April 23, 1957 J. V. DAVIS 2,789,569

PLATING MACHINE

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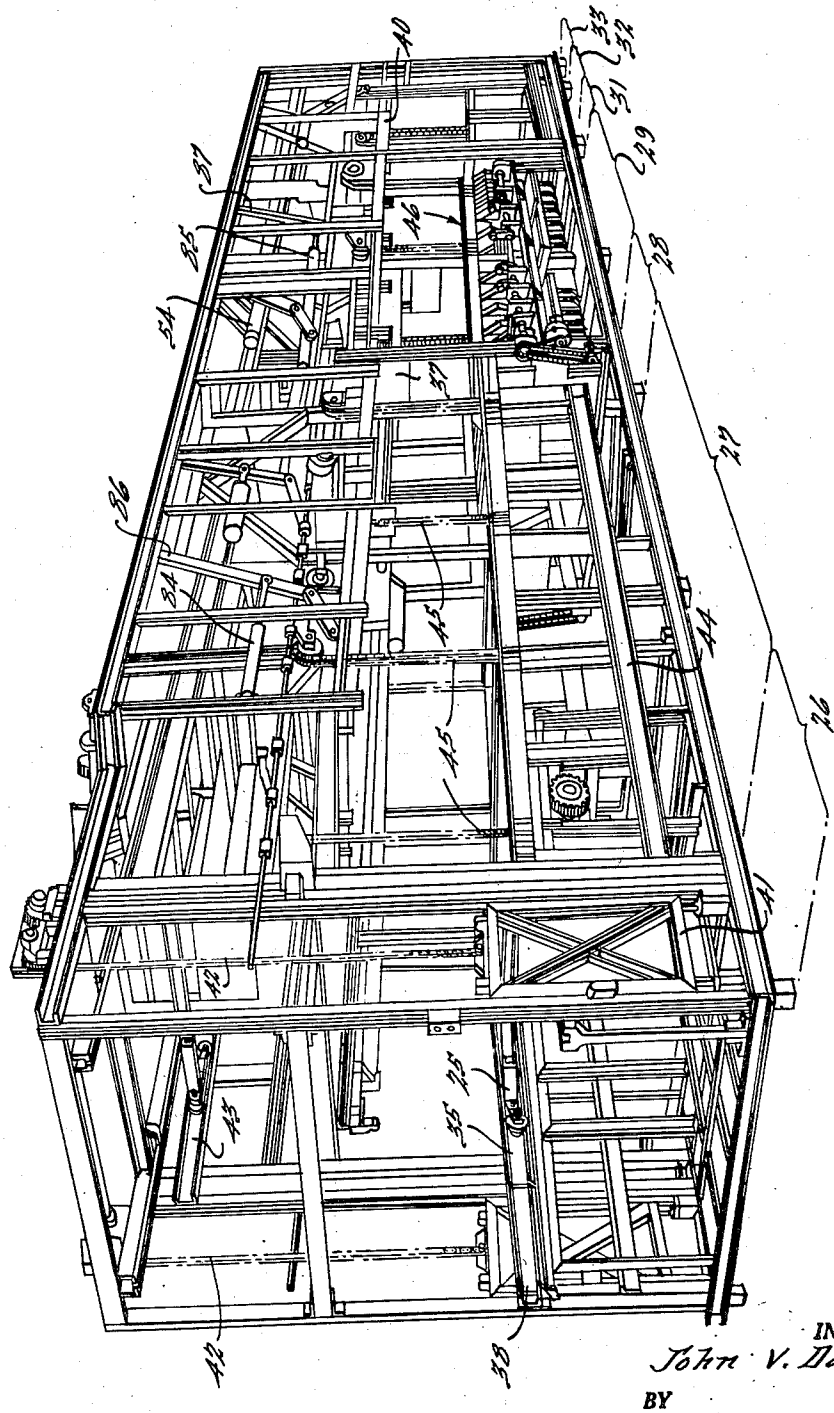


Fig. 1.

INVENTOR.
John V. Davis.
BY
Harness, Dickey & Pierce.
ATTORNEYS.

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PLATING MACHINE

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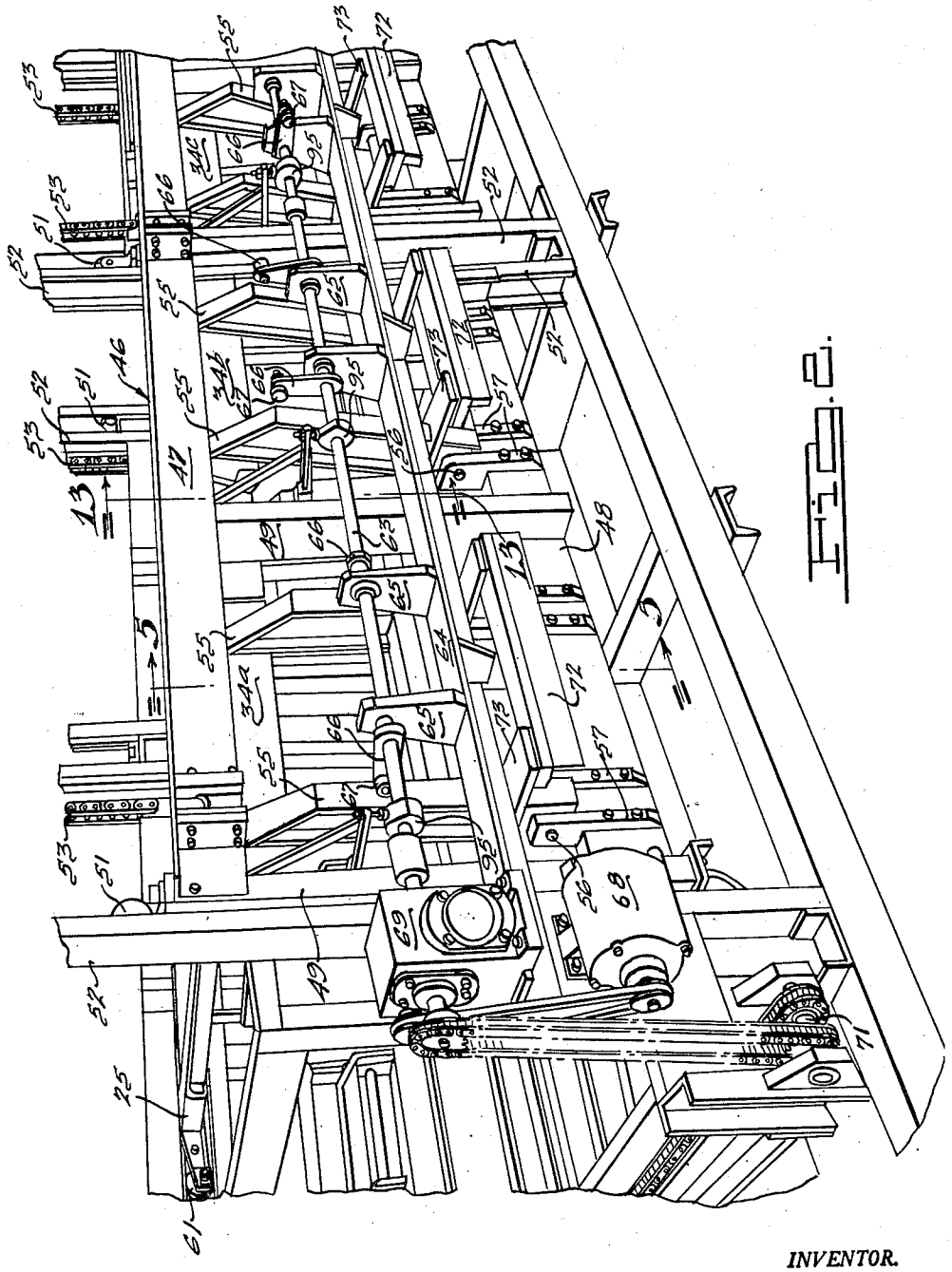


Fig. 2.

INVENTOR.
John V. Davis.
BY
Harness, Dickey & Pierce.
ATTORNEYS.

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PLATING MACHINE

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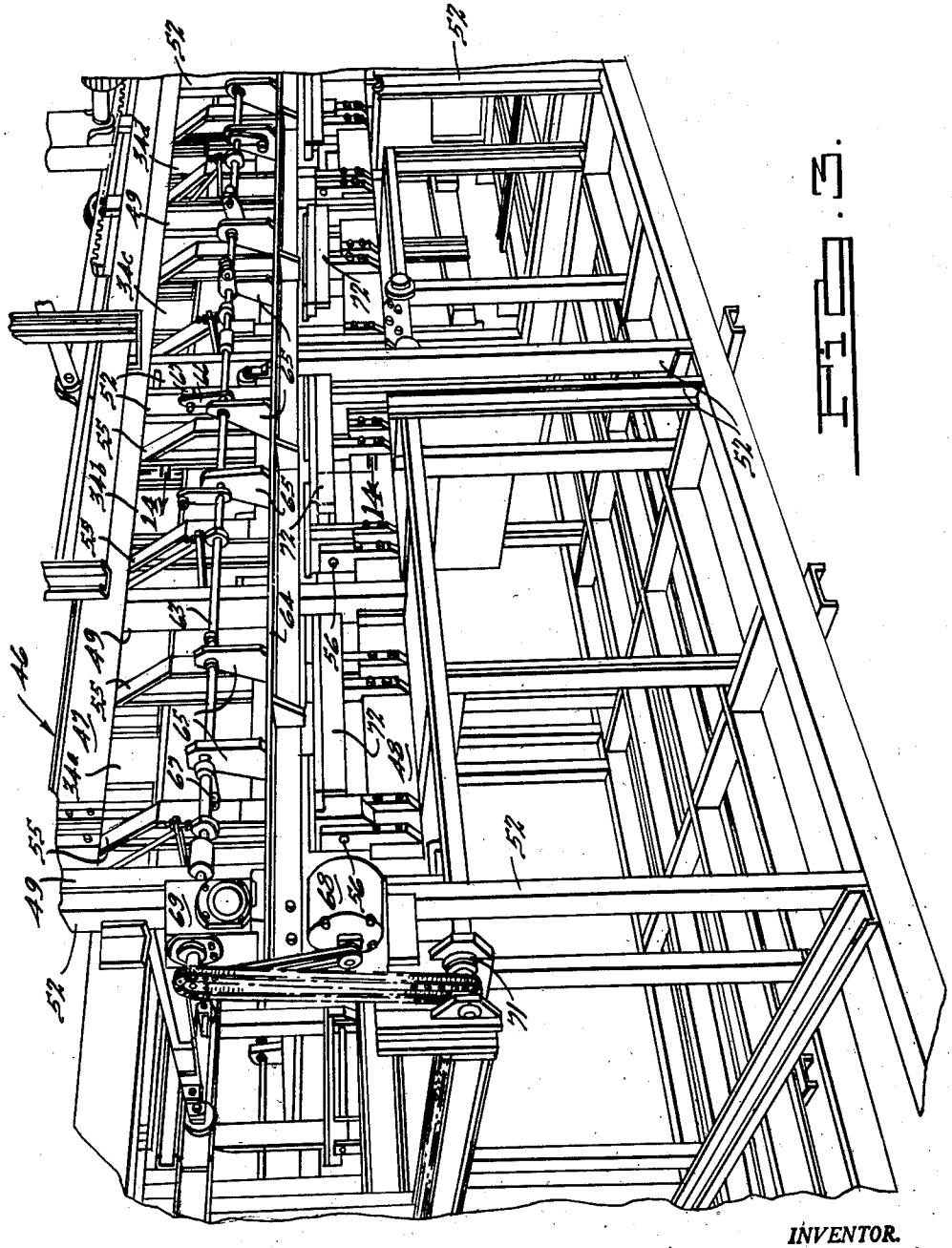


FIG. 3

INVENTOR.
John V. Davis.
BY
Harness, Dickey & Pierce
ATTORNEYS

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PLATING MACHINE

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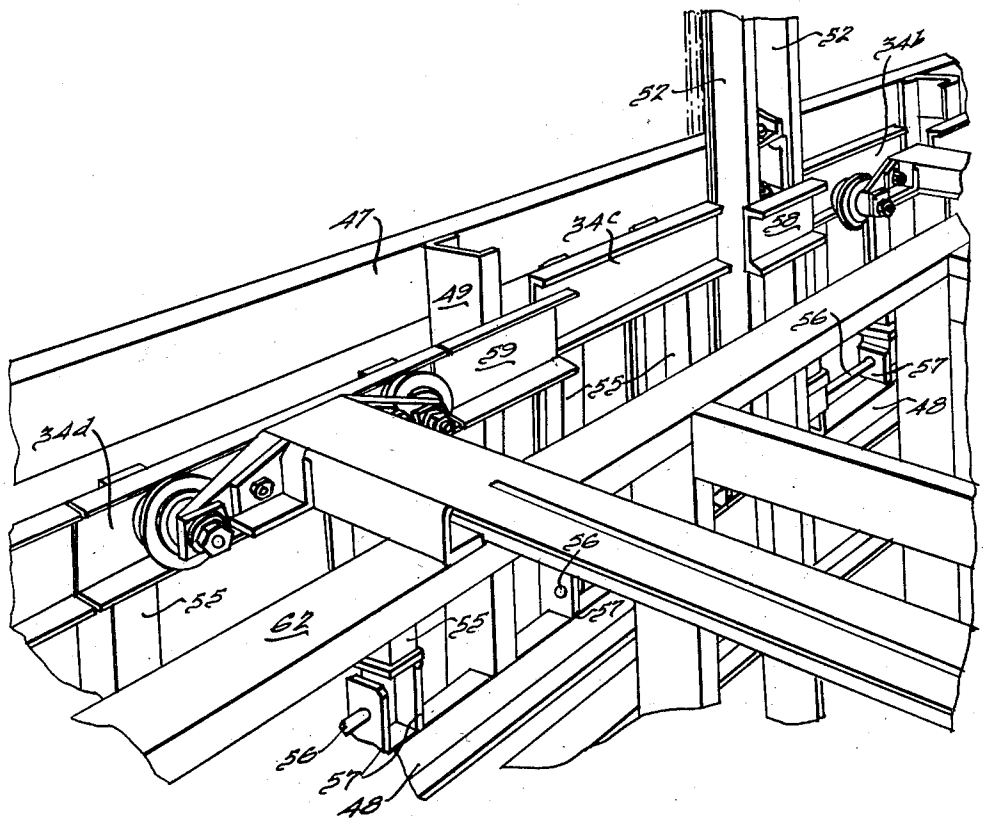


Fig. 4.

INVENTOR.
John V. Davis.
BY
Harness, Dickey & Pierce.
ATTORNEYS.

April 23, 1957 J. V. DAVIS 2,789,569

PLATING MACHINE

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FIG. 5.

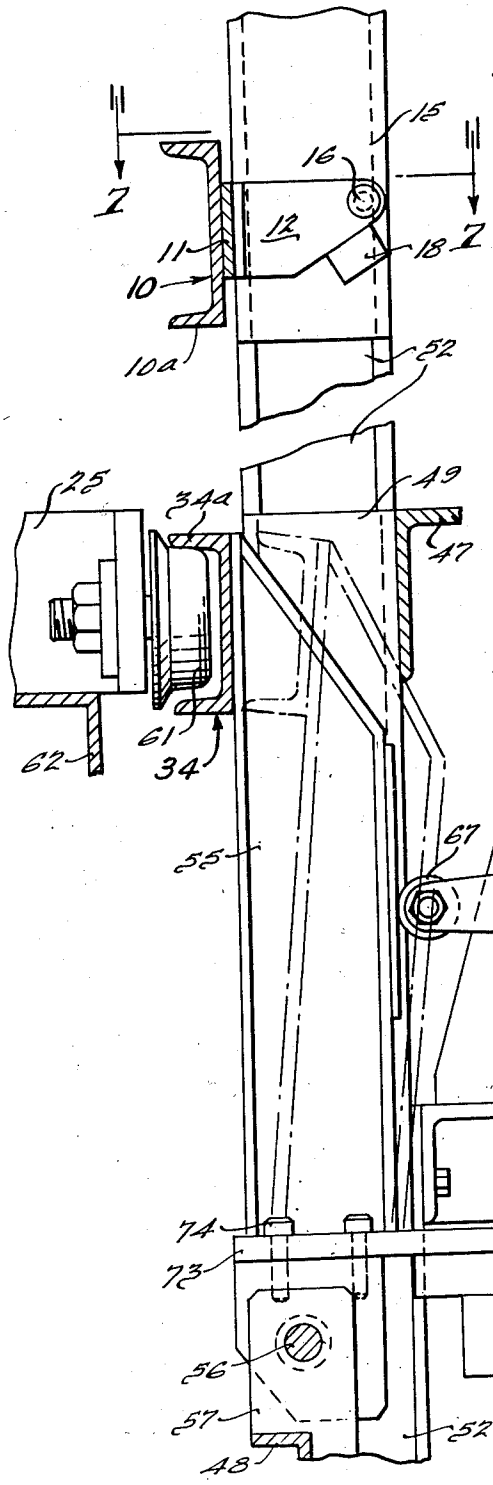


FIG. 6.

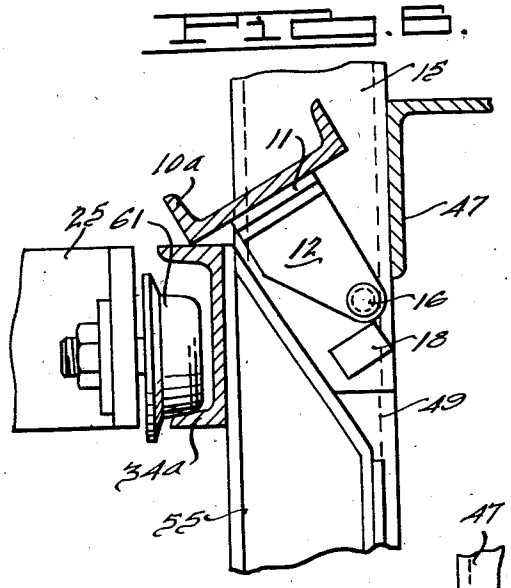
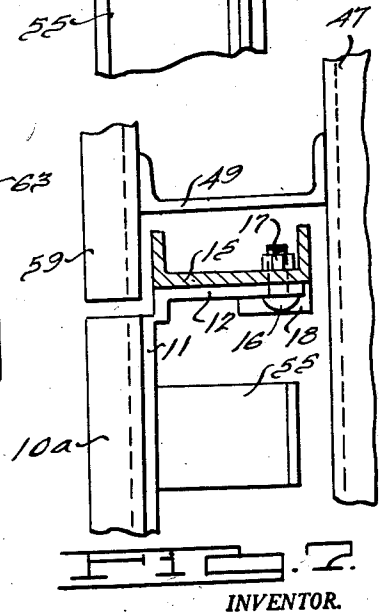


FIG. 7.



INVENTOR.
John V. Davis
BY
Harness, Dickey & Pierce
ATTORNEYS

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PLATING MACHINE

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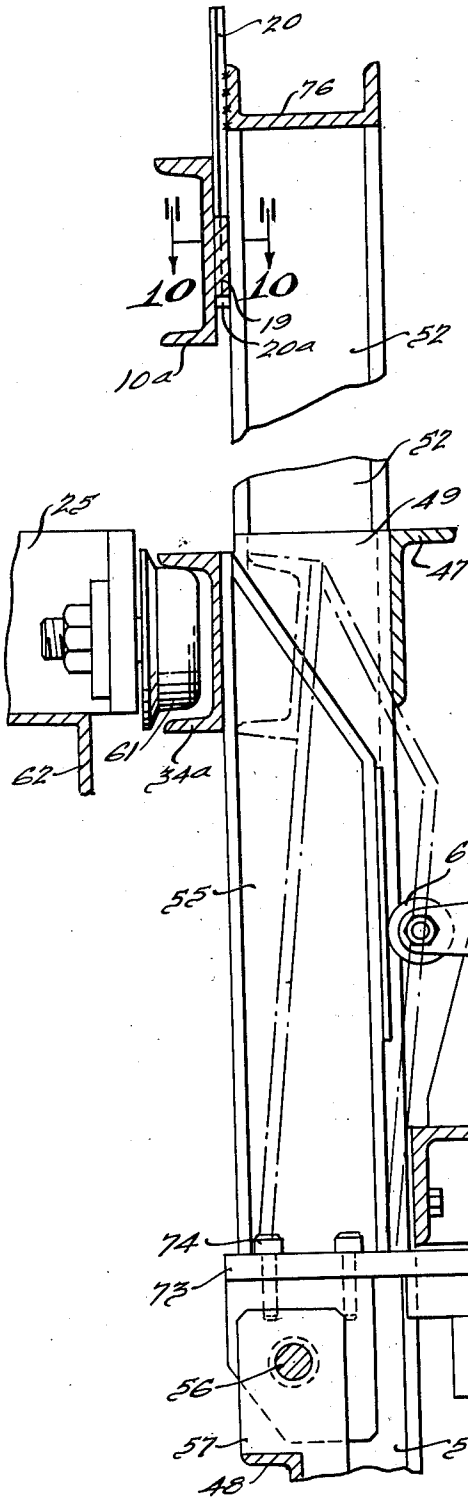


Fig. 8.

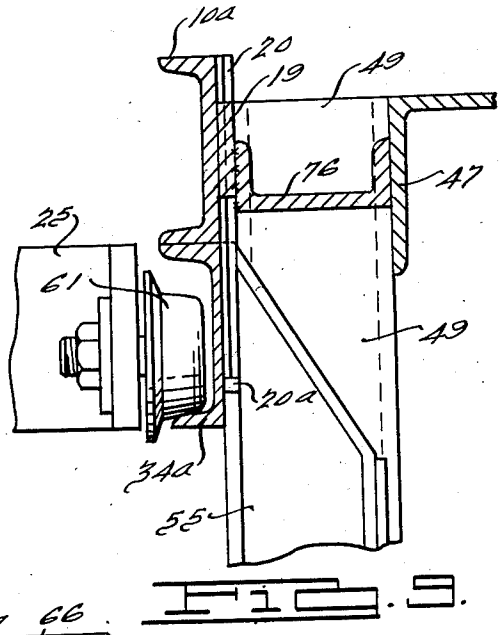


Fig. 9.

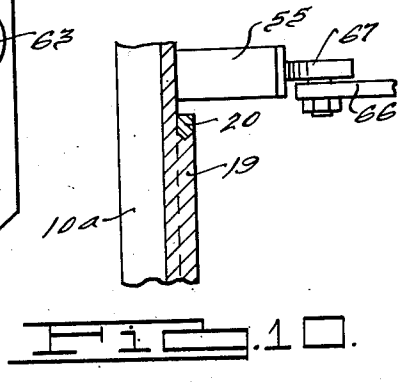


Fig. 10.

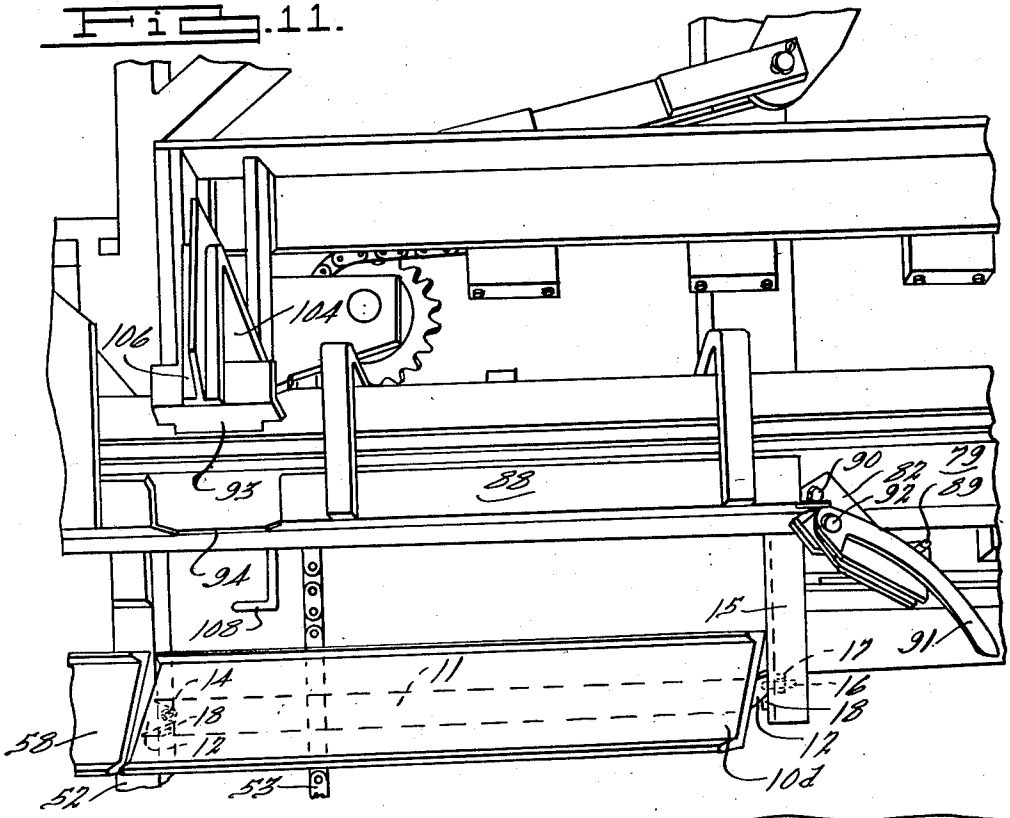
INVENTOR.
John V. Davis.
BY
Harness, Dickey & Pierce.
ATTORNEYS

April 23, 1957 J. V. DAVIS 2,789,569

PLATING MACHINE

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Fig. 11.



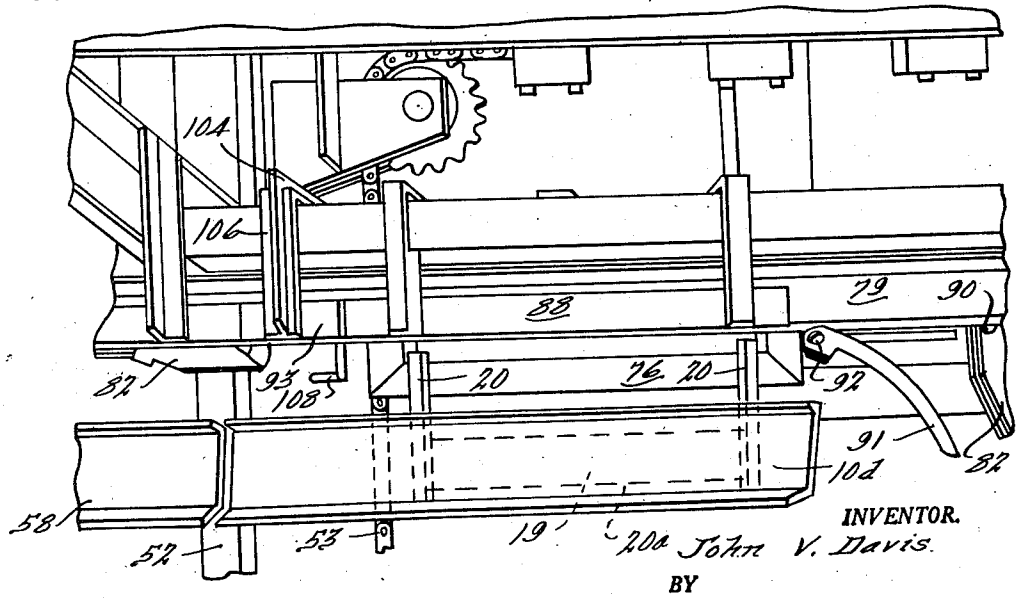


Fig. 12.

INVENTOR.
John V. Davis.
BY
Barnes, Dickey & Pierce.
ATTORNEYS.

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PLATING MACHINE

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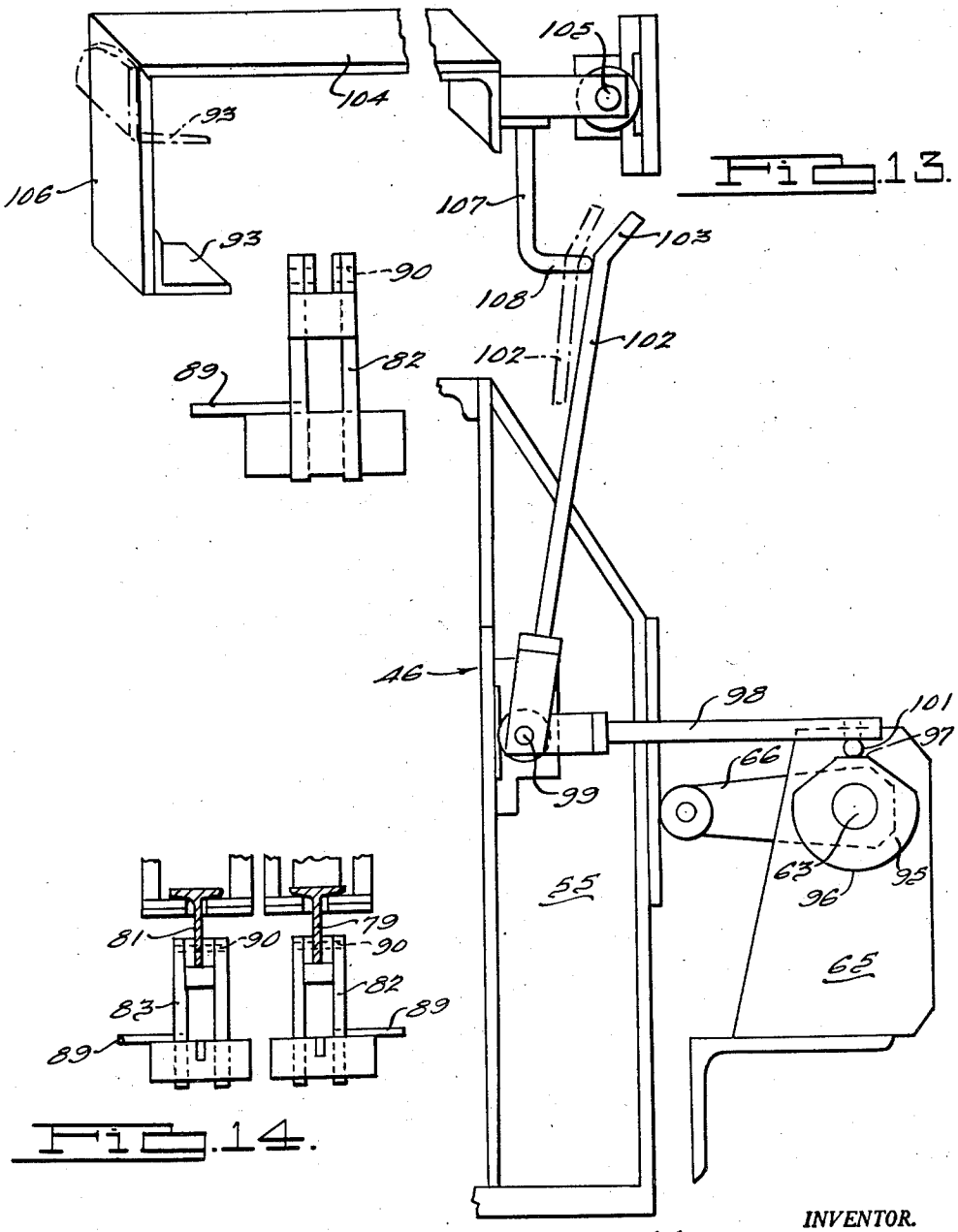


Fig. 13.

Fig. 14.

INVENTOR.
John V. Davis
BY
Harness, Dickey & Pierce
ATTORNEYS.

April 23, 1957 J. V. DAVIS 2,789,569

PLATING MACHINE

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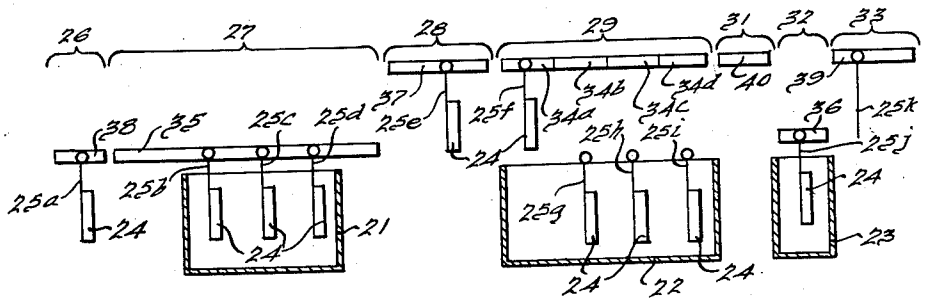


FIG. 15.

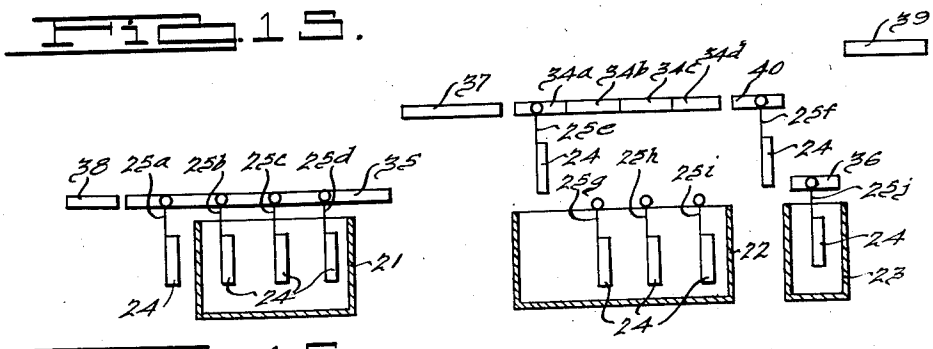


FIG. 16.

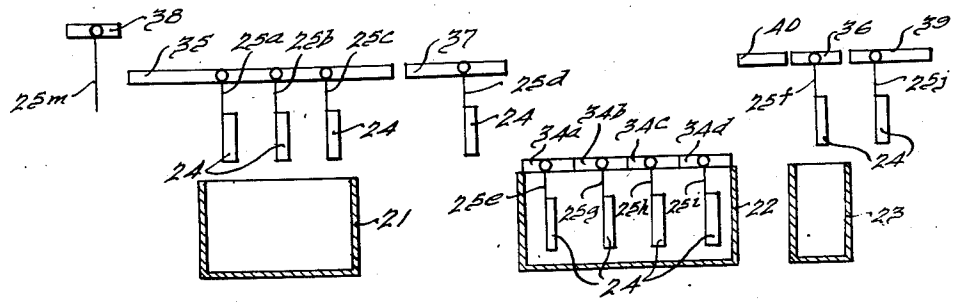


FIG. 17.

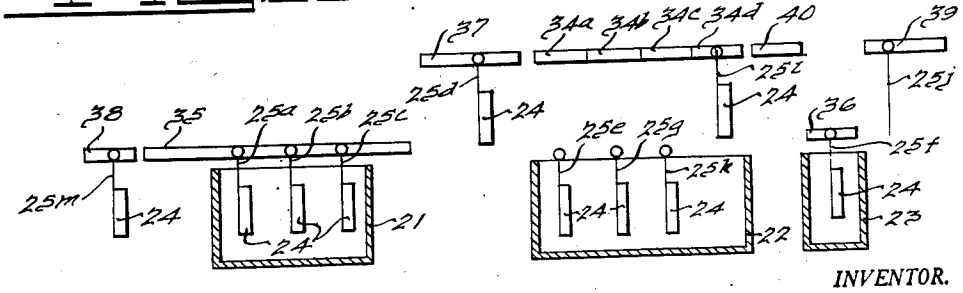


FIG. 18.

INVENTOR.
John V. Davis.
BY
Harness, Dickey & Pierce
ATTORNEYS.

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PLATING MACHINE

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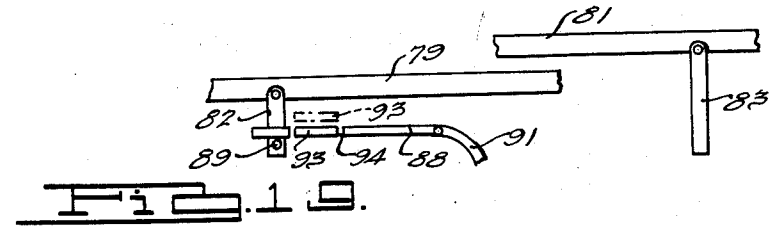


Fig. 19.

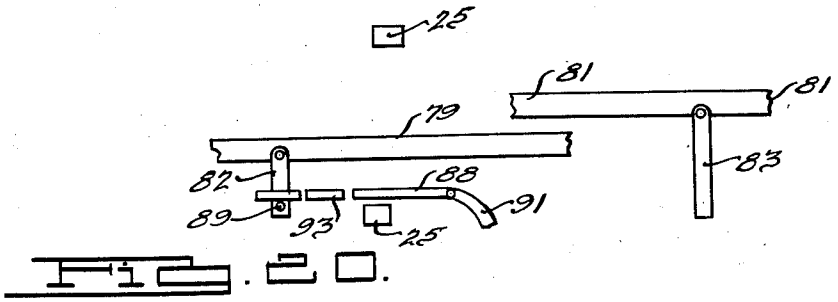


Fig. 20.

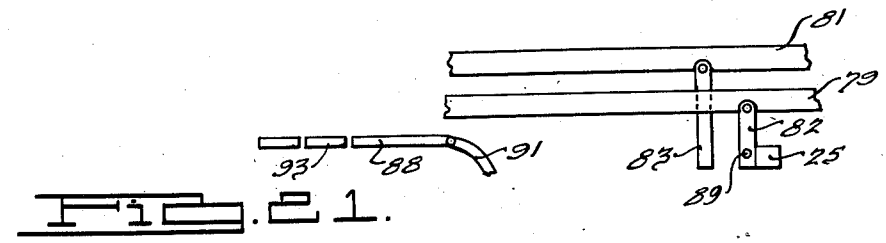


Fig. 21.

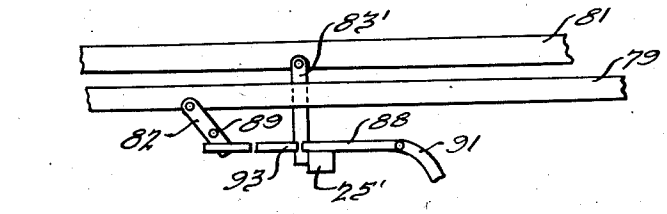


Fig. 22.

INVENTOR.
John V. Davis.
BY
Harness, Dickey & Pierce.
ATTORNEYS

April 23, 1957 J. V. DAVIS 2,789,569

PLATING MACHINE

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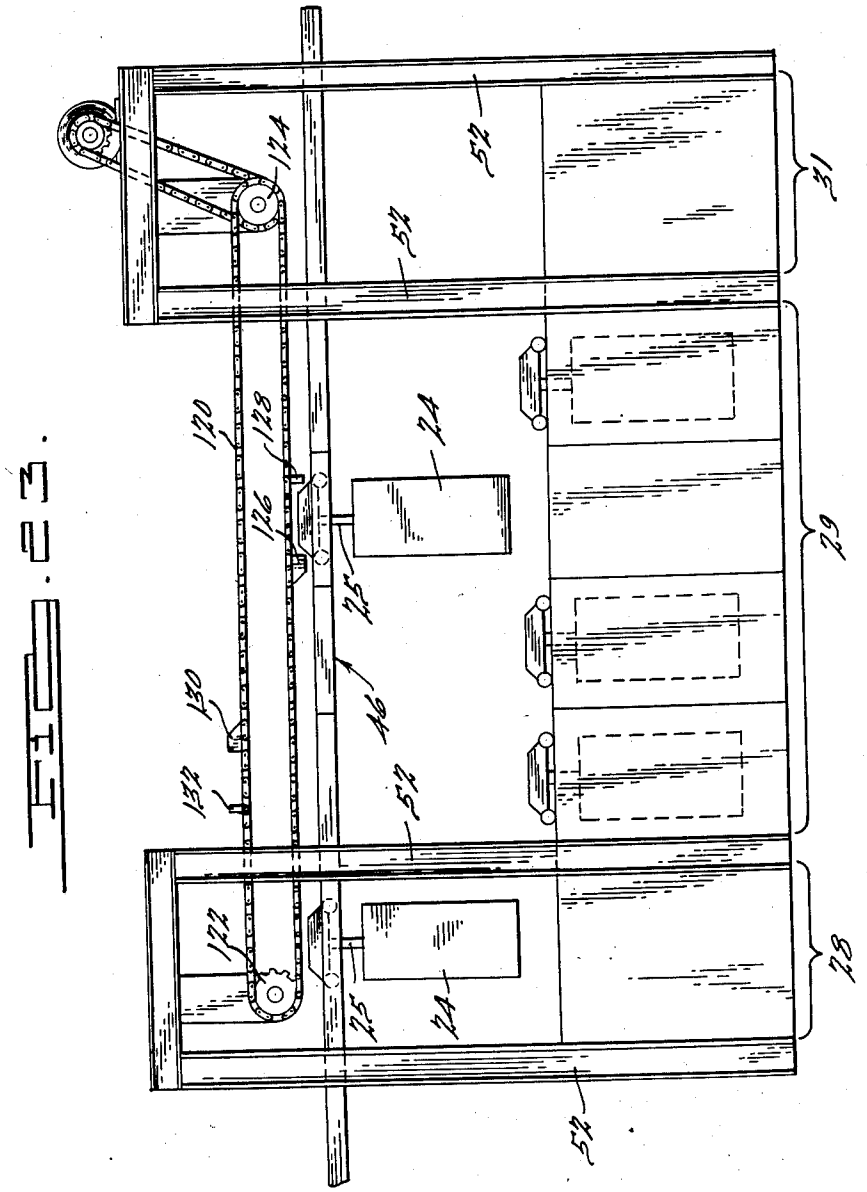


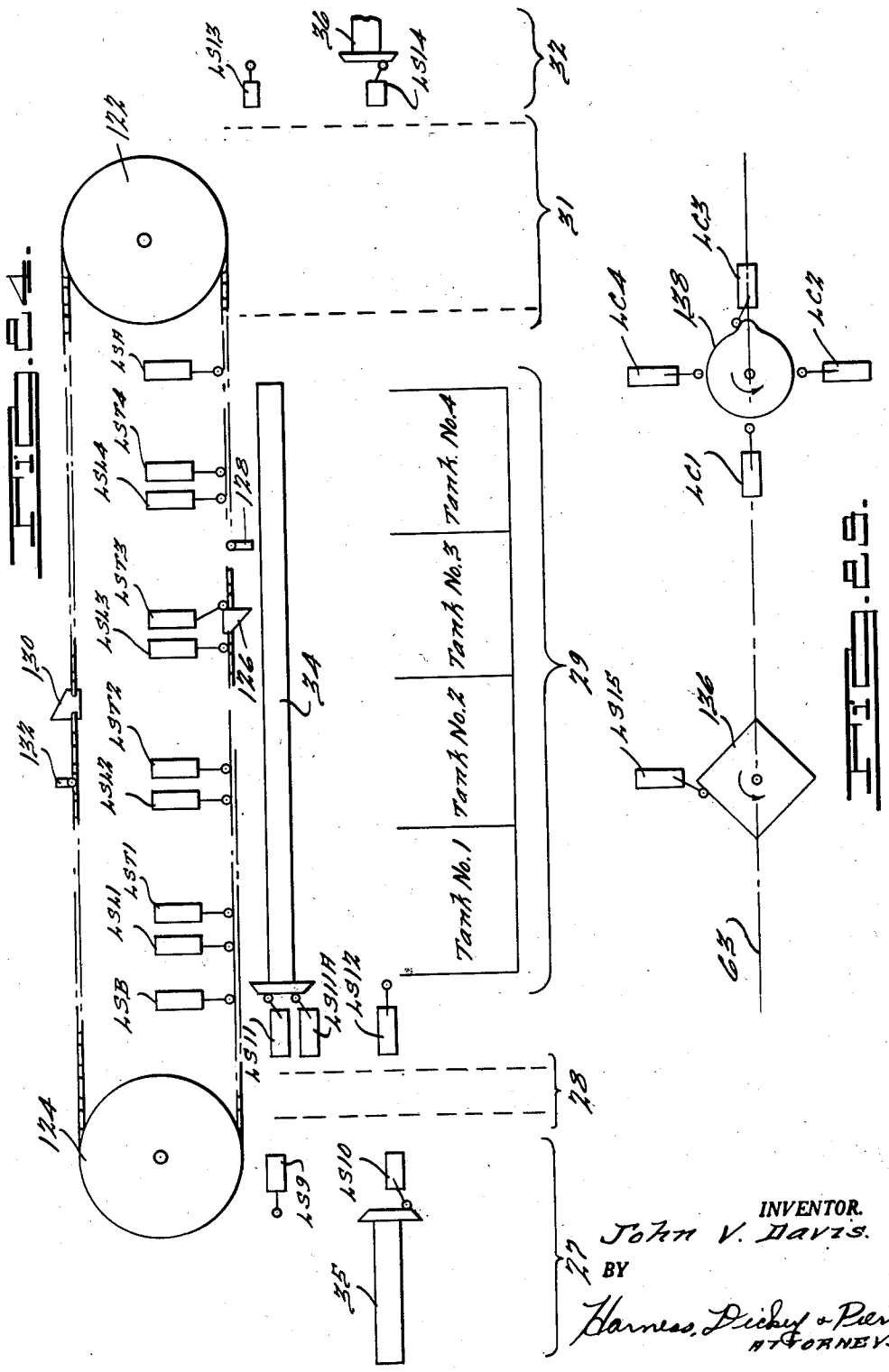
FIG. 11.

INVENTOR.
John V. Davis.
BY
Harness, Dickey & Pierce.
ATTORNEYS.

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PLATING MACHINE

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INVENTOR.
John V. Davis.
BY
Harness, Dickey & Pierce
ATTORNEYS.

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PLATING MACHINE

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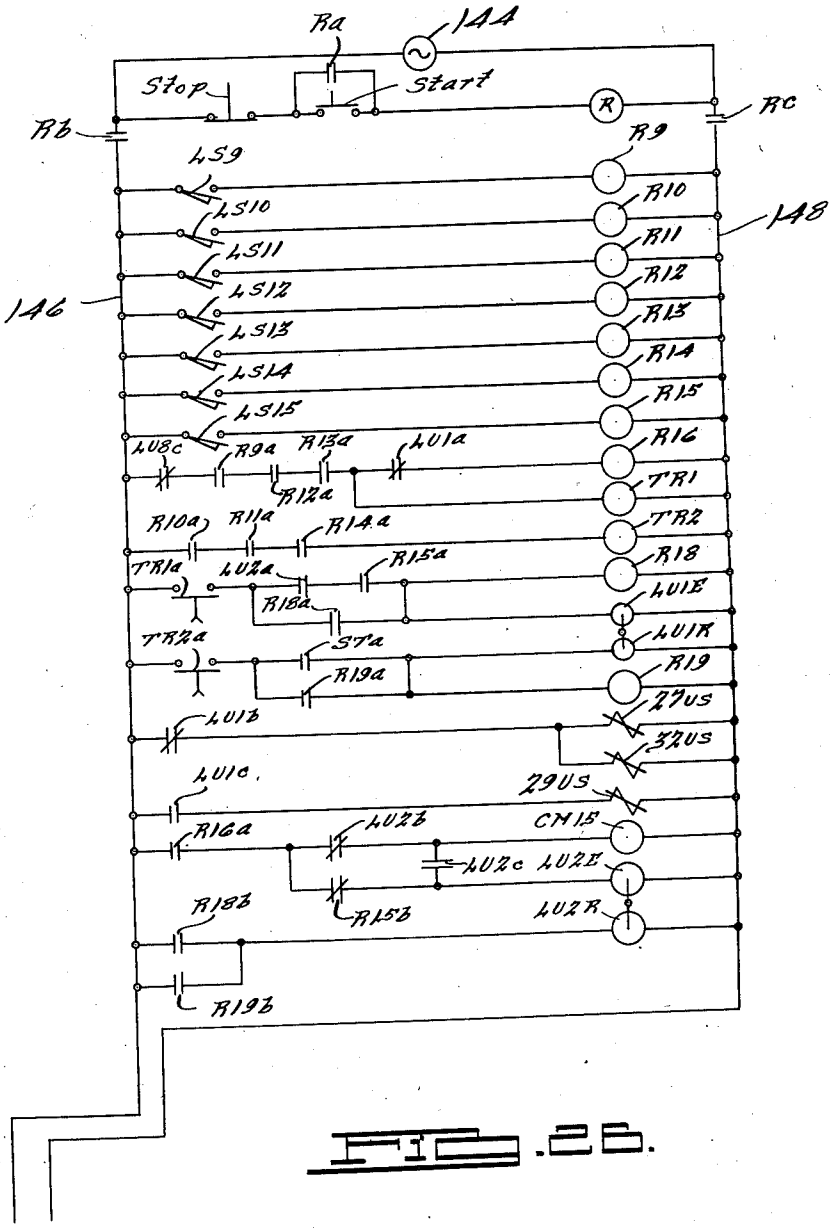


FIG. 28.

INVENTOR.
John V. Davis.
BY
Harness, Dickey & Pierce.
ATTORNEYS.

April 23, 1957 J. V. DAVIS 2,789,569

PLATING MACHINE

Filed Aug. 24, 1955 16 Sheets-Sheet 14

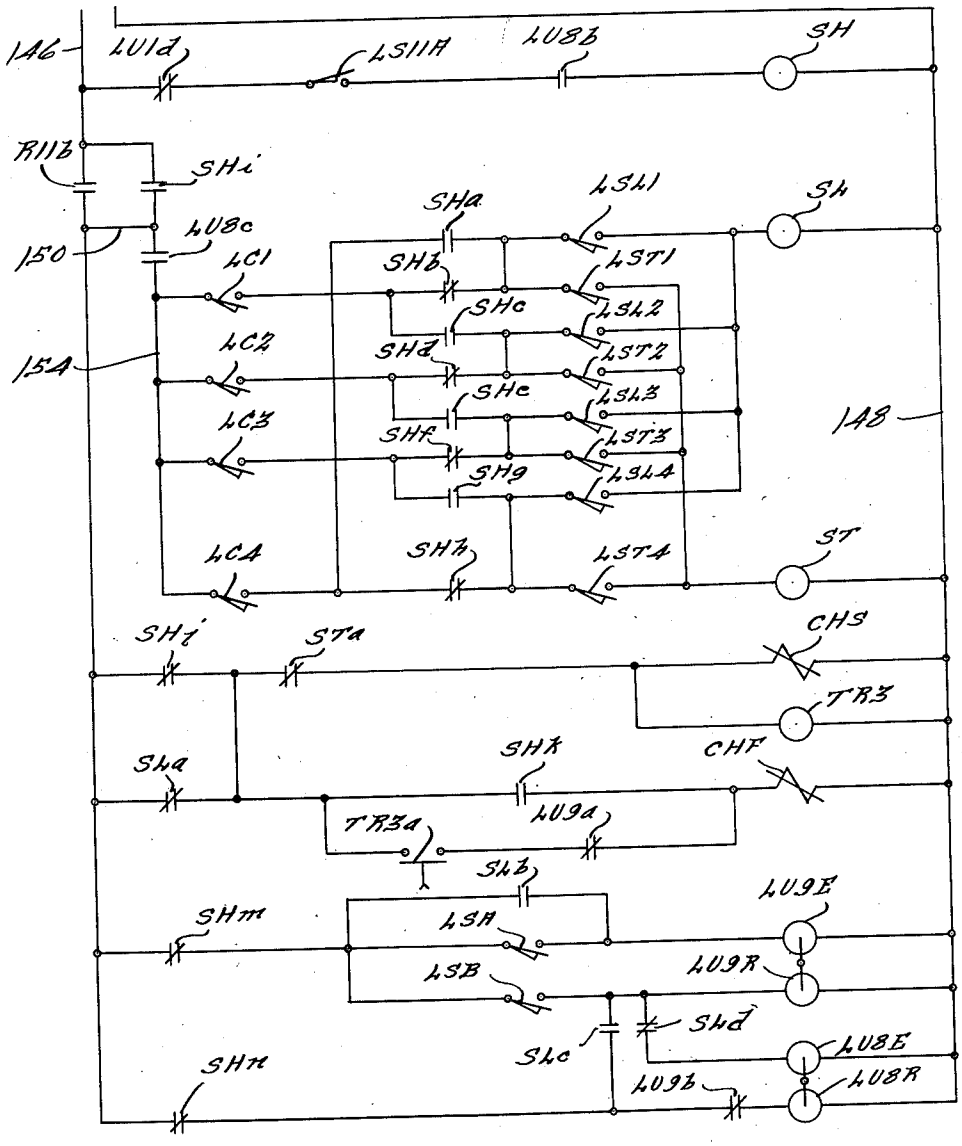


FIG. 12.

INVENTOR.
John V. Davis
BY
Harness, Dickey & Pierce
ATTORNEYS

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PLATING MACHINE

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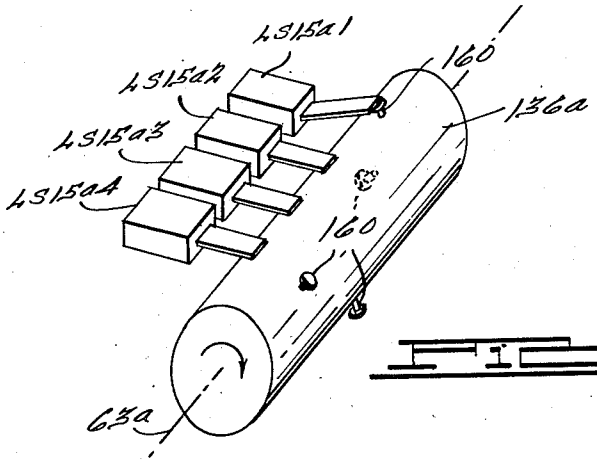


FIG. 28.

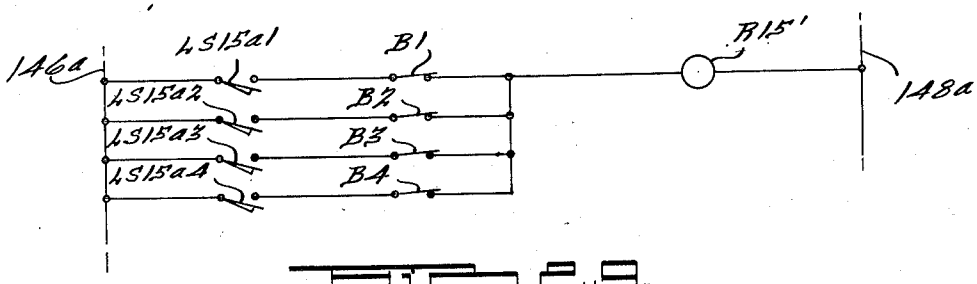


FIG. 29.

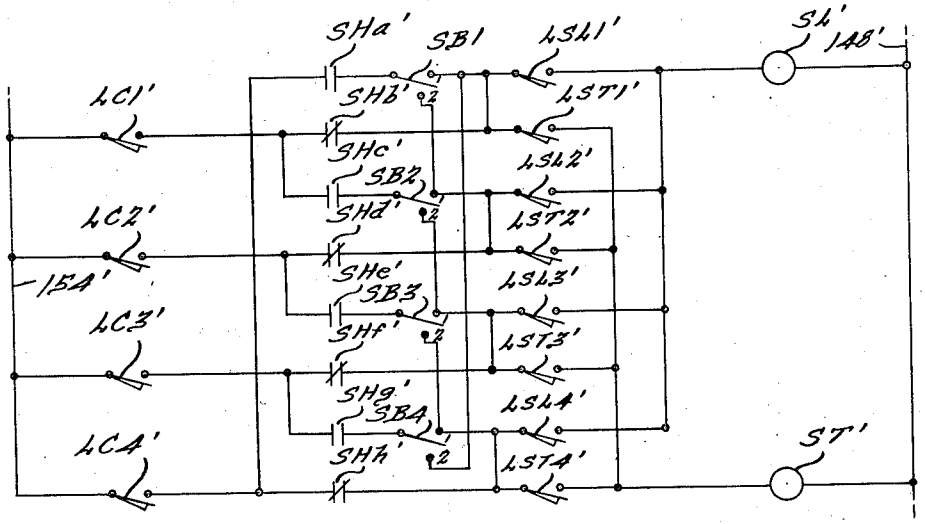


FIG. 30.

INVENTOR.
John V. Davis
BY
Harness, Dickey & Pierce.
ATTORNEYS.

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PLATING MACHINE

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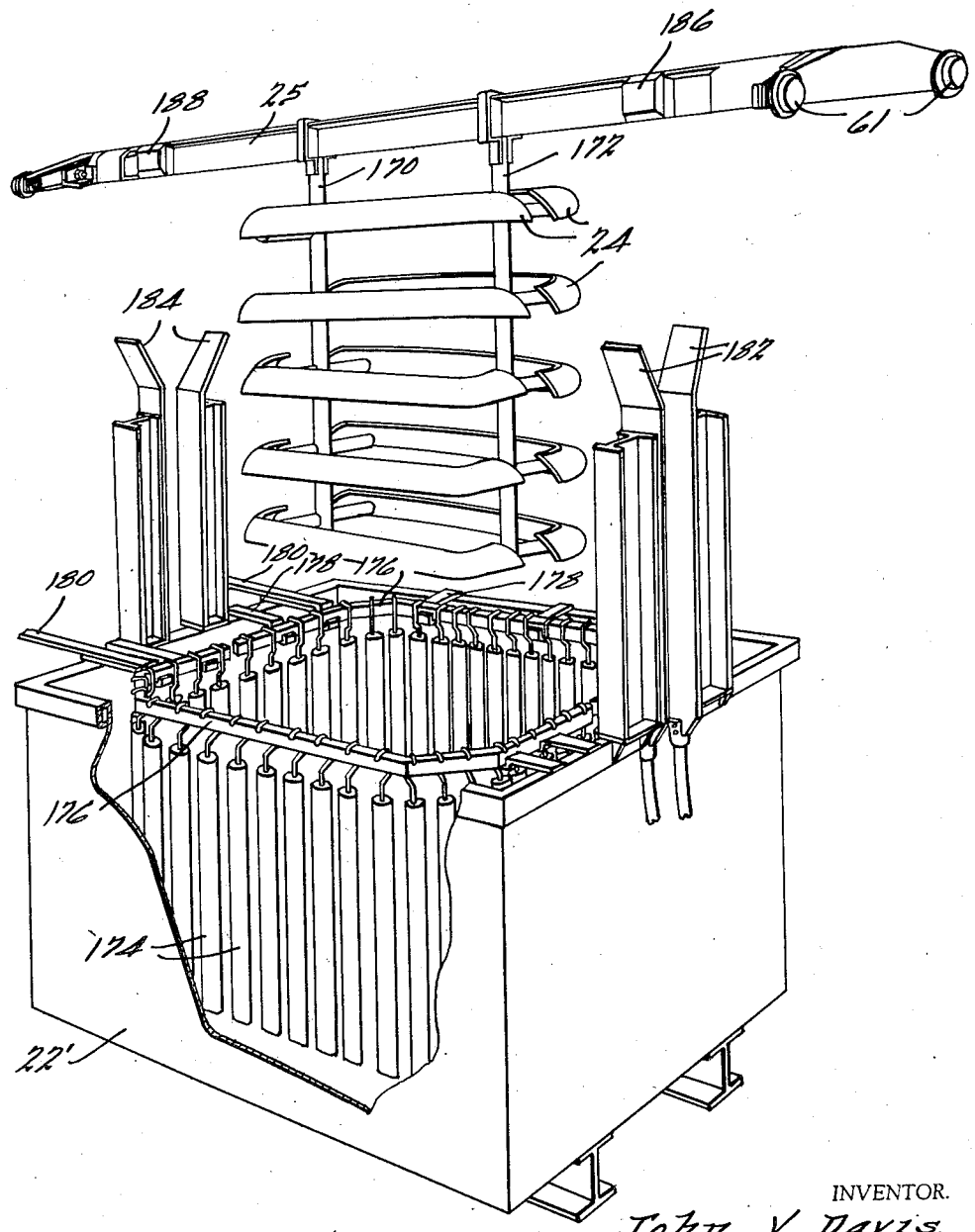


Fig. 31.

INVENTOR.
John V. Davis.
BY
Harness, Dickey & Pierce.
ATTORNEYS.

United States Patent Office 2,789,569 Patented Apr. 23, 1957

2,789,569

PLATING MACHINE

John V. Davis, Grosse Pointe Farms, Mich., assignor to The Udylite Corporation, Detroit, Mich., a corporation of Delaware

Application August 24, 1955, Serial No. 530,223

29 Claims. (Cl. 134—58)

This application is a continuation-in-part of my application Serial No. 397,506, filed December 11, 1953, now abandoned, bearing like title.

This invention relates to plating machines and more particularly to straight line automatic electroplating machines of the type in which a series of articles are conveyed on carriers through the machine from one end to the other and are removed from the carriers after being plated.

In conventional straight line automatic plating machines, the work carriers enter one end of the machine having a series of tanks which run the full length of the machine and the work travels from one tank to the next tank in an elevated position, and in the down position travels between rows of longitudinally disposed anodes to emerge from the plating bath at the opposite end of the machine. Such an arrangement permits only slight adjustments of the anodes to accommodate varied shaped parts in order to obtain uniform plating over the entire surface of the part. In the usual case where the part to be plated requires adjustment of the anodes, it is preferable and cheaper to plate the parts in a still tank with the parts disposed horizontally and the anodes disposed in nested relationship around the part even though it is necessary to move the plated parts by overhead hoists operated by a skilled plater.

It is an object of the present invention to provide a straight line plating machine of an improved nature which eliminates the disadvantages of previous devices of this type and results in a substantial saving of time and space when plating a plurality of workpieces simultaneously.

It is another object to provide an improved plating machine of the above nature in which means are provided for selectively lifting one or more of a plurality of workpieces from the plating bath, and allowing the workpieces which have not been fully plated to remain continuously in the plating bath until their removal time has arrived.

It is a further object to provide a plating machine of the above nature in which the fully plated workpieces are "skip transferred," that is, selectively and automatically removed from the plating station in any desired sequence, regardless of their relative longitudinal position in the plating station, and in which unplated workpieces are automatically transferred to those positions in the plating station vacated by plated parts.

It is also an object to provide a plating machine of the above nature in which the number and size of plating tanks, workpiece capacity, sequence of removal and plating time may be varied to suit individual requirements.

It is another object to provide a plating machine of the above character in which novel means are provided for preventing an unplated workpiece from stopping in a plating section which is unable to receive the workpiece, and which automatically halts the forward movement of a workpiece which has reached its proper position on the transfer track.

It is a further object to provide a plating machine of the above type, which is provided with a transfer track having displaceable sections, and in which the means for lifting and lowering the workpiece with respect to the plating bath operates to displace the displaceable section of the transfer track directly thereabove, thereby providing a simple and efficient mechanism for effecting skip transfer of the articles being plated.

It is a further object of this invention to permit any one or more of a plurality of cells or tanks at a liquid-treating station to be selectively bypassed, to facilitate inspection, cleaning and repair thereof, without interruption of the operation of the other elements of the machine and without interruption of the continuous processing of workpieces by the machine.

Other objects, features, and advantages of the present invention will become apparent from the subsequent description, taken in conjunction with the accompanying drawings.

In the drawings:

Figure 1 is a perspective view of a straight line plating machine with the tanks removed having included therein the principles of the present invention and showing the general location of the novel plating station with respect to the other portions of the machine;

Figure 2 is a perspective view of the plating station with the frame down and showing the cam shaft and cam drive mechanism for the movable track sections;

Figure 3 is a perspective view similar to Figure 2 but with the frame in the raised position and with one of the movable track sections (34*a*) held inwardly so as to displace the transfer track section directly thereabove, and to form a continuous track;

Figure 4 is a perspective view of the interior of the transfer track of station 29, showing the movable track sections thereof with the selecting station in contact with a carrier in its lowered position;

Figure 5 is a fragmentary cross-sectional view taken along the line 5—5 of Fig. 2 and showing the cooperation of a track selector cam and a movable track support as well as the manner in which a movable track section engages a carrier; this figure also shows a first embodiment of a pivotally mounted transfer track displaceable section which is disposed directly above the movable track section of station 29;

Figure 6 is a fragmentary cross sectional view similar to the upper portion of Figure 5 but showing the selected movable track section in its raised position with the displaceable section of the transfer track directly thereabove being pivoted upwardly to allow the movable track section to be aligned with and become a part of the transfer track;

Figure 7 is a fragmentary sectional view taken along the line 7—7 of Fig. 5 showing a means for pivotally mounting the transfer track displaceable sections above station 29;

Figure 8 is a fragmentary cross-sectional view similar to Fig. 5 but showing a second embodiment of a displaceable transfer track section disposed above station 29;

Figure 9 is a fragmentary cross-sectional view similar to the upper portion of Fig. 8 but showing the selected movable track section in its raised position with the displaceable section of the transfer track directly thereabove being slid upwardly to allow the movable track section to be aligned with and become a part of the transfer track above station 29;

Figure 10 is a fragmentary sectional view taken along the line 10—10 of Figure 8 showing a means for slidably mounting the transfer track displaceable sections above station 29;

Figure 11 is a perspective view of a pusher retractor guide with its gate in the open position to allow a pusher to fall behind a carrier;

Figure 12 is a perspective view similar to Figure 11 but with the gate in the closed position to maintain the retracted position of the pusher;

Figure 13 is a fragmentary elevational view taken along the line 13—13 of Figure 2 and showing the operating means for the pusher retractor gate;

Figure 14 is a fragmentary cross-sectional view taken along the line 14—14 of Figure 3 showing the pusher slides and their attendant mechanism;

Figure 15 is a schematic view showing the relation between the various stations and tanks, the pretreating and rinsing stations being shown in their lowered positions and the plating station in its upper position;

Figure 16 is a schematic view similar to Figure 15 but with a workpiece moved from the plating station to the rinse standby station and a new workpiece replacing the previous one in the plating station;

Figure 17 is a schematic view similar to Figures 15 and 16 but with the pretreating and rinse stations in their raised positions and the plating station in its lowered position;

Figure 18 is a schematic view similar to Figures 15 to 17 but with the plating station again raised with another finished workpiece;

Figure 19 is a schematic view showing the pusher slides and their cooperation with a pusher retracting guide, a first pusher being shown in its engaging position;

Figure 20 is a schematic view similar to Figure 19 but with the carrier raised to the upper position;

Figure 21 is a schematic view similar to Figure 19 but with the carrier advanced by the first pusher;

Figure 22 is a schematic view similar to Figures 19 and 20 but with a new carrier in plating position;

Figure 23 is a side elevation view of the apparatus of this invention, partly schematic, illustrating a chain pusher means for transferring a selected carrier along the transfer track to another portion of the machine, and for tansferring another carrier to the position vacated by the previously removed carrier;

Figue 24 is a functional representation of the physical relationship between the movable elements of the apparatus of Fig. 23, and adjacent stations, and the limit switches which control, in part, the several movements of those elements;

Figure 25 is a functional representation of the physical relationship between certain cam operated switches and cams mounted upon the cam shaft 63 of Figure 2 which control, in part, the energization of the cam motor 68 of Figure 2 and the chain of Figure 23;

Figure 26 is a schematic representation of a portion of a suitable electrical system for controlling the operation of the apparatus of this invention when the chain-type of horizontal transfer means is employed;

Figure 27 is a schematic representation of the remaining portion of the electrical system represented in Figure 26, and should be placed below Figure 26 for proper orientation;

Figure 28 is a functional representation of a cam, modified in form from the cam of Figure 25, and the switches actuated thereby for permitting the selective bypassing of any one of the tanks of Figures 23 or 24;

Figure 29 is a partial schematic representation of a manner of changing the circuits of Figure 26 to utilize the cam actuated switches of Figure 28 of the drawings;

Figure 30 is a partial schematic representation of a manner of changing the circuits of Figure 27 to coordinate the one-cell shift operation with the bypassing arrangements of Figures 28 and 29; and

Figure 31 is a fragmentary, partially cut-away perspective view of one plating cell with its anode nest and with a work carrier in position thereover.

The present invention provides automatic apparatus which allows a rack of parts to remain at rest in a cell of the plating tank provided with a nest of conforming anodes for the time period required to produce the required deposit, and concurrently enables the most efficient utilization of preliminary tanks, such as cleaning and rinsing tanks, which require much shorter dwell periods of the part being plated than the plating cells. In general, this automatic cycle is accomplished by a plating station which is provided with means for selecting in sequence empty plating cells to accommodate work carriers as they emerge from the preliminary tanks, as is more fully described hereinbelow.

The general arrangement and operation of the straight line plating machine embodying the present invention is perhaps best seen in schematic Figures 15 through 18. The machine includes a plurality of treatment tanks, three such tanks being shown in the present embodiment, namely a pretreatment tank 21, a plating tank 22 and a rinse tank 23. Plating tank 22, which is schematically indicated in Figures 15 through 18 is in the actual apparatus of this invention a segmented tank, the plurality of segments forming plating station 29 of Figure 1. In each of the segments of tank 22, the anodes are hung across the width of the machine in nests which conform to the shape of the part being plated, and it will be apparent that continuous forward travel through these tanks is impossible. It will be understood that the nature, number and capacity of the tanks could be varied from those shown and that the principles of the invention could be applied to other than the illustrated sequence of operations. The workpieces 24 are held by carriers 25 during their movement through the machine and into and out of the various tanks. These carriers travel along a pair of transfer tracks each of which extends the length of the machine and is made up of sections corresponding to the stations of the machine. Since the sequence of movement of the carriers is important in understanding the operation of the invention, each carrier in Figures 15 through 18 is given a separate reference numeral. Thus, in the figures, carriers 25*a* to 25*m* are marked.

Section 22′ of the plating tank 22, with a representative anode nest and with a carrier 25 in position thereover, is illustrated in Figure 31 of the drawings. In that view the work carrier 25, including its rollers 61, is disposed over tank 22′ and supports a pair of hangers 170 and 172 which have suitably conformed projections to support a plurality of workpieces 24, those workpieces representatively being shown to be automobile bumpers.

Anodes 174 are hung or otherwise supported upon anode bars 176 which are disposed rectangularly or octagonally so that the anodes 174 define a nest into which the workpieces 24 may be moved. Anode bars 176 are supported upon tank section 22′ by means of support elements 178, either the elements 178 or the tank section 22′, or both, being of insulating material. Electrical connection is made to the anode bars 176 and hence to the anodes 174 by means of anode terminals 180. Pairs of spring arms 182 and 184 are disposed at opposite sides of the tank section 22′ and in position to engage contact pads 186 and 188, respectively, which are electrically integral with the work carrier 25 and hence with the workpieces 24. Appropriate electrical connection is made to the pairs of arms 182 and 184 so that the workpieces 24 serve as the cathode of the electrolytic cell. In view of the use of anode nests, each of which is defined by a plurality of anodes, such as anodes 174, supported upon anode bars, such as anode bars 176, the workpieces must be moved into and out of the individual nests in a vertical sense.

The stations of the illustrated straight line plating machine include a loading station 26, pretreatment station 27, a transfer and drain station 28, a plating station 29, a rinse transfer station 31, a rinse station 32 and an unloading station 33. The workpieces on their carriers move in succession from station 26 to station 33, and as the workpieces reach tanks 21, 22 and 23 they are lowered into these tanks for appropriate treatment. For this purpose, the transfer track sections above each tank are movable

in a vertical direction so that the carriers disposed on such vertically movable sections can be lowered. As will be seen later, the portion of the transfer track above plating tank 22 includes means for selectively removing and replacing one or more workpieces from a group which are being plated. It may be stated here briefly, for purposes of describing the general operation of the machine, that the movable transfer track sections in station 29 comprise a plurality of relatively movable track sections 34*a*, 34*b*, 34*c*, and 34*d*, and that means are provided for causing these track sections to selectively engage one or more carriers 25 when station 29 is in its lower position, so that those carriers 25 not engaged by their respective track sections remain in the plating tank when the track sections of station 29 are raised.

In describing the sequence of operations of the straight line plating machine embodying this invention, we start with an initial condition in which track 35 of station 27 and track 36 of station 32 are in their lower positions, whereas track sections 34 of station 29 are in their upper positions. At this time the workpieces held by carriers 25*b*, *c*, *d* are being pretreated and the workpiece held by carrier 25*j* is being rinsed. Track section 34*a* of station 29 has just lifted carrier 25*f* during its upward movement, but carriers 25*g*, *h*, *i* have remained in their lower positions within plating tank 22. Carrier 25*e* is on track 37 of plating transfer station 28, ready to be transferred to track section 34*a* to replace carrier 25*f*. Carrier 25*a* on track 38 of loading station 26 has just received a workpiece, whereas carrier 25*k* on track 39 of unloading station 33 has just been relieved of its finished workpiece.

The carrier transfer mechanism (described in detail below) now operates to shift carrier 25*f* past carriers 25*g*, *h*, *i* to track 40 of rinse transfer station 31 and to shift carrier 25*e* into place on track section 34*a*, as shown in Figure 16. This means of course that the workpiece held by carrier 25*e* may now take the position in plating tank 22 which was vacated by carrier 25*f*, the latter being held in readiness for rinsing in tank 23. Meanwhile, carrier 25*a* has been transferred to the first portion of track 35 in station 27 which extends rearwardly from tank 21. Track 39 of unloading station 33 has been elevated to permit its carrier 25*k* to be returned by a pair of overhead return tracks (not shown in the schematic drawings).

Track sections 34 of plating station 29 are then lowered, placing carrier 25*e* into the plating tank as shown in Figure 17. At the same time, tracks 35 and 36 of stations 27 and 32 respectively are raised. The transfer mechanism now operates to shift carrier 25*d* from track 35 onto track 37 of plating transfer station 28, and to move carriers 25*a*, *b*, *c* forwardly on track 35, carrier 25*a* moving into position above pretreatment tank 21. Track 38 is simultaneously elevated into alignment with the overhead return track (not shown) to receive a new carrier 25*m*. At the same time, carrier 25*f* is moved from rinse transfer station 31 onto track 36 of rinse station 32, carrier 25*j* which had been in the rinse tank being shifted onto descended track 39 of unloading station 33.

When another workpiece has been completely plated, for example the workpiece held by carrier 25*i*, this workpiece is removed from plating tank 22 by its appropriate track section 34*d*. This is shown in Figure 18, wherein it will be noted that tracks 35 and 36 are again lowered and track sections 34 raised, as in Figure 15. It is thus seen that due to the novel arrangement of the movable track sections in plating station 29, the workpieces in plating tank 22 are selectively removed, the sections of the transfer track serving as the selecting means. Carrier 25*i* will now be shifted to track 40 of rinse transfer station 31 and carrier 25*d* will be shifted from plating transfer station 28 into position on track section 34*d*. Meanwhile, track 38 of loading station 26 has been lowered to receive a new workpiece on carrier 25*m* and the workpiece on carrier 25*j* has been removed at unloading station 33.

The cycle will continue as before, with the workpieces in plating tank 22 being removed in any desired sequence.

Referring now more particularly to the construction of Figures 1–14, Figure 1 shows the general arrangement of the machine, and includes loading station 26, pretreating station 27, plating transfer station 28, plating station 29, rinse transfer station 31, rinse station 32, and unloading station 33. The construction of portions of the machine is generally similar to that shown in patent to Davis No. 2,484,079 for Hydraulically Operated Plating Machine, and certain parts of the present machine not relating to the present invention therefore need not be described in detail. Loading station 26 includes an elevator frame 41 which can be lifted by actuating chains 42 so that tracks 38 of the loading station may be aligned with overhead carrier return tracks 43. When in its lowered position tracks 38 of the elevator frame are aligned with tracks 35 of pretreatment frame 44 at pretreatment station 27. The latter frame is also vertically movable by means of a plurality of chains as 45, and when in their upper position tracks 35 of pretreatment frame 44 are aligned with tracks 37 of plating transfer station 28. Pusher means, preferably in the form of reciprocating pusher slides, described later, are provided for transferring carriers 25 from elevator fame 41 to pretreatment frame 44 and from the pretreatment frame to station 28. The means for vertically moving the loading and unloading elevators, and pretreatment frame, as well as the actuators for the carrier pusher means, forming in themselves no part of the present invention, need not be described in detail, but reference is here made to the above mentioned Patent No. 2,484,079 wherein such means are described. It may be here stated, however, that reference is hereinafter made to the pusher mechanism as it affects the transfer of carriers from plating transfer station 28 to plating section 29 and from the plating section to rinse transfer station 32.

The general construction of plating station 29 is best seen in Figures 2 and 3. The station includes a vertically movable frame generally indicated at 46 which has a pair of upper longitudinal members 47, a pair of lower longitudinal members 48, and vertical members 49. The frame carries a plurality of rollers 51 by means of which the entire frame is vertically movable, rollers 51 being guided by a plurality of vertical stationary rails 52. The means for lifting and lowering the frame preferably comprises a plurality of chains 53 on both sides of the machine, these chains being operable by a hydraulic cylinder 54 visible in Figure 1, together with linkage similar to that for elevating pretreatment frame 44.

As indicated previously, plating frame 46 includes means for selectively lifting one or more of a plurality of carriers resting on the plating tank, and this means includes a plurality of pairs of movable track sections 34. As is best seen in Figures 2 and 4, track sections 34 are disposed inwardly of upper longitudinal frame members 47, and are each pivotally supported by a pair of pivoted arms 55. Each of these arms is pivoted by a pin 56 to a pair of lugs 57 secured to lower longitudinal members 48, so that arms 55 are movable between an outer position as shown by the central and right hand pairs of arms in Figures 2 and 4 and an inner position as shown by the left hand pair of arms in Figures 2 and 4. Sufficient lateral space is of course allowed between track sections 34 and longitudinal frame members 47 to permit this swinging movement.

When any selected set of arms 55 is swung to the inner position, with frame 46 in its upper position, the track sections 34 carried by such arms 55 will be in alignment with tracks 37 of station 28 and with tracks 40 of station 31. In order to allow a carrier 25 to be moved from the frame 46 when such frame is in its upper position a displaceable track section, as 10, is suitably disposed in alignment with the transfer track directly above each movable track section 34. The displaceable track sections 10 are preferably either pivotally or slidably mount-

ed, as shown in Figures 5 through 7, and 8 through 10, respectively.

The displaceable track sections 10 may be pivotally mounted in any suitable manner. In Figures 11, and 5 through 7, is shown one embodiment wherein the numerals 10*a* and 10*d* designate displaceable track sections which are disposed in horizontal alignment with the transfer tracks of stations 28 and 31, and which are in vertical alignment with the track sections 34*a* and 34*d*, respectively, on frame 46. Each track section 10 is provided with a supporting member as 11 having a pair of rearwardly extending arms as 12. The outer transfer track sections 10 that are disposed over the end movable track sections 34*a* and 34*d* may have their outer ends pivotally mounted on the adjacent vertical rail 52, by any suitable means, as indicated in Figure 11 by the numeral 14. The inner ends of the outer track sections 10, and both ends of all the other track sections 10 may be pivotally mounted on vertical rails as 15 secured to the machine frame above the transfer track to prevent any interference with movable frame 46. The arms 12 may be suitably secured to the vertical rails 15 as by the bolts 16 and nuts 17. A stop 18 is fixed to all the rails supporting any of the arms 12 and such stops function to maintain the displaceable track sections 10 in alignment with the transfer tracks of stations 28 and 31. As is best seen in Figures 5 through 7, the displaceable track sections 10 are adapted to be pivoted upwardly to allow any selected set of movable arms 55, supporting a carrier 25, to move upwardly and displace the track sections 10 directly thereabove with a set of track sections 34. The other track sections 10 would remain in place to permit the carrier 25 so raised to be transferred past the other carriers 25 at station 29.

The displaceable track sections 10 may be slidably mounted in any suitable manner, one such manner being shown by a second embodiment in Figures 12, and 8 through 10 wherein is shown displaceable transfer track sections 10*a* and 10*d*, which are disposed over track sections 34*a* and 34*d*, respectively, on frame 46. As illustrated, each displaceable track section 10 may be provided with a rearwardly extending portion 19 adapted to be slidably supported between two vertical rails 20 suitably fixed on a horizontally disposed channel 76. The vertical rails 20 are provided with a cross member 20*a* on which the displaceable track section portions 19 are held so as to maintain the displaceable track sections in alignment with the transfer tracks of stations 28 and 31. The slidably mounted displaceable track sections 10 function similarly to the aforementioned pivotally mounted displaceable track sections. As is best seen in Figures 8 through 10, whenever a selected set of movable arms 55 is carried upwardly by frame 46, the slidably mounted displaceable transfer track sections 10 disposed directly thereabove will be slid upwardly to allow the track sections 34 carried by such arms to be aligned with the transfer track to permit a carrier 25, on such track sections 34, to be transferred past the other carriers 25 at station 29.

Due to the interposition of vertical rails 52 and of vertical members 49 of frame 46, it is necessary to provide a plurality of stationary interconnecting track sections 58 and 59 secured to rails 52 and vertical members 49 respectively. These stationary interconnecting tracks, which are relatively short, serve to interconnect adjacent movable track sections 34 and displaceable track sections 10. The stationary track sections 59 are carried upwardly on frame 46 to complete the transfer track between a selected track section 34*a*, 34*b*, 34*c* or 34*d* and adjacently disposed displaceable track sections 10 when frame 46 is in the upper position. Stationary track sections 58 will be disposed toward the lower end of rails 52 to form a continuous track for frame 46 when it is in the lower position (as shown in Fig. 4) and other stationary track sections 58 will be disposed toward the upper end of rails 52 so as to form a continuous track for frame 46 when it is in the upper position. When frame 46 is in its lowered position, as seen in Figures 2 and 4, track sections 34 are aligned with rollers 61 at the outer ends of carriers 25, so that inward movement of a particular pair of track sections will engage the flanged rollers of their adjacent carrier. It may be here stated that in Figure 4 the carriers 25 are shown as resting on a rail 62, this rail representing the edge of the plating tank which is not shown in the figure.

Means are provided for moving each of the movable pairs of track sections 34 into carrier-engaging position in timed sequence, and this means includes a cam shaft 63 rotatably supported on a longitudinal member 64 secured to frame 46. Member 64 carries a plurality of bearing members 65 through which shaft 63 extends, and the shaft carries a plurality of cams 66 which are adapted to engage supporting arms 55 of the movable track sections 34. As is best seen in Figures 2 and 3, cams 66 comprise arms carrying rollers 67 at their outer ends, and a pair of cams is provided for each pair of arms 55 which support a movable track section 34. In the illustrated embodiment, succeeding pairs of cams are angularly displaced 90°, although it will be understood that other arrangements could be used if desired. Cam shaft 63 is driven by a motor 68 through a gear reduction drive 69, and a chain coupling 71 is provided from gear reduction drive 69 to a symmetrically operating cam shaft (not shown) on the opposite side of frame 46.

As is best seen in Figures 5 and 8, each cam 66 is adapted to swing its corresponding arm 55 inwardly when the cam is in a position extending toward the center of the machine. When in this position movable track section 34 is disposed over a pair of rollers 61 attached to carrier 25, the carrier thus being liftable when frame 46 is raised. A counterweight 72 is secured to the lower ends of each pair of arms 55 by means of outwardly extending members 73 and bolts 74. As frame 46 descends the downward travel continues until carrier 25 rests on rail 62 and arms 55 are free of rollers 61, and it will thus be seen that when cams 66 are rotated away from their position shown in Figures 5 and 8, counterweight 72 will cause arms 55 to swing clockwise about their pivoted ends 56 into the dot-dash position shown in Figures 5 and 8. When in this position movable track section 34 is clear of rollers 61, so that frame 46 may be lifted without disturbing the corresponding carrier 25. It should be noted that the position of any pair of movable track sections 34 as determined by the position of their corresponding cams 66 will not affect the position of any other pair of movable track sections, since the track sections are independently movable as determined by cams 66 and counterweights 72.

As indicated above, the displaceable track sections 10 combine with a selected set of inwardly and upwardly moved track sections 34 to form a continuous track when frame 46 is in its upper position, so that the carrier 25 which has been selectively lifted from the plating tank may be transferred to rinse standby station 31. The non-selected track sections 34 remain in their outer non-working positions and ride upwardly with frame 46 in such positions.

The means for moving carriers 25 along the transfer tracks is generally similar in construction to the moving means described in aforementioned Patent No. 2,484,079, and comprises a pair of inner pusher slides or carriers 79 and a pair of outer pusher slides or carriers 81, one of each pair of slides being shown in Figure 14. Each inner slide 79 has a plurality of pushers 82 pivotally suspended therefrom, and each outer slide 81 carries a plurality of pushers 83. Each pusher 82 and 83 is so constructed as to swing freely about its pivot axis when engaged on its rearward side, but is prevented from free swinging movement when engaging a carrier on its forward side. As is best seen in Figures 12 and 14, slides 79 and 81 are slid-

ably supported by the frame of the machine and are actuatable by hydraulic cylinders as 84 and 85 (Fig. 1) on each side of the machine, these cylinders acting through links 86 and 87 respectively, as described more particularly in the aforesaid patent. When either pair of slides therefore is actuated in a forward direction, that is toward the right in Figure 1, appropriate pushers 82 or 83 carried by the moving slides will engage adjacent carriers 25 and will move these carriers in a forward direction. Engagement of the carriers during rearward movement of slides 79 and 81 will merely result in pivoted retracting movement of the pushers, with no effect on the carriers.

Two pairs of pusher slides, 79 and 81, are shown in the illustrated embodiment for plating station 29 and its related stations, but it will be understood that a different number of slides could be used in appropriate circumstances. In the present example, it is apparent that by reciprocating slides 79 and 81 alternately and properly spacing pushers 82 and 83 one may transfer a carrier from a given position in plating station 29 to rinse standby station 31, the carrier passing over or skipping the carriers still in the plating tank. It is thus possible in a single operation to move a carrier 25 from a plating station position furthest from station 31 to station 31, slides 79 and 81 operating alternately to effect this transfer in a rapid manner. At the same time, a new carrier 25 may replace that removed from the plating tank in the same relative position. In actual practice of course, one or the other of pusher slides 79, 81 could also be utilized for transferring carriers from pretreatment station 27, plating standby station 28 and from rinse standby station 31 to rinse station 32.

It will be seen from an examination of Figures 15 through 18 that in the case of a carrier such as carrier 25*f* which must be transferred from the rearward end of plating station 29 to station 31, several alternate strokes of inner and outer pusher slides 79 and 81 will be required, since each stroke will only move the carrier a fraction of the total distance, and in the embodiment shown this distance is one station width. When new carrier 25*e* arrives into the position vacated by carrier 25*f*, it is necessary to prevent carrier 25*e* from being moved out of its newly acquired position by the continued reciprocation of slides 79 and 81 which are necessary to complete the transfer of carrier 25*f* into station 31. The means for insuring that each carrier newly arriving in plating station 29 will be transferred to and halted in its proper position includes a plurality of pusher retractor guides 88, shown best in Figures 11 and 12. These guides each comprise stationary angle members supported adjacent pusher slides 79 and 81 at points longitudinally spaced along the slides, each guide controlling a corresponding pusher 82 or 83. Each pusher 82 or 83 carries a pin 89, and means are provided for causing pin 89 to ride up onto its corresponding guide 88 when the slide is moving rearwardly, or to the left in Figures 11 and 12, thus causing retracting movement of the pusher about its pivot 90. This means includes a curved member 91 pivoted at 92 to the forward end of each guide 88 and extending forwardly and downwardly therefrom. Member 91 is adapted to swing freely in a forward direction when engaged by pin 89 from the rear with pusher 82 or 83 moving forwardly. However, after pin 89 passes under member 91 and the slide is moved rearwardly, pin 89 will ride up on member 91, which is prevented from swinging in a clockwise direction as seen in Figures 11 and 12, by a stop (not shown). This action will cause counterclockwise or retracting movement of pusher 82 about its pivot 90, lifting the pusher above a level at which it can engage a carrier 25, such carrier being shown schematically in dot-dash lines in Figures 11 and 12. Therefore, unless the pusher is allowed to drop into its engaging position before it is again moved forwardly, it will clear any carrier which would normally be in its path and thus be prevented from moving such carrier.

Means are provided for selectively permitting each pusher 82 or 83 to again drop into its engaging position before its forward stroke, the purpose of such mechanism being, as stated previously, to continue transfer of a carrier not yet in its proper position in the plating station but to halt a carrier which has reached its proper position. This means includes a movable gate 93 which is part of each pusher retracting guide 88 and is controlled, in a manner described below, by cam shaft 63. When in its raised position, as seen in Figure 11, gate 93 uncovers an opening 94 in the bottom of guide 88. The relative positions of the parts are such that when pusher slides 79 and 81 are in their extreme rearward positions, pushers 82 and 83 are disposed rearwardly of gate openings 94 as seen in Figure 12. Thus, if gate 93 is lifted into its open position, upon the next rearward stroke of the pusher its pin 89 will drop through opening 94 and the pusher will then be in its operative or engaging position, ready to transfer any carrier 25 which it may engage. However, when gate 93 is in its lowered or closed position as seen in Figure 12, it closes opening 94 forming a continuous guide 88 so that pusher 82 or 83 cannot drop out of its retracted position on guide 88 and will thus be prevented from engaging a carrier 25. The pusher will merely ride along guide 88 in its retracted position, descending along member 91 and being again retracted upon its next rearward movement. Thus, with a particular gate 93 in its closed position a slide 79 or 81 may make any number of strokes without disturbing a carrier 25 adjacent the closed gate.

As stated previously, the position of each pair of gates 93 is controlled by cam shaft 63, and in particular those gates 93 are closed which are adjacent a pair of movable track sections 34 held in carrier-lifting position by cams 66. The purpose of this arrangement is so that a carrier 25 newly arriving in plating station 29 will continue to advance until it reaches that position which has just been vacated by a carrier 25 lifted from tank 22 by a pair of movable track sections 34. The gate-controlling means is best seen in Figure 13 wherein cam shaft 63 is shown as having a plurality of gate cams 95 fixed thereto, one such cam being provided for each pair of track actuating cams 66. Each cam 95 has a high dwell portion 96 and a low dwell portion 97, and a bell crank 98 is pivoted at 99 to frame 46 adjacent each cam 95. Bell crank 98 has a cam follower 101 riding on cam 95 and an upwardly extending arm 102 with an outwardly sloping upper end 103. Each gate 93 is carried by an arm 104 pivoted at 105 to the machine frame and extending inwardly therefrom, this arm having a downwardly extending portion 106 to which gate 93 is secured. A downwardly extending member 107 is secured to arm 104 adjacent pivot 105 and has an outward extension 108 engageable by arm 102 of bell crank 98 when frame 46 is lifted.

Bell crank 98 is movable between an inactive position shown in solid lines in Figure 13 and a gate lifting position shown in dot-dash lines. The inactive position s caused by engagement of cam follower 101 on lower dwell porton 97 of cam 95, and the gate lifting position is caused by upper dwell portion 96. When arm 102 is in its gate-lifting position as shown in dot-dash lines, its engagement with extension 108 of arm 107 when frame 46 is lifted will cause arm 104 to swing clockwise about pivot 105, thus causing gate 93 to be lifted as shown in dot-dash lines. With arm 102 in its inactive position, however, it will clear extension 108 when frame 46 is lifted and will therefore not affect the position of gate 93 which, as is evident from Figure 13, will normally be held by gravity in its closed position as shown in solid lines. When in this latter position, as indicated previously, gate 93 will prevent pin 89 of pusher 82 or 83 from dropping through opening 94 in guide 88. The relative lateral positions of gate 93 and pin 89 are illus-

trated in Figure 13 which shows a typical pusher 82, the pusher being shown below its actual height for purposes of clarity.

It is evident from viewing Figure 13 that lower dwell portion 97 of each cam 95 will be effective when its corresponding track actuating cams 66 have moved their respective tracks inwardly to their carrier-engaging positions. Thus, gates 93 of those guides 88 which are adjacent the carrier being lifted will be in closed position, permitting the newly arriving carrier to be properly positioned. Preferably, the extent of upper dwell portion 96 is such that each pair of gates 93 will be lifted whenever their corresponding pair of track sections 34 are not activated to remove a carrier from plating tank 22. In the present embodiment, since four pairs of movable track sections 34 are shown, this is accomplished by having upper dwell portion 96 effective in the three 90°-spaced positions other than that in which track sections 34 are held inwardly. This may perhaps be best understood by referring to Figures 2 and 3 wherein it will be seen that succeeding sets of cams 66 are angularly spaced 90° apart, so that track sections 34 may be operated in sequence by rotating cam shaft 63 90° during each cycle. For each cam 95 therefore, its lower dwell portion 97 will be effective when its corresponding cams 66 are effective, and upper dwell portion 96 will be operative in the other three positions.

The manner in which gates 93 are effective in permitting the skip transfer and sequential plating operations to take place is illustrated schematically in Figures 19 through 22. In these figures a single pusher retracting guide 88 is shown, together with portions of pusher slides 79 and 81 carrying pushers 82 and 83 respectively. The pusher slides are shown at different levels and the pushers of different sizes for purposes of clarity, although it will be understood that in the illustrated embodiment the slides are at the same level and the pushers of the same size as shown in Figure 14. Figure 19 shows gate 93 in its closed position, in which it is held by gravity when frame 46 is lowered. Pusher 82 is however in its extended or engaging position since during the previous rearward movement of slide 79 gate 93 had been in dot-dash lines in Figure 19, allowing pin 89 to drop through opening 94. When frame 46 is raised with the pair of track sections 34 adjacent the illustrated guide 88 in their carrier-engaging position, carrier 25 will be raised as shown in Figure 20 until it is aligned with pusher 82. Gate 93, which would ordinarily be opened by the mechanism shown in Figure 13 when frame 46 is lifted, will remain closed since arm 102 is in its solid line position as shown in Figure 13. Pusher slide 79 is then actuated in a forward direction, and pusher 82 will engage carrier 25 and push it forwardly as seen in Figure 21. During this movement pin 89 of pusher 82 will pass under the swingable curved member 91. At the end of its stroke, pusher 82 will have transferred carrier 25 slightly past that pusher 83 which is immediately forward of the original position of pusher 82.

In the next phase of the operation, slide 79 will move rearwardly and slide 81 will simultaneously move forwardly. In this manner pusher 83 will pick up carrier 25 and carry it still further forwardly. At the same time, the next rearward pusher 83' on slide 81 will transfer a new carrier 25' to the position previously occupied by carrier 25. It will also be seen that pusher 82 will be moved rearwardly and that pin 89 thereof will ride up on curved member 91 and will stay on pusher retracting guide 88, since the closed position of gate 93 will not permit pin 89 to fall therethrough. It is at this point that the benefit of the closed position of gate 93 will be realized. On the next forward movement of slide 79 (necessary to continue the transfer of carrier 25 to station 31) pusher 82 will clear carrier 25', permitting this carrier to remain in this position to be plated when frame 46 is finally lowered. During the course of the transfer operation, slides 79 and 81 may therefore be retracted and advanced, but this will not affect the position of carrier 25'. It is apparent that any number of strokes of slides 79 and 81 may be had and that therefore the arrangement is applicable to machines having any appropriate number of carrier spaces in plating tank 22. In the next cycle of operation, carrier 25' will ordinarily remain in the plating tank when frame 46 is raised, and gate 93 will then be opened permitting its adjacent pusher 82 to be effective on each forward stroke of slide 79 to transfer forwardly any carrier which may be delivered to the position occupied by carrier 25'.

The cooperation of the various parts described in the straight line plating machine embodying this invention may perhaps best be understood by an overall description of the operation of the machine, omitting those details which have been previously described for various phases of the operation. Since the invention is more particularly concerned with plating station 29 than with the other treatment stations, the cooperation of the various elements and parts in this area will be reviewed. Starting with a condition in which frame 46 has just been lowered with a carrier 25 to the position shown in Figure 2, cam shafts 63 on either side of the frame will be rotated by motor 68 to cause one set of track actuating cams 66 to engage corresponding track arms 55, swinging these track arms inwardly and causing track sections 34 to engage carrier rollers 61. Those track arms 55 which are not so actuated will be held outwardly by counterweights 72 so that their corresponding carriers are disengaged. The gate controlling cams 95 adjacent the carrier-engaging track sections 34 are rotated by cam shaft 63 to a position in which gate-controlling arm 102 is in its solid line position in Figure 13. All other cams 95 are so rotated that their corresponding arms 102 are in the dot-dash line position of Figure 13. At the same time, a new carrier 25 is moved into position at plating standby station 28, and the carrier which has just been removed from the plating station to rinse standby station 31 is transferred to rinse station 32.

Frame 46 is now raised by chains 53, and when the frame reaches its upper position, the track sections 34 on the selected set of track arms 55 which was swung inwardly will engage the displaceable track sections 10 directly thereabove and move them upwardly so as to allow the track sections 34 to be aligned with the transfer tracks of stations 28 and 31 and with the rest of the displaceable track sections 10. During the upward movement of frame 46 only that carrier 25 which is engaged by track sections 34 will be lifted out of plating tank 22, all other carriers remaining in the tank. As frame 46 approaches its upper position, gates 93 of those pusher retracting slides 88 which are adjacent inactive track sections 34 will be opened. However, gates 93 adjacent those track sections 34 which have lifted a carrier 25 from the plating tank will remain closed. Pusher slides 79 and 81 will now be alternately reciprocated to transfer lifted carrier 25 to rinse standby station 31, this carrier skipping any lowered carriers between it and the rinse standby station. The reciprocating movement of the pusher slides will also transfer a new carrier 25 from station 28 into the position vacated by the carrier 25 transferred to the station 31. The positions of gates 93 as described with respect to Figures 19 through 22 will automatically result in a new carrier 25 being moved forwardly until it reaches its proper position.

After the proper number of reciprocating movements of slides 79 and 81 have taken place, frame 46 will again be lowered. The selected set of inwardly moved arms 55 will be held inwardly by cams 66, since cam shaft 63 has not rotated during the time in which frame 46 was in its upper position. It will be apparent, therefore, that cam shaft 63 may be supported on a stationary support and that the desired selection will be obtained so long as cams 66 are in position to contact arms 55. When frame

46 reaches its lower position cam shaft 63 will again be rotated to select another carrier for removal from the plating tank.

The above described sequence of operations of the various moving parts of the machine of this invention may be obtained and timed by a cascade electrical circuit which actuates the hydraulic pusher and elevating means aforementioned. The sequence is obtained by electrical contacts suitably positioned to actuate the succeeding movement upon the conclusion of the previous movement.

It should be emphasized that the principles of this invention are of wide use and are not confined to the particular arrangement shown in the illustrated embodiment. The system described is of a flexible nature and could be applied to plating machines having widely varying capacities, different numbers of treatment stations, and various plating times. The arrangement affords a continuous and uninterrupted delivery of plated articles even when the articles require a relatively long plating time, and this is done with a minimum of occupied space and using relatively inexpensive parts. As one example of the flexibility of the basic arrangement of parts, it may be mentioned that the advancement of the carriers into and from the sections of plating station 29 to rinse transfer station 31 may be accomplished by the use of a chain instead of employing the reciprocating slides 79, 81 of the hereinabove described type. In machines having a long plating station 29 accommodating a large number of work carriers which must be selected and moved to rinse transfer station 31, it is preferred to employ chain means for advancing the selected carriers because the transfer can be effected in a shorter period of time. A chain arrangement for this purpose which has been successfully employed consists of a pair of chains such as chain 120 (Fig. 23) carried by a suitable frame supported by stationary rails 52 and disposed immediately above the upper transfer track, each chain being disposed adjacent to a side of the machine. The chains are mounted on vertically disposed sprockets such as sprockets 122 and 124 positioned at the ends of the supporting frame, which frame has a length corresponding approximately to the length of plating station 29. Each chain carries a pair of pushers rigidly secured thereto and positioned one hundred and eighty degrees apart on the chain. The pushers may be of the type above disclosed or may consist of a forward pivoted portion such as portion 126 or 130 and a rearward stationary portion such as portion 128 or 132 which are spaced apart to receive a carrier 25 therebetween as the chain advances toward station 31. Such a two-piece pusher construction assures positive stopping of the carrier when the chain stops and avoids overrunning of the desired position.

The chains may be actuated intermittently by conventional driving means controlled electrically by suitably positioned limit switches as will be described. When using chains, the above described sequence of operations is basically unchanged except that the successive operation of pusher slides 79 and 81 is eliminated and the positioning of a new carrier 25 in the position vacated is accomplished by a limit switch which stops the forward motion of the chains when the vacated position is reached by the new carrier 25. The use of two pushers on each chain instead of one reduces the transfer time as will be apparent from the following general description of the transfer operation employing chain means in the plating station 29.

The chains are driven synchronously and hence reference will be made to only the shown chain 120. With frame 46 in the raised position and a new carrier in transfer station 28 ready to be moved into plating station 29, the chain 120 is forwardly actuated and pusher 126, preliminarily positioned slightly rearwardly of the carrier to be moved to rinse standby station 31, contacts the carrier and moves that carrier to station 31. The chain continues its forward motion and the other pusher 130 contacts the new carrier in station 28 and advances it to the vacated position in station 29, at which position the chain 120 is stopped by appropriate limit switch action. As the frame 46 lowers to position the new carrier in the plating tank, the chain 120 advances until pusher 130 is immediately behind the position which the next carrier to be removed will occupy when the frame 46 is again raised to its upper position. The positioning of pusher 130 during this portion of the cycle insures immediate contact between the pusher and the carrier to be removed to station 31 when the chain 120 is again forwardly actuated and avoids any possibility of pusher 126 contacting the new carrier 25 in station 28 prior to the transfer of the old carrier from plating station 29 to station 31 by pusher 130.

While the described apparatus may be operated in any appropriate manner, the ensuing detailed operational description is based upon the use of an electrical-hydraulic control system.

The tracks 35, 34 and 36 (Figs. 15 to 18) of stations 27, 29 and 32, respectively, are assumed to be hydraulically actuated, with each track (in the disclosed arrangement, a pair of opposed rails) being movable by hydraulic cylinder means individual thereto, and with each cylinder means being controlled by a solenoid-controlled, spring-return two-position hydraulic valve. Thus, with the assumed arrangement, when the appropriate solenoid is energized, the cylinder means will drive the associated track 35, 34 or 36 upwardly, the track will be stopped at its upper position by the cylinder means or by a mechanical abutment, the track will remain in the upper position as long as the solenoid remains energized, and upon de-energization of the solenoid, the track will descend under gravitational force, but at a controlled rate, to its appropriate lower position.

The following description is predicated upon the use of the chain-type horizontal transporting mechanism shown in Fig. 23 of the drawings. Upon that basis, it is further assumed that the chain sprockets, such as sprockets 122 and 124 (Fig. 23), are driven hydraulically, electrically or pneumatically at either of two selected speeds, the energization of a first of two solenoids (or contactors) alone producing forward (counterclockwise, Fig. 23) motion of the chains at a slow or creep speed, and the concurrent energization of both solenoids (or contactors) producing forward motion of the chains at a fast speed.

The controlling limit switches, mentioned hereinbefore, are represented in their physical relation to the moving parts in Fig. 24 of the drawings. A series of limit switches is positioned adjacent the chain 120 in a position to be actuated by the pushers, such as pushers 126 and 130. Limit switches LST1, LST2, LST3 and LST4 are so positioned above tank No. 1 to tank No. 4, respectively, that a carrier being moved along track 34 by pusher 126 or 130 will be stopped directly above the appropriate tank when the pusher is stopped, as will be seen, by actuation of the noted limit switches. Limit switches LSL1 to LSL4 are spaced a short distance, such as two or three inches, before the corresponding limit switches LST1 to LST4. Limit switch LSA is positioned beyond tank No. 4 and preliminary to sprocket 122 and limit switch LSB is positioned before tank No. 1 but after sprocket 124. The function of these several limit switches is to sense the position of the pushers 126 and 130 and to control the motion of the chain 120.

The down position of track section 35 of station 27 is sensed by limit switch LS10 and the up position of that track section is sensed by limit switch LS9; the down position of track section 36 of station 32 is sensed by limit switch LS14 and the up position of that track is sensed by limit switch LS13; and the down position of track section 34 of station 29 is sensed by limit switch

LS12 and the up position of that track section is sensed by limit switches LS11 and LS11A.

All of the described limit switches, except limit switch LS11A, are assumed to be spring-biased to their normal positions, and each is assumed to have a single, normally open contact. Limit switch LS11A is also spring biased to its normal position and is assumed to be provided with a single, normally closed contact.

In the following description of an exemplary arrangement, it is assumed that the tanks are sequentially and cyclically recharged with workpieces, under the partial control of limit switches LS15 and LC1 to LC4 (Fig. 25). For clarity, a normal sequence is assumed, with tanks Nos. 1 to 4 being recharged in order. Limit switch LS15 (Fig. 25) is actuated by a cam 136 mounted upon the cam shaft 63 (Fig. 2) and positioned upon that shaft in appropriate relationship to the cams 66. Limit switch LS15 is spring biased to its normal, open position and is tripped closed only when cam 136 is in its shown orientation or has been turned to a position an integral multiple of 90° from the shown position, with the exemplary four-tank arrangement. Limit switches LC1 to LC4 are sequentially tripped by cam 138 which is also mounted upon the cam shaft 63 and which is also coordinated with the position of the several cams 66. Switches LC1 to LC4 are also spring biased to their normal positions and are assumed to be provided with a single, normally open contact.

For convenience and clarity of presentation, in the following description, the apparatus will be assumed to be in an initial condition somewhat prior to the condition represented in Fig. 23 of the drawings. Thus, referring to Fig. 24, it is assumed that track section 34 of station 29 is up, that track section 35 of station 27 is down, and that track section 36 of station 32 is down, all as shown. As a result, limit switches LS10, LS11, LS11A and LS14 are tripped while limit switches LS9, LS12, and LS13 are normal. It is further assumed that pusher 126 is engaging limit switch LST3 and has positioned a carrier over tank No. 3 preparatory to the lowering of that carrier into the now empty tank No. 3. As a result, limit switch LST3 is tripped while the other chain limit switches are normal. It is further assumed that cam shaft 63 is not rotating so that limit switch LS15 is tripped, and that the cam 138 has tripped switch LC3.

Referring now to the circuit diagrams of Figs. 26 and 27, upon the closure of the start switch (Fig. 26), the alternating voltage from source 144 is applied through the normally closed stop switch and the now closed start switch to operate relay R. Relay R, in operating, closes its normally open contact R*a* to seal itself operated and closes its contacts R*b* and R*c* to apply the source voltage between the conductors 146 and 148.

Under the assumed initial conditions, limit switches LS10, LS11, LS14 and LS15, are tripped to their closed positions so that relays R10, R11, R14, and R15 are operated. Further, under the assumed initial conditions, mechanically latching relay LU1, having an energizing winding LU1E and a release winding LU1R, is released so that its contact LU1*b* is now closed and its contact LU1*c* is now open. Consequently, solenoids 27US and 32US are energized and solenoid 29US is released. Solenoid 27US controls the hydraulic means for elevating track section 35 (Fig. 24) in station 27 and hence track section 35 commences to move upwardly, lifting all carriers in station 27 to the upper position for transfer of the last of those carriers to station 28. Solenoid 32US similarly controls track section 36 in station 32 and that track section also commences to move upwardly, lifting carriers in station 32. Solenoid 29US controls the hydraulic means for elevating the track section 34 in station 29 so that upon its de-energization track section 34 commences to descend, lowering the carrier into tank No. 3.

In the chain control circuits of Fig. 27, under the assumed initial conditions, switch LC3 is closed, switch LST3 is closed, and all other limit switches represented in that figure are open. Control relay ST is operated and mechanically latching relays LU8 and LU9 are operated and mechanically locked. All other relays and solenoids represented in Fig. 27 are de-energized.

As track section 34 (Fig. 24) starts down, limit switch LS11 opens to release relay R11 (Fig. 26) to open contacts R11*b* (Fig. 27). As track section 34 moves slightly further downwardly, limit switch LS11A is released and hence closes, completing a circuit (Fig. 27) from conductor 146, now-closed contact LU1*d*, limit switch LS11A, contact LU8*b* and through relay SH to conductor 148, whereupon relay SH is operated. Upon the operation of relay SH its contact SH*f* is opened so that the previous energizing path for relay ST (through closed limit switch LST3) is now interrupted and relay ST releases.

The release of relay ST completes a circuit from conductor 146, contact SH*i*, conductor 150, now-closed contact SL*a*, and through contact ST*a* to energize solenoid CHS. Solenoid CHS is adapted to control the chain actuating mechanism and, when operated alone, causes the chain to move forward at a slow or creep speed.

A further circuit is completed at this time from conductor 150, contact SL*a*, and through contact SH*k* to energize solenoid CHF which, when energized concurrently with solenoid CHS, causes the chain to move at its fast speed. Time delay relay TR3 (which may be electromagnetic, electronic, or pneumatic) is energized concurrently with solenoid CHS but serves no function at this time, As will be seen, the function of relay TR3 is to delay, under certain circumstances, the energization of solenoid CHF so that the chain will start at a slow speed and then accelerate to a rapid pace. Since, however, the pusher is not now in engagement with a carrier, the chain may be started at high speed.

The chain 120 (Fig. 24) continues to advance until pusher 126 strikes and trips limit switch LSL4. When this occurs, a circuit is completed from conductor 150 (Fig. 27), through now-closed contact LU8*c*, conductor 154, closed switch LC3, contact SH*g*, and through the now-closed limit switch LSL4 to energize relay SL. Relay SL, in operating, opens its contact SL*a* to interrupt the previously traced energizing paths for both solenoids CHS and CHF. As a consequence, the chain immediately stops, with the pusher 126 (Fig. 24) now being positioned at a point spaced slightly in advance of the position which the carrier from tank No. 4 will assume when track section 34 is again moved to its shown upper position. This operation is known as the one-cell shift, and, as previously noted, its purpose is to position the pushers in a position where they can pick up the completed carrier with a minimum of waste motion and yet be adequately separated from the normal position of the carrier so that there is no danger of the ascending carrier striking the pusher.

The operation of relay SL also completes a circuit from conductor 150 through the now-closed contacts SH*n* and SL*c* to energize the restoring winding LU9R of mechanically latching relay LU9, whereupon that relay is restored to normal. When latching relay LU9 restores to normal to close its contact LU9*b*, the restoring winding LU8R of mechanically latching relay LU8 is also energized to release that relay. As a result, contact LU8*c* is opened to release relay SL and contact LU8*b* is opened to release relay SH. The chain control circuit remains in this condition until the carrier from tank No. 4 (Fig. 24) is raised.

As a result of the raising of track section 35 in station 27 and of track section 36 in station 32 and as a result of the lowering of track section 34 in station 29, limit switch LS10 (Fig. 26) is opened to release relay R10, limit switch LS9 is tripped to operate relay R9, limit switch LS14 is restored to normal to release relay R14, limit switch LS13 is tripped to operate relay R13, limit

switch LS12 is tripped to operate relay R12, and relay R11 is released as previously noted. As a result of these changed circuit conditions, a circuit is completed from conductor 146 (Fig. 26), through the now-closed contact LU8*c* of mechanically latching relay LU8, and through the now-closed contacts R9*a*, R12*a* and R13*a* to energize time delay relay TR1, and another circuit is completed through the aforesaid contacts and through the now-closed contact LU1*a* to operate relay R16.

Relay R16, in operating, completes a circuit from conductor 146, contact R16*a* and through now-closed contact LU2*b* to energize contactor CM15. The function of contactor CM15 is to apply voltage to motor 68 (Fig. 2) which drives, through the gear reduction unit 69, cam shaft 63. Hence, after track sections 35 and 36 (Fig. 24) are fully up and track section 34 is fully down, cam shaft 63 commences to rotate to perform the previously described mechanical shifting operation, as well as to rotate cams 136 and 138 (Fig. 25).

When cam 136 starts to rotate, limit switch LS15 is restored to its normal open position to release relay R15 (Fig. 26). As a result, contact R15*b* is closed to complete a circuit through contact R16*a* to energize the operating winding LU2E of mechanically held relay LU2. As a result of the operation of mechanically held unit LU2, its contact LU2*b* is opened and its contact LU2*c* is closed. As a result, contactor CM15 remains operated, but the continued operation of that contactor is placed under the control of contact R15*b*. Hence, when cam 136 (Fig. 25) has turned approximately 90° (under the assumed four-cell arrangement), limit switch LS15 is again tripped to re-operate relay R15, which opens contact R15*b* to release contactor CM15. This terminates the operation of motor 68 and consequently stops the rotation of cam shaft 63.

As a result of the 90° rotation of cam shaft 63, switch LC3 (Fig. 25) is restored to its normal open position and switch LC4 is closed for a purpose hereinafter to be noted.

These events are normally completed prior to the operation of time delay relay TR1, and hence, the equipment remains in this condition until the termination of the delay period established by that time delay relay. When relay TR1 operates to close its contact TR1*a* (or otherwise when cam shaft 63 completes its rotation, if that occurs later), operating circuits are completed for the operation of relay R18 and for the energizing winding LU1E of mechanically latching relay LU1, since contacts LU2*a* and R15*a* are now both closed. The closure of contact R18*a* establishes a sealing circuit for relay R18 in bypass of contacts LU2*a* and R15*a*. Relay R18, in operating, closes its contact R18*b* to apply current through the restoring winding LU2R of mechanically latching relay LU2 to restore that relay to normal in preparation for further operation.

The operation of relay LU1 causes contact LU1*a* to be opened to release relay R16. Further, the opening of contact LU1*b* de-energizes solenoids 27US and 32US and the closure of contact LU1*c* energizes solenoid 29US. Hence, track sections 35 and 36, in stations 27 and 32, respectively, are permitted to descend, while track section 34, at station 29, is driven to its upper position. It will be observed that this downward movement of track sections 35 and 36 results in carriers being placed in the tanks individual to station 27 and 32, respectively, and that by virtue of the 90° shift of the position of cam shaft 63 and cams 66 (Fig. 2) and the consequent change of the mechanical relationships, as hereinbefore described, the carrier previously immersed in tank No. 4 (Fig. 24) is carried upwardly as track section 34 is elevated.

As a result of these movements of the several track sections, limit switch LS9 is opened, limit switch LS10 is closed, limit switch LS11 is closed, limit switch LS11A is opened, limit switch LS12 is opened, limit switch LS13 is opened and limit switch LS14 is closed. Therefore, relay R9 (Fig. 26) is released, relay R10 is operated, relay R11 is operated, relay R12 is released, relay R13 is released and relay R14 is operated.

The first of the contacts R9*a*, R12*a* and R13*a* to open releases time delay relay TR1 which releases relay R18. The arrival of all of these track sections at their new positions will be signalled by contacts R10*a*, R11*a* and R14*a* being concurrently closed to produce the energization of time delay relay TR2 which will commence timing.

The closure of contact R11*b* (Fig. 27) results in the application of the voltage on conductor 146 to conductor 150. Since relays SH and ST are both released, this voltage on conductor 150 is applied through now-closed contacts SH*j* and ST*a* to energize solenoid CHS and time delay unit TR3. As a result, the chains start to move forwardly at creep speed. After a short delay, time delay unit TR3 closes its contact TR3*a* to complete a circuit through now-closed contact LU9*a* to energize solenoid CHF whereupon the chain commences to move at a rapid speed. During the creep interval, between the operation of solenoid CHS and the operation of solenoid CHF, pusher 126 (Fig. 24), which was situated but a short distance from the carrier just removed from tank No. 4, engages that carrier. The chain will then move rapidly to push the carrier to station 31. This motion is uninterrupted even though pusher 126 trips limit switch LST4 during the course of its motion and even though, under other than the assumed circumstances such as in the removal of finished carriers from other tanks, the pallet may strike a plurality of the limit switches LSL1 to LST4 during the course of its motion. No one of these limit switches is effective to terminate the motion of the chain at this time since relay LU8 is released and its contact LU8*c* (Fig. 27) is open so that there is no voltage on conductor 154 and neither relay SL nor relay ST can be operated.

When pusher 126 (Fig. 24) strikes limit switch LSA, a circuit is completed (Fig. 27) including conductor 150, now-closed contact SH*m* and limit switch LSA to energize winding LU9E of the mechanically latching relay LU9 to operate that relay. Upon the operation of relay LU9, contact LU9*a* is opened to de-energize solenoid CHF so that the chain reverts to its slow or creep speed while the pushers 126 and 130 (Fig. 24) are rounding the sprockets 122 and 124, respectively. As pusher 130 passes around sprocket 124 and over station 28, it engages a new carrier and advances it onto track section 34. As pusher 130 strikes limit switch LSB, a circuit is completed (Fig. 27) for the energization of the release winding LU9R of mechanically latching relay LU9 whereupon solenoid CHF is again energized to cause the chain to be moved at high speed. It will be noted that concurrently, the de-energization of relay LU9 is completed through the closure of limit switch LSB and mechanically latching relay LU8 is operated, over a circuit including limit switch LSB and contacts SH*m* and SL*d*. This enables the chain limit switches LSL1 to LST4 to exercise their selective control over the chain motion.

Pusher 130 will continue to move at its higher speed, carrying the new carrier therewith, and successively tripping the limit switches LSL1, LST1, LSL2, and so forth without controlling effect, until pusher 130 strikes limit switch LSL4. When limit switch LSL4 is closed, a circuit is completed from conductor 150 through now-closed contact LU8*c*, conductor 154, switch LC4 (the only one of the switches LC1 to LC4 which is now closed), now-closed contact SH*h*, limit switch LSL4, and the winding of relay SL to operate that relay. As a result of the operation of relay SL, voltage is applied from conductor 150 through now-closed contact SH*m*, and contact SL*b* to operate mechanically latching relay LU9 to open contact LU9*a* and hence to de-energize solenoid CHF. As a result, the chain slows to creep speed. The chain continues to advance, however, releasing limit switch LSL4, which releases relay SL to restore that relay to normal.

When pusher 130 (Fig. 24) moves an additional couple of inches to trip limit switch LST4, a circuit is completed (Fig. 27) through switch LC4, contact SH*h*, limit switch LST4, and the winding of relay ST to operate that relay. The resultant opening of contact ST*a* de-energizes solenoid CHS and releases time delay unit TR3 so that the chain is stopped with the new carrier centered over tank No. 4 (Fig. 24).

The apparatus remains in this condition until relay TR2 (Fig. 26) times out and closes its contact TR2*a* to complete a circuit through contact ST*a* to release mechanically latching relay LU1 and to operate relay R19, which seals. It will be observed that this will not occur upon the closure of contact TR2*a* if for any reason the chain motion is retarded or interrupted, but will await the tripping of limit switch LST4 and the operation of relay ST, as described.

The closure of contact R19*b* produces the de-energization of mechanically latching relay LU2. The apparatus is now in the condition originally described preparatory to repeating its cycle. It will be noted that while time delay relay TR2 and relay R19 remain operated, they will be released as soon as rail section 35 or 36 commences to rise or rail section 34 commences to lower.

The cycles then repeat, with, under the shown arrangement, carriers being successively removed and replaced in tanks No. 1 to No. 4 (Fig. 24). As tank No. 4 is being refilled, the one-cell shift will occur, the finished carrier in tank No. 1 will be carried upwardly by the rail section 34, transferred to station 31, and a new carrier will be placed in tank No. 1, this cyclic arrangement accruing from a mechanical standpoint by virtue of the 90°-spaced positions of the cams 66 (Fig. 2) upon the cam shaft 63, and being accomplished electrically by virtue of the arrangement of cam 138 and its switches and by virtue of the connection of switch LC4 (Fig. 27) through normally open contact SH*a* to limit switches LSL1 and LSLT1.

It will be noted that the one-cell shift occurs just as rail section 34 commences to lower and hence just as rail section 35 commences to raise. Therefore, when pusher 126, for example, has brought a carrier over tank No. 4 in position to be lowered into that tank at the beginning of the downward movement of the rail section 34, the one-cell shift occurs, but in this case, it is the other pusher, 130 for example, which trips limit switch LSL1 and stops short of the center line of tank No. 1 in preparation for the removal of a completed carrier from that tank. During the course of the motion of pusher 130 around sprocket 124 and into engagement with limit switch LSL1, it will not contact a new carrier in station 28 since there can be no carrier in that station at least until rail section 35 has reached its uppermost postion. In pragmatic arrangements it is easy to insure that the time required for pusher 130, for example, to move around sprocket 124 and into position above tank No. 1 is much less than the time required for rail section 35 to ascend. However, means may be provided if desired to insure that this sequence will properly occur. It will be apparent to those skilled in the art that if it is not desired to employ the one-cell shift, and if two pushers are employed, as shown, means should be provided to insure that the transfer mechanism at station 27 will feed a new carrier to station 28 in appropriate timed relation to the movement of the chain pushers.

A number of modifications and improvements may well occur to those skilled in the art, and various pragmatic forms of the invention have incorporated a number of such modifications and embellishments. As one example, it will be apparent that a single limit switch for each tank will suffice, even without dispensing with the one-cell shift, if the circuits be arranged so that the tripping of the limit switch is the electrical equivalent of tripping the corresponding LSL– limit switch and the release of the limit switch is the electrical counterpart of tripping the corresponding limit switch LST–.

The shown and described circuitry for controlling the operation of a system embodying the chain-type horizontal transfer mechanism will enable those skilled in the art to construct a control system for causing the apparatus embodying the transfer-bar-type horizontal transfer mechanism to operate in the manner set forth hereinbefore.

In the plural-cell and/or plural-tank machines of the size customarily employed in industry, it is desirable that the machine be capable of operating continuously for extended periods. In the present state of development of the art, it is feasible to so design and construct the mechanical, electrical and hydraulic elements described herein so that they will properly perform their functions over extended periods even though the machine is not regularly shut down to permit inspection and maintenance of those elements.

However, the plating tanks normally require periodic inspection, draining, cleaning, and anode replacement, and means are desirably provided for permitting the performance of these functions upon one or more of the individual cells or tanks while the remainder of the cells or tanks continue to operate. By the provision of means for selectively bypassing any one or more of the plurality of cells or tanks, the inspection and repair of the entire complement of cells and tanks can be accomplished in a sequential fashion over a period of time without interrupting the continuous operation of the machine as an entity.

It will be recalled that regardless of which type of horizontal carrier-transporting mechanism is employed, the selection of which one of the cells is next to be emptied of its carrier is determined by means including the cam shaft 63 shown in Fig. 2 of the drawings. Whatever sequence of cell emptying is selected, this sequencing is accomplished, in the disclosed arrangement, by rotating cam shaft 63, during each cycle, a fraction of a complete revolution equal to the reciprocal of the number of cells provided. Thus, with four cells exemplarily being provided, cam shaft 63 is rotated one quarter of a revolution, or 90°, each cycle of operation. As a result, the four carriers supported in the four cells or tanks are individually replaced with new carriers in a predetermined sequence, with the sequence 1, 2, 3, 4, and cyclic repeat, being described as a representative example.

Hence, any one of the cells or tanks may be selectively bypassed by arranging the control mechanism so that the cam shaft 63 will not stop at the position at which that cell is normally selected, but will continue to rotate another appropriate fraction of a revolution to select the next cell or tank, and a plurality of cells may be bypassed by an expansion of this process.

In the previously described arrangement, the rotation of the cam shaft 63 in 90° increments is accomplished by circuit means including limit switch LS15 (Fig. 25) actuated by cam 136. As one means for permitting the selective bypassing of a cell or cells, the cam and switch arrangement represented in Fig. 28 may be substituted for cam 136 and limit switch LS15 of Fig. 25. Thus, cylindrical member 136*a* shown in Fig. 28 is mounted upon the cam shaft 63*a* and is provided with four longitudinally offset and quadrantly spaced pins 160 insertable in and removable from individual sockets formed in the surface of the cylindrical member 136*a*. Four switches LS15*a*1 to LS15*a*4 are disposed in a position to be individually engaged by the four pins 160. Obviously, if any one of the pins 160 is removed, the limit switch individual thereto will not be actuated.

It will be recalled from the previously described operation of the circuitry of Fig. 26 that at an appropriate time the cam motor 68 is energized by contactor CM15, and continues to be energized until limit switch LS15 is closed, whereby cam shaft 63 (Fig. 2) is regularly stepped in 90° increments. To employ the modified

cam and switch arrangement of Fig. 28 in lieu of cam 136 and limit switch LS15 of Fig. 25, the circuit shown in Fig. 29 should be substituted for limit switch LS15 and relay R15 of Fig. 26, with no other change being made in Fig. 26 of the drawings. The four normally open limit switches LS15*a*1 to LS15*a*4 are connected in parallel with one another, with each switch being in an individual energizing circuit for relay R15'. Relay R15' is the counterpart of relay R15 in Fig. 26, and operates the same contacts in Fig. 26 as does relay R15. Therefore, upon the closure of any one of the limit switches LS15*a*1 to LS15*a*4, assuming the switches B1 to B4 all to be closed, relay R15' is operated. Consequently, if all of the pins 160 in Fig. 28 are in place, the system will operate exactly as previously described. If, however, any one of the pins 160 is removed, such as, for example, the pin individual to limit switch LS15*a*3, when the cam is energized as a result of the operation of contactor CM15 in Fig. 26, limit switch LS15*a*3 will not be operated to terminate the energization of that motor and the cam shaft 63 will be rotated 180°, not stopping until limit switch LS15*a*4 is tripped.

As a result, the movable track sections individual to tank No. 3 will not be pivoted inwardly while the frame is raised, and cell No. 3 will therefore be omitted from the sequence, with the carrier in cell No. 4 being raised on the next cycle of operation following the raising of the carrier from cell No. 2. In a similar fashion any other one of the cells may be bypassed by removing the appropriate one of the pins 160 (Fig. 28).

Switches B1 to B4 (Fig. 29) are included to show an alternative method of controlling the bypassing of any one of the cells. Even if the pins 160 (Fig. 28) are not removed or are not removable, any one of the cells may be selectively bypassed by opening the corresponding one of the switches B1 to B4 to interrupt any energizing circuit for relay R15' therethrough.

It will be recalled that when the chain-type horizontal transporting mechanism is employed, a one-cell shift occurs as track 34 (Fig. 24) starts downwardly and releases limit switch LS11A. If any one of the cells is selectively disabled or bypassed as just described with reference to Figs. 28 and 29 of the drawings, the circuitry for controlling the one-cell shift operation should preferably be suitably modified so that the shifting operation will occur in a manner appropriate to the changed conditions. This may be accomplished by modifying a portion of the circuits of Fig. 27 in the manner represented in Fig. 30.

In the modified arrangement, a group of single-pole, double-throw switches SB1 to SB4 are interposed the contacts SH*a*' to SH*h*' of relay SH and the several limit switches LSL1' to LST4'. When switches SB1 to SB4 are in their upper, No. 1, positions, the circuit of Fig. 30 is electrically identical to the corresponding portion of the circuit of Fig. 27. When one of the cells is selected to be bypassed by pulling one of the pins 160 of Fig. 28 or by opening one of the switches B1 to B4 of Fig. 29, then proper one-cell shift operation may be obtained by moving the corresponding one of the switches SB1 to SB4 to its No. 2 position.

As an example, let it be assumed that cell No. 4 has been selected to be bypassed, to facilitate inspection or repair, by pulling the one of the pins 160 (Fig. 28) individual to limit switch LS15*a*4 or by opening switch B4 (Fig. 29), and by moving switch SB4 (Fig. 30) into engagement with its No. 2 contact. In accordance with the initial operational assumptions in the description of the control circuitry, let it further be assumed that pusher 126 (Fig. 24) is positioned as shown over tank No. 3 and that track 34 is about to be lowered to carry a new carrier into now empty tank No. 3.

As track section 34 starts to move downwardly and releases limit switch LS11A, the circuits previously described with reference to Fig. 27 are energized to operate relay SH (Fig. 27) and to initiate forward motion of the chain 120. Under normal circumstances, when relay SH (Fig. 27) operates to open its contact SH*f* and to close its contact SH*g*, the appropriate preliminary conditions are established for relay SL to be operated when pusher 126 (Fig. 24) contacts limit switch LSL4 (Fig. 27), and relay SL, in operating, terminates the forward motion of the chain, completing the one-cell shift.

However, with the shift bypass switch SB4 (Fig. 30) moved into engagement with its No. 2 contact, the operation of relay SH and the closure of contact SH*g*' will not place relay SL' under control of limit switch LSL4', but rather will place that relay under control of limit switch LSL1'. Hence, the chain will not be stopped when pusher 126 (Fig. 24) strikes limit switch LSL4' (Fig. 30) nor when it strikes limit switch LST4', but will continue to move, advancing at creep speed after pusher 126 (Fig. 24) strike limit switch LSA, returning to rapid speed when pusher 130 strikes limit switch LSB and continuing until pusher 130 strikes limit switch LSL1' (Fig. 30). When this occurs, a circuit is completed for the operation of relay SL' which terminates the forward motion of the chain. As a result, the one-cell shift has occurred between operative cells.

It will be noted that this one-cell shift operation still occurs prior to the time that track section 35 (Fig. 24) has been fully raised to its upper position so that there is no new carrier in station 28 prior to the time that the one-cell shift operation has been completed.

When track section 34 (Fig. 24) reaches its lower position, the cam motor 68 (Fig. 2) is energized in the fashion previously described, but will continue to rotate for 180°, as previously discussed with reference to Fig. 29 of the drawings. As a result, it is the carrier in tank No. 1 which will be next selected for removal and a pusher has been appropriately positioned just short of the center line of that tank to move that carrier to station 31 (Fig. 24).

As noted, the representation of but four cells or tanks in the skip-transfer section is but exemplary. It is contemplated that in practice a greater number of cells may well be employed, with a proportionate increase in the mechanical and electrical selective means, including a proportionate decrease in the incremental stepping of the cam shaft, or the provision of additional cam shafts arranged to be sequentially and cyclically, individually operative.

While it will be apparent that the embodiments of the invention herein disclosed are well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation, and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. In combination, a liquid treating station adapted to receive work carried on a plurality of work carriers, stationary means for supporting the work carriers at said station in lower, horizontally fixed positions, a frame forming a part of said station, a plurality of pairs of opposed movable track sections carried by said frame, driving means for repetitively moving said frame and the pairs of movable track sections carried thereby between an upper position and a level proximate work carriers supported at said lower positions by said stationary means, means for selectively moving each pair of said movable track sections when said frame is proximate work carriers supported at said lower position between a retracted position and a position in which it will engage a work carrier supported at said lower position by said stationary means whereby a selected carrier may be lifted upon movement of the frame to its upper position, and means including said selected pair of track sections forming when the frame is in its upper position a continuous track on which carriers may be conveyed over others of

the work carriers that are then supported on said stationary means.

2. In a plating machine of the type having carriers and a track comprising a plurality of pairs of opposed displaceable carrier transfer track sections, a plating station including a frame vertically movable between a lower position and an upper position, a plurality of pairs of opposed movable track sections carried by said frame, stationary means for supporting said carriers in a position proximate said movable track sections when said frame is in said lower position, means for selectively moving each pair of said movable track sections when said frame is in its lower position between a retracted position and a carrier-engaging position, said carrier-engaging position being in vertical alignment with one of said displaceable track sections, and means for holding the selected track sections in their carrier-engaging position as said frame is being lifted into its upper position whereby the selected movable track sections will displace the displaceable carrier transfer track sections directly thereabove thereby allowing the selected carrier to be lifted to the level of others of said displaceable transfer track sections.

3. The combination according to claim 1, further provided with means for transferring a selected carrier which has been lifted by said frame along said track to another portion of said machine, and means for transferring another carrier to the position vacated by said first carrier.

4. The combination according to claim 1, further provided with means for pivotally supporting said movable track sections upon said frame, and cams movably supported at said station and engageable with said sections to swing said sections between said disengaged and said engaged positions.

5. The combination according to claim 4, said movable track sections being further provided with means constantly urging the movable track sections into their disengaged positions, said cams acting in opposition to said last-mentioned means.

6. The combination according to claim 1, further provided with pusher means adapted to engage a carrier held by said movable track sections when said frame is in its upper position, and means for actuating said pusher means to convey a carrier lifted by said movable track sections along said continuous track and away from said station.

7. The combination according to claim 6, said pusher means further including means for transferring a carrier along said continuous track to a selected position on one of the track sections carried by said frame, and means for disabling a portion of said pusher means when said carrier arrives at such position, whereby said carrier is retained in such position.

8. In a plating machine, a first station, a second station, a plating station between said first and second stations and having a plating tank, a pair of opposed tracks at said first and second stations, a plurality of pairs of opposed displaceable track sections intermediate the tracks of said first and second stations, a frame at said plating stations, means for vertically moving said frame between an upper and a lower position, a plurality of pairs of opposed movable track sections carried by said frame, means for selectively moving a pair of said movable track sections inwardly when said frame is in its lower position, said movable track sections when moved inwardly being adapted to engage opposite ends of a workpiece carrier and being in vertical alignment with said displaceable track sections, mounting means for said displaceable track sections operative to cause said inwardly moved track sections on said frame to displace an equal number of said displaceable track sections when said frame is moved to its upper position, transfer means extending along said first and second stations and said plating station adjacent said tracks and track sections, pusher means carried by said transfer means and adapted to engage a carrier held by said inwardly moved track sections when said frame is in its upper position, additional pusher means carried by said transfer means and adapted to engage a carrier held by the tracks of said first station, and means for actuating said transfer means to transfer the carrier held by said inwardly moved track sections to said second station, and to transfer the carrier at said first station to one of said pairs of movable track sections.

9. The combination according to claim 6 wherein said pusher means includes a chain.

10. The combination according to claim 9 wherein said chain is continuous and carries a pair of pushers, which pushers are positioned 180° apart on said chain.

11. The combination according to claim 10 wherein said pushers consist of a forward pivotally mounted portion and a rearward stationary portion spaced from said forward portion.

12. In a machine having a liquid treating station, a plurality of aligned treating cells at said station adapted to receive work carried on work carriers each of which is equipped with a set of rollers, means for supporting a work carrier at each of said cells with the work carried thereby in such cell, elevating means including a horizontally disposed track repetitively movable between a level at which said track is below the level of the sets of rollers on carriers supported at said cells and an upper position, means effective each of the successive times when said track is below the level of the sets of rollers on carriers supported at said cells for selectively establishing a mechanical engagement between said track and the rollers on at least one of said carriers, control means for establishing the sequence in which said sets of rollers are mechanically engaged by said track during the successive times said elevating means is at said level, and horizontal transporting means effective each of the successive times when said elevating means is in said upper position for moving a carrier along said track.

13. In a machine having a liquid treating station and a station preceding said liquid treating station both adapted to receive work carried on work carriers, means moving work carriers in sequence to said preceding station, a plurality of treating cells at said treating station, means supporting work carriers in a lower position with the work carried thereby in said cells, repetitively movable elevating means for raising work carriers from said cells to an upper position in a predetermined time sequence, control means for establishing the sequence in which said work carriers are raised during plural upward movements of said elevating means, and intermittently operated horizontal transporting means effective at each operation to move a raised work carrier away from vertical alignment with the cell from which it was removed and for moving a work carrier from said input station to a position over the then empty cell.

14. In combination, a liquid treating station, a plurality of aligned treating cells at said station adapted to receive work carried on work carriers, means for supporting a plurality of work carriers in a lower position proximate said cells so that work carried by said carriers is disposed within said cells for treatment, horizontally disposed track means extending parallel with the line of cells and engageable by support means fixed to said work carriers, repetitively operable elevating means for raising said plurality of work carriers and the support means fixed thereto in a predetermined sequence from said lower position to an upper position, control means for establishing the sequence in which said plurality of work carriers are raised during plural upward movements of said elevating means, all of said plurality of work carriers being raised to the upper position in but only in the course of plural operations of said elevating means, and horizontal transporting means effective after any one of said work carriers is raised to its upper position for moving the raised work carrier horizontally along said track means with the support means individual thereto engaging said track means.

15. In a machine having a liquid treating station and

an output station, a plurality of treating cells at said treating station adapted to receive work carried on work carriers, means for concurrently supporting a plurality of the work carriers in a lower position and at said cells, elevating means at said treating station common to all of said cells and movable between upper and lower positions, means for automatically and cyclically moving said elevating means as a unit, said elevating means being moved in each cycle of its movement from the lower position to the upper position and back to the lower position, means including said elevating means for moving any selected one of the plurality of work carriers from the cell in which it is supported to an upper position during a portion of one cycle of movement of said elevating means, means effective after said one of said first plurality of work carriers is raised to its upper position for moving said one work carrier to said output station, means including said elevating means for moving another work carrier from the upper position into the one of said cells vacated by said one work carrier during a portion of said one cycle of movement of said elevating means, and means including said elevating means effective after said other work carrier has been moved into said one of said cells and during the next succeeding cycle of movement of said elevating means for raising a different one of said plurality of work carriers from the cell in which it is supported to an upper position, said different one of said first plurality of work carriers being selected in accordance with a predetermined sequence.

16. In a machine having a liquid treating station, a plurality of treating cells at said treating station adapted to receive work carried on work carriers, means for supporting a plurality of the work carriers in a lower position at said treating cells, elevating means at said treating station having an uppermost and a lowermost position, means for repetitively moving said elevating means between said positions, means including said elevating means effective over the course of plural operations of said elevating means for moving all of said plurality of work carriers from said lower position to an upper position in a predetermined sequence, control means for establishing the sequence in which said plurality of work carriers are raised during the plural operation of said elevating means, horizontal transporting means, means including said horizontal transporting means effective when any one of said plurality of work carriers is raised to its upper position and while said elevating means is in its uppermost position for moving said any one of said plurality of work carriers horizontally, means including said horizontal transporting means effective after any one of said cells is vacated and while said elevating means is in said uppermost position for moving one of another plurality of work carriers into position over said vacated cell, means including said elevating means for moving said one of said other plurality of work carriers into said vacated cell, control means for establishing said predetermined sequence in which work carriers are moved from and to said cells, and selectively operable means for causing said control means to omit from said sequence any one of said cells so that said any one of said cells can be serviced without interrupting operation of the machine.

17. In a machine having a liquid treating station, a plurality of treating cells at said station each adapted to accept work carried on a work carrier, means supporting work carriers at said cells, transporting means for repetitively removing work carriers from said cells in a predetermined sequence, means including said transporting means for loading work carriers into the cells as said cells are emptied and prior to the unloading of others of said cells, electrical control means controlling said transporting means and presettable to establish the sequence in which said cells are loaded and unloaded, manually actuatable switch means individual to each of said cells, and means including said control means responsive to the actuation of any one of said switch means for automatically adjusting the operation of said transporting means to omit from said sequence the one of said cells to which said switch means is individual.

18. In combination, a pretreating station, a plating station, first elevating means for moving work carriers between a lower and an upper level in said pretreating station, driving means for repetitively moving said first elevating means between lower and upper positions, a transfer station intermediate said pretreating and plating stations, horizontal transporting means effective when said first elevating means has raised a work carrier to said upper level for moving the work carrier horizontally to said transfer station, means for maintaining said work carrier at said upper level in said transfer station, second elevating means for moving work carriers between a lower and an upper level in said plating station, driving means for repetitively moving said second elevating means upwardly and downwardly, means supporting a group of said work carriers at said lower level in said plating station, means effective when said second elevating means is proximate work carriers supported at said lower level in said plating station for interconnecting said second elevating means and said group of said work carriers in a preselected sequence, control means for establishing the sequence in which said work carriers are raised in but only in the course of plural operations of said elevating means, and horizontal transporting means effective after any work carrier has been raised by said second elevating means for moving the raised work carrier in a direction away from said transfer station and for moving a work carrier from said transfer station to said second elevating means.

19. In combination, a pretreating station, a plating station, first elevating means for moving work carriers between a lower and an upper level in said pretreating station, driving means for repetitively moving said first elevating means between lower and upper positions, a transfer station intermediate said pretreating and plating stations, horizontal transporting means effective when said first elevating means has raised a work carrier to said upper level for moving the work carrier horizontally to said transfer station, means for maintaining said work carrier at said upper level in said transfer station, second elevating means for moving work carriers between a lower and an upper level in said plating station, driving means for repetitively moving said second elevating means upwardly and downwardly, means supporting a group of said work carriers at said lower level in said plating station, means effective when said second elevating means is proximate work carriers supported at said lower level in said plating station for interconnecting said second elevating means and said group of said work carriers in a preselected sequence, control means for establishing the sequence in which said work carriers are raised in but only in the course of plural operations of said elevating means, and horizontal transporting means effective when said second elevating means is in said upper position for moving any work carrier raised thereby in a direction away from said transfer station and effective while said second elevating means is still in said upper position for moving a work carrier from said transfer station to said second elevating means.

20. In combination, a pretreating station, a plating station, first elevating means for moving work carriers between a lower and an upper level in said pretreating station, driving means for repetitively moving said first elevating means between lower and upper positions, a transfer station intermediate said pretreating and plating stations, track means at said transfer station, horizontal transporting means effective when said first elevating means has raised a work carrier to said upper level for moving the work carrier horizontally onto said track means at said transfer station, means including said track means for maintaining said work carrier at said upper level in said transfer station, horizontally disposed track

means at said plating station for supporting work carriers for horizontal movement at said plating station, second elevating means including a portion of said horizontally disposed track means for moving work carriers between a lower and an upper level in said plating station, driving means for repetitively moving said second elevating means upwardly and downwardly, means supporting a group of said work carriers at said lower level in said plating station, means effective when said second elevating means is proximate work carriers supported at said lower level in said plating station for interconnecting said second elevating means and said group of work carriers in a preselected sequence, control means for establishing the sequence in which said work carriers are raised in but only in the course of plural operations of said elevating means, and horizontal transporting means effective when said second elevating means is in said upper position for moving any work carrier raised thereby along said horizontally disposed track means in a direction away from said transfer station and effective when said second elevating means is in said upper position for moving a work carrier from said track means at said transfer station to said horizontally disposed track means at said plating station.

21. In a machine having a liquid treating station, a plurality of aligned treating cells at said station adapted to accept work carried on work carriers, means for concurrently supporting a plurality of the work carriers in a lower position at said cells so that the work carried thereby is disposed in the cells, horizontally disposed track means extending the length of said cells for supporting work carriers during the horizontal motion thereof over said cells, elevating means including portions of said track means, driving means for repetitively moving said elevating means including said portions of said track means between a level proximate said plurality of work carriers and an upper position, selectively actuatable means effective of the times when said elevating means is proximate work carriers supported at said lower position for establishing a mechanical connection between said portions of said track means and at least one but less than all of said plurality of work carriers, control means controlling said selectively actuatable means for causing said mechanical connection to be established between said portions of said track means and different ones of said work carriers at different times that said elevating means is at said lever proximate work carriers supported at said lower position and for causing all of said plurality of work carriers to be connected to said portions of said track means in the course of plural times that said elevating means is at said level proximate work carriers supported at said lower position, and horizontal transporting means effective when said elevating means is in said upper position for moving a work carrier along said horizontally disposed track means.

22. In a machine having a liquid treating station, a plurality of aligned treating cells at said station adapted to accept work carried on work carriers each of which is equipped with a set of rollers, means for concurrently supporting a plurality of work carriers in a lower position at said cells so that work carried thereby is disposed in the cells, horizontally disposed track means extending the length of said cells for supporting work carriers during horizontal motion thereof on said rollers over said cells, elevating means including portions of said track means, driving means for repetitively moving said elevating means including said portions of said track means between a level in which said portions of said track means are below the level of the sets of rollers on carriers supported at said cells and an upper position, selectively actuatable means effective when said elevating means is at said level in which said portions of said track means are below the level of the sets of rollers on carriers supported at said lower position for establishing a mechanical connection between said portions of said track means and the rollers on at least one but less than all of said carriers, control means controlling said selectively actuatable means for causing said mechanical connection to be established between said portions of said track means and different ones of said sets of rollers at different times that said elevating means is at said level in which said portions of said track means are below the level of the sets of rollers on carriers supported at said lower position and for causing all of said plurality of sets of rollers to be connected to said portions of said track means in the course of plural times that said elevating means is at said level in which said portions of said track means are below the level of the sets of rollers on carriers supported at said level, and horizontal transporting means effective when said elevating means is in said upper position for moving a work carrier along said horizontally disposed track means with the set of rollers individual thereto engaging said track means.

23. In a machine having a liquid treating station, an input station and an output station, means concurrently supporting a plurality of work carriers in a lower position at said treating station, means for sequentially moving other work carriers to said input station, elevating means at said treating station having an uppermost and a lowermost position, driving means for repetitively moving said elevating means between said positions, means including said elevating means for raising said plurality of work carriers to an upper position in a predetermined sequence, different work carriers being raised by said elevating means at different times said elevating means moves from said lowermost position to said uppermost position, control means for establishing the sequence in which the work carriers are raised during the plural operations of said elevating means, horizontal transporting means, means including said horizontal transporting means effective when any one of said plurality of work carriers is raised to its upper position and while said elevating means is in said uppermost position for advancing said any one of said plurality of work carriers forwardly towards said output station, and means including said horizontal transporting means and said elevating means for individually substituting one of said other work carriers at said input station for said any of said plurality of work carriers.

24. In a machine having a liquid treating station, a plurality of treating cells at said treating station, means for concurrently supporting a plurality of work carriers in a lower position at said treating cells, elevating means at said treating station having an uppermost and a lowermost position, means for repetitively moving said elevating means between said positions, means including said elevating means for raising said plurality of work carriers from said lower position to an upper position in a predetermined sequence, control means for establishing the sequence in which said work carriers are raised during the plural operations of said elevating means, horizontal transporting means, means including said horizontal transporting means effective when any one of said plurality of work carriers is raised to its upper position and while said elevating means is in said uppermost position for moving said any of said plurality of work carriers horizontally, means including said horizontal transporting means effective after any one of said cells is vacated and while said elevating means is in said uppermost position for moving one of another plurality of work carriers into position over said vacated cell, and means including said elevating means for moving said one of said other plurality of work carriers into said vacated cell.

25. In a machine having a liquid treating station and an output station, a plurality of treating cells at said treating station, means for concurrently supporting a plurality of work carriers in a lower position at said treating cells, track means at said treating station sup-

porting said work carriers during horizontal motion thereof over said cells, elevating means at said treating station including a portion of said track means, driving means for repetitively moving said elevating means including said portion of said track means upwardly and downwardly, means including said elevating means for moving said plurality of work carriers from said lower position to an upper position in a predetermined sequence, control means for establishing the sequence in which said work carriers are raised during the plural operations of said elevating means, horizontal transporting means effective after any one of said plurality of work carriers is raised to its upper position for moving said any one of said plurality of work carriers horizontally and relative to said track means to said output station, and means including said elevating means effective after any one of said cells is vacated for moving one of another plurality of work carriers into said vacated cell.

26. In a machine having a liquid treating station, an input station and an output station, a plurality of treating cells at said treating station, means for concurrently supporting a first plurality of work carriers in a lower position proximate said cells, means for sequentially moving a second plurality of carriers to said input station, track means at said treating station supporting said work carriers during horizontal motion thereof over said cells, elevating means at said treating station including a portion of said track means, driving means for repetitively moving said elevating means including said portion of said track means upwardly and downwardly, means including said elevating means for raising said first plurality of work carriers from said lower position to an upper position in a predetermined sequence, control means for establishing the sequence in which said work carriers are raised during the plural operations of said elevating means, horizontal transporting means, means including said horizontal transporting means effective when any one of said first plurality of work carriers is raised to its upper position for moving said any one of said first plurality of work carriers horizontally and relative to said track means to said output station, means including said horizontal transporting means for moving one of said second plurality of work carriers horizontally and relative to said track means to a position above the vacated cell, means including said elevating means effective after said one of said second plurality of work carriers is in position above the vacated cell for moving said one of said second plurality of work carriers into the vacated cell, and means effective after said vacated cell has been filled for causing said elevating means to move the next in said sequence of said first plurality of work carriers from its cell to an upper position.

27. In a machine having a liquid treating station and an output station, a plurality of treating cells at said treating station, means for concurrently supporting a plurality of work carriers in a lower position with the work carried thereby in said cells, elevating means at said treating station common to all of said cells and movable between upper and lower positions, means for automatically and cyclically moving said elevating means as a unit, said elevating means being moved in each cycle of its movement from the lower position to the upper position and back to the lower position, means including said elevating means for moving one of said plurality of work carriers from the cell in which it is supported to an upper position during a portion of one cycle of movement of said elevating means, means effective after said one work carrier is raised to its upper position for moving said one work carrier to said output station, means including said elevating means for moving another work carrier from the upper position into the one of said cells vacated by said one work carrier during a portion of said one cycle of movement of said elevating means, and means including said elevating means effective after said other work carrier has been moved into said one of said cells and during another cycle of movement of said elevating means for raising a different one of said plurality of work carriers from the cell in which it is supported to an upper position, said different one of said plurality of work carriers being selected in accordance with a predetermined sequence.

28. In a machine having a liquid treating station, a plurality of aligned treating cells each adapted to receive a work carrier, means for supporting a separate work carrier in each cell, reciprocating raising and lowering means extending the length of said cells, driving means for reciprocating said raising and lowering means as a unit, means for causing said raising and lowering means to selectively engage said work carriers in predetermined sequence to effect raising of said work carriers in said predetermined sequence, means operable after a work carrier is raised to move the same horizontally away from the cell thus vacated, means operable to move another work carrier horizontally into position on the elevated raising and lowering means above said vacated cell, means operable after said other work carrier is in said position above said vacated cell for causing said raising and lowering means to lower said other work carrier into the vacated cell, and means operable after said other work carrier is lowered and after the next one of said work carriers in said sequence has been engaged by said raising and lowering means for causing the next raising movement of said raising and lowering means.

29. In a machine having a liquid treating station and an output station, a plurality of aligned treating cells at said treating station, means for supporting a plurality of work carriers at a lower position proximate said cells, elevating means at said treating station, driving means for repetitively moving said elevating means upwardly and downwardly, means including said elevating means for moving any selected one of said plurality of work carriers upwardly from said lower position, control means for selecting the one of said first plurality of work carriers which is moved at any given operation of said elevating means in accordance with a predetermined sequence, a driven actuator element for moving another work carrier along a horizontal line over said aligned cells, means for stopping said actuator element when it is positioned over the then vacated one of said cells, means including said elevating means for lowering said other work carrier out of engagement with said actuator element and into said vacated cell, and means effective after said other carrier has become disengaged from said actuator element for moving said actuator element to a position over the next one of said plurality of work carriers which is to be moved upwardly from said lower position.

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