channel 108 welded along the central line on the top face of base 10.

Comparing Figs. 6 and 7, it will be observed that the break planes 28 occur at regularly spaced intervals on the panels 18 at the apices of the triangles formed by the diagonal braces 58 and that these break planes occur one at each side of the regularly spaced elevator stations 24 on carriage 16. At one side of each elevator station on the carriage 16, that is, at the upright channels 88, the break plane 28 passes through a plane adjacent the upper end of the diagonal brace 90. At the other side of channels 88, the break planes pass through the windows 110.

In determining where the splices should be located on a carriage after the carriage is laid out, the first break from the left end is located at the closest break plane under 40 feet. The successive carriage sections, with the exception of the last one, will be 40 feet in length; and so the splices will occur at regular intervals of 40 feet. The last splice plane is located just past the last elevator on the carriage. If additional carriage length is required such as to support pushers, it can be provided in the form of a cantilever extension at the right end of the carriage similar to that shown at 134 in Fig. 6.

In order to stabilize the carriage 16 laterally between panels 18, at each of the windows 110, the carriage has mounted thereon upper and lower guide bars 112 and 114. An upper guide bar 112 is secured at each side of stringer 84 by bolting to a plurality of support bars 116 (Fig. 11). Support bars 116 are welded to the top face of stringer 84 and are interconnected by a capping plate 113. Each guide bar 112 is backed by blocks 115 welded to the support bars 116. A lower guide bar 114 is secured at each side of the lower stringer 86 by bolting to support bars 118 welded to the top face of bottom stringer 86. Support bars 118 are welded to the top face of stringer 86 and are interconnected with the vertical web of I-beam 104 by capping plates 117. Each guide bar 114 is backed by blocks 119 welded to the underside of support bars 118. Each bracket 66 at the inside of the upper stringers 54 has a plate 122 pivoted thereon as at 123. A roller 124 is journalled on each plate 122 for engagement with upper guide bar 112 and adjusting screws 126 are provided for shifting roller 124 toward and away from the plane of the panels so as to obtain the proper vertical alignment and positioning of carriage 16 relative to panels 18. Each bracket 68 at the inside of lower stringers 56 is similarly provided with a plate 128 and a roller 130 is journalled thereon for rolling contact with the lower guide bars 114. Adjusting screws 132 are provided for adjusting the position of rollers 130. Thus, at each location of the internal

braces 76, means are provided on the panels 18 for providing lateral support to the carriage 16. In view of the cross bracing shown, it will be observed that the load on rods 76 and bolts 72 is a tension load. This makes the arrangement an inherently rigid one.

In the arrangement illustrated in Fig. 6, the basic frame construction of the carriage without the elevators 34 is illustrated. This section of the carriage is one end section. The overhanging portion 134 of the carriage is located at the end return of the machine, not illustrated. The end return portion of the machine, as mentioned previously, may comprise a generally semi-circular tank; and means are provided for conveying the work racks through an arcuate path within this tank. If necessary, pusher arms 36 may be secured to the upright brackets 136 on the overhanging portion 134 of the carriage. At a point corresponding with the break lines defined by the braces 52 on the base and the braces 64 on the panels, the carriage 16 is also broken. At these break planes, carriage 16 is provided with angle irons 138 welded to the outer faces of stringers 84, 86, 96, 98. In initially assembling the carriage at the manufacturers, two pairs of angle irons 138 are bolted together back to back and then placed one against each side of the end portions of a pair of adjacent, properly aligned carriage sections. The angles 138, bolted together, are then welded to the carriage so that when the machine is assembled at the customer's plant, the carriage sections are automatically aligned by again bolting angles 138 together.

The basic arrangement thus far described with reference to the base 10, the panels 18 and the carriage 16 presents a modular construction. Each of these sections has a repetitive pattern, and the machine as a whole is built up by simply joining together a series of these standard sections. Thus, it will be appreciated that the individual sections of the panels 18 and of carriage 16 may be fabricated through the use of standard fixtures including drills for accurately locating mounting holes, etc. Obviously, the cost of fabricating such a machine in this manner is very substantially reduced as compared with the practice of the prior art of custom fabricating each machine to specifications which differ with each machine. In the present arrangement, for example, the uprights 88 provide regularly spaced elevator stations; that is, housings for the elevator columns. In the final construction of these machines, elevators may be located at some of these stations and not at others. Likewise, the uprights 102 provide regularly spaced stations for pusher arms on which pusher arms may or may not be mounted, depending upon the particular tank arrangement of the machine being constructed. Nevertheless, regardless of the length of the machine or the tank arrangement thereof, the sections of the base 10 and of the panels 18 and of the carriage 16 may be prefabricated all to the same standard size and pattern shown in Figs. 6, 7 and 8; and then the particular elevator and pusher arm arrangement required for the machine may be incorporated on the standard sections. Furthermore, it will be noted that the pattern of construction of the base, the panels and the carriage enables the location of regularly spaced break planes which enable these sections to be prefabricated to standard lengths. With this arrangement, it is usually only the opposite end sections of the base, panels and carriage that have to be constructed to a length different from the standard length.

Referring now to Figs. 5 and 9, the elevator construction employed is illustrated. In the arrangement shown in Fig. 5, elevators are provided at the first two elevator stations 24 of the machine. The construction of these elevators is shown generally in Fig. 9 and each includes a hollow casting or housing 140 which is bolted or otherwise secured to the stringers 96 and 98 of the carriage by bolting to blocks 142 on channel 98 and to pillow block mount 144. Housings 140 extend upwardly from the upper ends of uprights 88; and within uprights 88 and housing 140, there is arranged a vertically extending elevator column 146. Column 146 is in the form of a composite T-section. It includes a vertically extending plate 147 having lateral flanges 148 at each side thereof and a perpendicularly arranged web portion comprising a gear rack 150 connected to plate 147 by a series of vertical spacers 152 (see Figs. 9 and 12). At the upper end of housing 140, there is arranged a yoke 151 pivoted as at 153 and carrying a pair of rollers 154. Rollers 154 are adapted to contact one face of plate 147. An adjusting screw 155 is provided for varying the position of rollers 154. Adjacent the lower end of housing 140, there is arranged a second yoke 156 provided with rollers 157 arranged to engage the opposite face of plate 147 adjacent the flanges 148. Yoke 156 is adjustably supported on housing 140 by a floating spherical bearing 158 and an adjusting screw 159 is provided for controlling the adjustment of yoke 156. At each side of housing 140, there is also provided upper and lower pivoted bell cranks 161 and 163 having rollers 165 journalled thereon and arranged to engage the opposite edges of flanges 148. Adjusting screws 167 are provided at the free ends of bell cranks 161 and 163.

With the arrangement thus described, it will be observed that a very rigid structure for the elevators is provided. The composite of the elevator column provides a very rigid arrangement with minimum weight and minimum space occupied by the elevator housing 140. In addition, by locating the rollers as shown on opposite sides of and adjacent the opposite edges of the flanges 148 of column 146, a very good aspect ratio is obtained. The particular roller arrangement is desirable from another standpoint as well. It will be observed that since the four side rollers 165 are adjustably mounted on housing 140, it is merely necessary to adjust these rollers so that the elevator column 146 is plumb; and we are thus assured of the elevator column traveling a vertical path. The face rollers 154 are mounted on the fixed pivot 153 of yoke 151 and serve to guide the column vertically with respect to the transverse axis of the machine. Since the lower rollers 157 are mounted on the floating yoke 156, they accommodate for any twist, etc. that might be present in the column. This assembly, it will be observed, provides for rolling contact exclusively with the elevator column; and at the same time, the elevator can be prefabricated as a package assembly.

The drive means for the elevators comprises a series of hydraulic motors 160 (Fig. 5) which are arranged along the upper stringer 96 of the carriage. At the location of each motor 160, the carriage is reinforced with uprights 161 (Figs. 5 and 6). Each motor is provided with a drive gear 162 which meshes with pinions 164 fixed on a longitudinally extending shaft 166 which is journalled for rotation on upper stringer 96 in pillow blocks 168. At each of the elevators, there is fixed on shaft 166 a pinion 170 which meshes with the gear rack 150 of column 146. As the shaft 166 is rotated in one direction, the columns 146 on one side of the machine are elevated and the columns on the other side of the machine are lowered.

At its upper end, each of the columns 146 has a laterally extending arm 172 mounted thereon as by gusset plates 174 and 176. Gusset plates 174 have a pair of adjustable bolts 178 mounted thereon which are adapted to contact rubber bumpers 180 mounted on the upper end of housing 140 to cushion the columns 146 when they reach their lowermost position. At the outer ends of arms 172, the booms 38, which were previously referred to in conjunction with Fig. 2, are mounted. As pointed out previously, the booms 38 may be mounted at the end of only one arm 172 or one continuous boom may extend between and connect a plurality of arms 172; for example, three, as shown in Fig. 2 at the tanks 12*a*, 12*b*, 12*c* and 12*d*. The manner in which boom 38 is mounted on the end of arm 172 is illustrated in Fig. 9.

This connection includes a pair of plates 182 welded to boom 38 and arranged to overlap the top and bottom faces of arm 172. A pin 186 passes through plates 182 and arm 172 to support the boom at the end of arm 172. Where the boom is supported by two arms 172, the holes for pin 186 on one of the arms are elongated to accommodate for possible floating of the two arms 172 relative to each other. Arm 172 is preferably in the form of a tubular member of square cross section. At each transfer station, boom 38 has a cross arm 188 secured thereto as by welding; and an angle iron leg 190 depends from the opposite ends of cross arm 188. At their lower ends, angle iron legs 190 have lift angles 192 welded thereto.

The tanks 12 and 14 are provided along their upper longitudinal edges with flange portions 194 (Fig. 10), and on these flanges are supported the electrical conducting bus bars 196 as by brackets 198 and the electrical conducting rails 200 as by brackets 202. The rails 200 extend intermittently above and along all the tanks, one at each side thereof. Breaks occur in rails 200 adjacent the ends of each tank. Each work rack, a portion of which is shown at 204, is slidably supported on rails 200 by work rack carriers 206. Each carrier 206 comprises a transverse bar 208 provided with brackets 210 for supporting work racks 204; and at each end thereof, bars 208 are provided with castings 212. Each of the castings 212 includes an outer end web portion 214 having a rail engaging pad 216 and an angle section having a lifting flange 218 formed integrally therewith. In the lowered position of elevators 34, the horizontal flanges 220 of lift angles 192 are disposed at a level below the horizontal lift flange 218 of carriers 206 as shown in Fig. 9. Thus, when the carriage 16 is advanced, the lift angles 192 are shifted to a position underlying the lift flanges 218; and when the elevators 34 are raised, the work rack carriers 206 are elevated and carried by the lift angles longitudinally of the machine with the carrier to a location above the first station of the next tank.

As indicated above, pusher arms 36 are mounted on whichever of the upright supports 102 of the carriage that are conveniently located. Each of these upright supports 102, it will be remembered, forms a pusher station 26. Thus, referring to Figs. 1 and 2, it will be observed that at tank 12*b*, pusher arms 36 are mounted, one at each side of elevator 34*a* on upright supports 102. At tank 12*d*, two pusher arms 36 are mounted on the two pusher stations 26. For reasons that will become presently apparent, pusher arms 36 may be mounted singly, in pairs, or even in greater numbers.

Referring now to Fig. 11, each pusher arm 36 is mounted on an upright support 102 by means of gusset plates 222 to which it is secured by bolts 223. Pusher arms 36 each have a pair of plates 224 welded to the bottom face thereof. I-beam booms 226 have one or more plates 228 secured to the upper face thereof depending upon whether the pusher arm 36 is used singly or in multiples. Pusher bars 230 are supported from each I-beam 226 by means of clamps 232 which are slidably adjustable along the bottom flange of I-beam 226 and arranged to be locked in position by bolts 234. In Fig. 10, two pusher bars 230 are shown supported from a single I-beam boom 226. These two pusher bars are arranged for moving the work racks 204 that are suspended from the two carriers 206 shown in this view. Each of the carriers is provided at opposite ends inwardly of the web section 214 with pivoted flapper elements 236. When the pusher arms 36 move through the retracting portion of their stroke, pusher bars 230 on the two booms 226 engage flapper members 236 at each end of carriers 206 to pivot them upwardly out of the way so that the pusher bars 230, at the end of the retraction stroke, are positioned one behind each of the flapper members 236. Then on the feed stroke, pusher bars 230 will engage flappers 236; but since the flappers 236 cannot pivot in the opposite direction beyond the vertical position shown in Fig. 10, the carriers 206 are advanced forwardly on rails 200 a distance equal to the stroke of the carriage minus the overtravel of the pusher bars 230 with respect to the flapper members 236 on the retraction stroke. Thus, in multiple station tanks, the work rack carriers 206 are advanced progressively to the successive stations in the tank until they reach the transfer station at the end of the tank. They are then picked up by the elevators 34 and deposited at the first station of the next successive tank.

Referring now to Fig. 5, it will be observed that the carriage 16 is actuated through its stroke by means of a hydromotor 238 provided with a crank arm 240 that connects with a link 242 that is in turn pivotally connected to one end of the carriage as at 244. In the arrangement illustrated in Fig. 5, the carriage 16 is in the retracted position. The carriage moves from the position shown in a direction to the right on the feed stroke. In the retracted position, the cross bracing 76 for panels 18 is located at the far end of each window 110 in the carriage. The stroke of the carriage is always less than the length of the window 110; and thus, there is no interference whatever between the cross bracing 76 and the carriage. The term "feed stroke" has been used herein to indicate movement of the carriage in a direction towards the right in the various figures. It will be appreciated, however, that when the carriage moves towards the right from the position shown in Fig. 2, for example, the pusher bars 230 at the tanks 12 advance the work at the various tanks while the pusher bars 230 over the tanks 14 are moving in the retracting direction. Hydromotors 160 that actuate elevators 34 and hydromotor 238 that oscillates carriage 16 are intermittently operated in successive cycles. With the carriage shown in the position of Fig. 2 and assuming that the work racks are advanced through the machine in a direction towards the right in the tanks 12, then the first portion of the cycle consists in raising elevators 34*a*, 34*b*, 34*c* and 34*d* and, of course, simultaneously lowering elevators 34*e* and 34*f*. When the elevators 34*a*, 34*b*, 34*c* and 34*d* are raised, the work racks at the transfer stations in tanks 12*a*, 12*b*, 12*c*, 12*d* and 12*f* are elevated to a position wherein the lower ends of the work racks clear the uppermost portions of the tanks. Hydromotor 238 is then arranged to be actuated so as to move the carriage 16 through its stroke to the right. During this portion of the cycle, the elevated work racks are carried over the ends of the tank to a position directly above the first station in the next adjacent tank while the pusher bars 230 engage the flapper members 236 of the work rack carriers 206 and move each of the work rack carriers on rails 200 to the next successive station in the various tanks. On the opposite side of the machine, namely, in the tanks 14, the elevators are in the lowered position; and when the carriage is moved to the right, the lift angles 192 simply move past and beneath the lift flanges 218 of the work rack carriers and the pusher bars 230 move rearwardly past the work rack carriers 206 by engaging the flapper members 236 and pivoting them out of the way. The next portion of the cycle consists in the actuation of the hydromotors 160 to lower the elevators over tanks 12 and raise the elevators over tanks 14. When the elevators over tanks 12 are lowered, the work carriers supported by lift angles 192 are deposited on rails 200 and the carriers within the extent of the lift angles 192 on the other side of the machine are elevated. Thus, the work is advanced in one direction along one row of tanks and in the opposite direction along the other row of tanks.

The end return mechanism can be any of several types and does not constitute part of the present invention.

Thus, it will be seen that I have provided an automatic plating machine construction which is based on an entirely new concept. Each of the basic structural sections are formed to a predetermined repetitive pattern; and at fixed spaces along the pattern of the carriage, means are provided for accommodating pusher arms and elevators. The pattern of each of the structural sections pro-

vides for an inherently rigid structure and at the same time incorporates planes which form convenient break points along the structure for enabling the machine to be built up as a series of standard sections. This also enables the machine to be initially assembled at the manufacturing site for try-out and then disassembled, shipped to the customer and then reassembled in the customer's plant in a relatively short time without the necessity for numerous readjustments. The pattern of the base, the panels and the carriage are all interrelated so that in one position of the carriage, the break plane on the carriage coincides with the break plane on the base and panels. Thus, as shown in Fig. 8, on the base and panels, the break plane always occurs at an apex of a triangle formed by the diagonally arranged braces 46 and 58; and as shown in Figs. 6 and 7, these break planes on the base and panels align with convenient planes on the carriage for joining carriage sections together.

Another important feature of the present invention resides in the provision of internal bracing such as by rods 76 for the panels 18. In prior art arrangements with which I am familiar, the panels are reinforced by external bracing in the form of large gusset plates which are secured to the panels and the base in the spaces between adjacent tanks. Bracing of the latter type is subjected primarily to compressive forces and is apt to buckle, whereas the internal bracing arrangement employed in the present invention is subjected primarily to tension and is thus inherently more rigid. It will also be observed that this form of bracing is independent of the tank arrangement. Furthermore, the novel pattern of the carriage accommodates this internal bracing without any interference whatever to the reciprocation of the carriage. Nevertheless, the carriage is rendered very stable in a lateral direction because the arrangement of guide rollers 124 and 130 results in a concentration of the loading on the panels at those portions of the panels that are reinforced by the cross bracing 76. In this connection, it is also important to note that the mounting of the guide rails 112 on the carriage as distinguished from panels 18 reinforces the carriage structure where maximum bending would occur. Furthermore, it will be observed that the tension force of cross rods 76 and the lateral force of the carriage intersect within the plane of the top stringers 54 of the panels and the bending moment is thus reduced to a minimum. By locating the pusher arms 36 at fixed stations provided and by supporting pushers 230 by clamps 232 so that they may be adjusted to any position along boom 226, the need for custom locating arms 36 to avoid structural interferences is eliminated.

Another feature of the present invention which makes this modular construction feasible is the design of the elevators which enables them to be located at fixed points on the carriage regardless of the exact location of the transfer stations. The elevator construction, particularly as illustrated in Figs. 9 and 12, is capable of sustaining substantial loads; and this means that the elevators need not be located directly over the transfer stations. As a matter of fact, the rigid elevator construction coupled with the use of booms such as shown at 38 reduces the number of elevators that would otherwise be required. For example, in the arrangement shown in Fig. 2, there are five transfer stations along the tanks 12 that are serviced by four elevators 34; and along tanks 14, there are five elevator stations that are serviced by only two elevators 34.

I claim:

1. A machine for conveying work pieces along successive treating stations comprising a base, a plurality of tanks arranged as two spaced apart rows, a pair of upright panels on said base extending one along the inner sides of each of said rows of tanks, a carriage movably mounted on said base for reciprocation between said panels longitudinally of said rows of tanks, said base, panels and carriage each comprising a plurality of individual longitudinally extending sections joined together in end-to-end relation, the sections of said base, panels and carriage intermediate the end sections thereof being formed of a uniformly repetitive structural pattern.

2. A conveying machine as called for in claim 1 wherein said intermediate sections are each provided at opposite ends thereof with transversely extending structural members, said structural members being secured together in face-to-face relation and forming the means joining said sections together.

3. A conveying machine as called for in claim 1 wherein the pattern of said carriage includes regularly spaced reinforcing upright members comprising elevator stations.

4. A conveying machine as called for in claim 1 wherein said base comprises a plurality of parallel spaced and longitudinally extending structural members and diagonally arranged braces connecting said longitudinally extending members together, said diagonally arranged braces being uniformly spaced to provide said base with a uniformly repetitive geometric pattern.

5. A conveying machine as called for in claim 1 wherein said panels each comprise upper and lower stringers extending longitudinally of the machine, said stringers comprising structural members, and diagonally arranged braces connecting said stringers together, said diagonally arranged braces being uniformly spaced to provide said panels with a uniformly repetitive geometric pattern.

6. A conveying machine as called for in claim 1 wherein said base and panels each comprise a plurality of longitudinally extending structural members, said structural members of the base being spaced apart and parallel in the same horizontal plane, said structural members of each panel being spaced apart and parallel in a single vertical plane, a plurality of diagonally extending braces connecting the structural members of the base and the structural members of each panel, said diagonally extending braces being uniformly spaced along said structural members of the base and panels to provide the base and panels with a uniformly repetitive geometric pattern, the geometric pattern of the base and the geometric pattern of the panels having apices lying in the same plane transversely of the machine.

7. A conveying machine as called for in claim 6 wherein said intermediate sections of the base and panels terminate in a single transverse plane extending through a set of said apices of the base and panel patterns.

8. A machine for conveying work pieces along successive treating stations comprising a base, a pair of longitudinally extending upright panels spaced apart transversely of the base, a carriage supported on said base between said panels, means for reciprocating said carriage through a predetermined stroke forwardly and rearwardly longitudinally of said base, said carriage comprising an assembly of structural members forming a uniformly repetitive pattern lengthwise of the carriage, said pattern including regularly spaced vertically extending windows opening transversely of the carriage and of a length greater than the stroke of the carriage and regularly spaced reinforcing members between said windows, said panels having regularly spaced cross bracing therebetween to provide lateral stability thereto, said cross bracing extending transversely through said windows on said carriage.

9. A conveying machine as called for in claim 9 wherein said cross bracing is located on said panels to correspond with the forward end portion of said windows when the carriage is in its retracted position.

10. A conveying machine as called for in claim 8 wherein said panels are provided with generally transversely aligned guide rollers at a location closely adjacent said cross bracing, said carriage being provided with longitudinally extending guide bars at said windows adapted to form a track for said guide rollers, whereby

the lateral loading of said panels by said carriage is concentrated adjacent the portions of said panels reinforced by said cross bracing.

11. A conveying machine as called for in claim 8 wherein said carriage is provided with an upright reinforcement adjacent opposite ends of each of said windows, said uprights forming elevator stations spaced regularly along the length of the carriage.

12. A conveying machine as called for in claim 11 wherein elevators are provided at some of said elevator stations.

13. A conveying machine as called for in claim 12 wherein said elevators include upright columns and wherein said upright reinforcements are hollow and house said elevator columns.

14. A machine for conveying work pieces along successive treating stations comprising a base, a pair of upright spaced apart panels extending longitudinally on said base, a movable carriage mounted on said base for reciprocation between said panels in a direction longitudinally thereof, said carriage comprising a plurality of longitudinally extending, vertically spaced stringers, vertical braces extending between and connecting said stringers together, a plurality of upright supports spaced regularly along said carriage and forming elevator stations, said supports dividing said carriage longitudinally into a plurality of successive windows, the alternate windows being substantially unobstructed between successive elevator stations and the windows between said alternate windows each having a bracing therein and cross-bracing interconnecting said panels and extending through said unobstructed windows of said carriage.

15. A conveying machine as called for in claim 14 wherein said windows are formed between a lower pair of vertically spaced stringers and including a plurality of regularly spaced vertical braces interconnecting an upper pair of said stringers above each of said windows, said last mentioned braces comprising stations for pusher bars.

16. A machine for conveying work pieces along successive treating stations comprising a base, a plurality of tanks arranged on said base as two spaced apart rows, a pair of upright panels on said base extending one along the inner sides of each of said rows of tanks, a carriage mounted on said base between said panels for reciprocation in a direction longitudinally of the panels, means for reciprocating said carriage through a predetermined stroke, said carriage having a plurality of regularly spaced windows therein, said windows having a longitudinal extent greater than the stroke of said carriage, said panels being secured to said base along the lower edges thereof, a generally horizontally disposed brace extending across and connecting said panels together adjacent their upper ends, a pair of cross braces lying in a vertical plane adjacent said horizontal brace and each extending from the upper portion of one panel to the lower portion of the other panel, said horizontal and cross braces extending through one of said windows.

17. A conveying machine as called for in claim 16 including means adjacent the upper portions of the panels interconnecting the panels and the carriage for relative horizontal movement and serving to transfer the lateral load of the carriage to said panels.

18. A conveying machine as called for in claim 17 wherein said last mentioned means comprise a pair of guide bars mounted one at each side of the carriage in a plane adjacent the upper end of said panels and a pair of rollers mounted one on each panel adjacent said horizontal brace and adapted to engage said guide bars for guiding the carriage longitudinally between said panels.

19. A conveying machine as called for in claim 18 including levers mounted on said panel for pivotal movement toward and away from the vertical plane of said carriage, said rollers being mounted on said levers and means for pivotally adjusting said levers to fixed positions on said panels.

20. A machine for conveying work pieces along successive treating stations comprising a base, a plurality of tanks arranged on said base as two spaced apart rows, a pair of upright panels on said base extending one along the inner sides of each of said rows of tanks, a movable carriage mounted on said base between said panels for reciprocation in a direction longitudinally of the panels, means for reciprocating said carriage through a predetermined stroke, a pair of guide bars mounted one at each side of the carriage at a plane adjacent the upper end of the panels and a pair of rollers mounted one on each panel and adapted to engage the guide bars for guiding the carriage longitudinally between said panels.

21. A conveying machine as called for in claim 20 including levers mounted on each of said panels for pivotal movement toward and away from the vertical plane of said carriage, said rollers being mounted on said levers and means for pivotally adjusting said levers to fixed positions on said panels.

22. In a machine for conveying work pieces through a series of tanks arranged as a row, the combination comprising a movable carriage mounted for reciprocation in a path adjacent one side of said tanks, said carriage having an elevator mechanism thereon, said elevator mechanism including a housing fixed on said carriage and extending upwardly above the tanks, an elevator column extending vertically through said housing, said elevator column having a pair of laterally extending flanges at each side thereof and a gear rack portion integrally connected thereto and projecting in a plane generally perpendicular to the plane of said flanges, a gear on said carriage engaging said rack portion of the column and adapted to raise and lower the column when rotated in opposite directions and means on said carriage engaging said flanges for guiding the vertical movement of the elevator column, said guide means comprising a pair of guide rollers adjacent the upper end of the housing contacting the faces of said flanges disposed adjacent said tanks and a second pair of guide rollers on the housing disposed at a level below said first mentioned rollers and contacting the opposite faces of said flanges, said column having an arm at the upper end thereof extending laterally over the adjacent tanks and lifting members supported from said arm.

23. A conveying machine as called for in claim 22 wherein the vertical spacing between said pairs of rollers is relatively small in comparison to the length of said column.

24. A conveying machine as called for in claim 22 including means for shifting said guide rollers toward and away from said column.

25. A conveying machine as called for in claim 22 including a yoke supporting said second pair of guide rollers, said yoke being mounted on said housing for universal pivotal movement.

26. In a machine for conveying work pieces through a series of tanks arranged as a row, the combination comprising a carriage mounted for reciprocation in a path adjacent one side of said tanks, said carriage having an elevator mechanism thereon, said elevator mechanism including a housing fixed on said carriage and extending upwardly above the tanks, a column extending vertically through said housing, said column being generally of T-shape in cross section with the cross member of the T forming a pair of laterally extending flanges and with the leg of the T projecting from said flanges in a direction away from the adjacent tanks, said housing having rollers adjacent the upper end thereof in rolling contact with the face of the flanges adjacent said tanks and having additional rollers adjacent the lower end thereof in rolling contact with the opposite faces of said flanges, said column having a work supporting arm at the upper end thereof extending laterally over the adjacent tanks

and means for raising and lowering said column through said housing.

27. A conveying machine as called for in claim 26 including a yoke on which said rollers adjacent the lower end of the housing are journalled, said yoke having a floating pivotal connection with said housing and means for adjusting the position of said yoke.

28. A conveying machine as called for in claim 26 including a third set of rollers on said housing engaging the opposite edge faces of said flanges.

29. A conveying machine as called for in claim 26 including a third set of rollers on said housing engaging the opposite edge faces of said flanges and means for adjusting each of the aforementioned rollers toward and away from the faces of said flanges against which they are in rolling contact.

30. A conveying machine as called for in claim 26 including two additional sets of rollers on said housing arranged to engage the opposite edge faces of said flanges and having at least two vertically spaced rollers in each of said two sets of rollers.

31. A conveying machine as called for in claim 26 wherein the free edge of the leg of the T comprises a gear rack portion, said last mentioned means comprising a gear mounted on said carriage and engaging said gear rack and means for driving said gear in opposite directions.

32. A conveying machine as called for in claim 31 wherein said gear engages said gear rack above the top set of rollers.

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