

Nov. 24, 1964

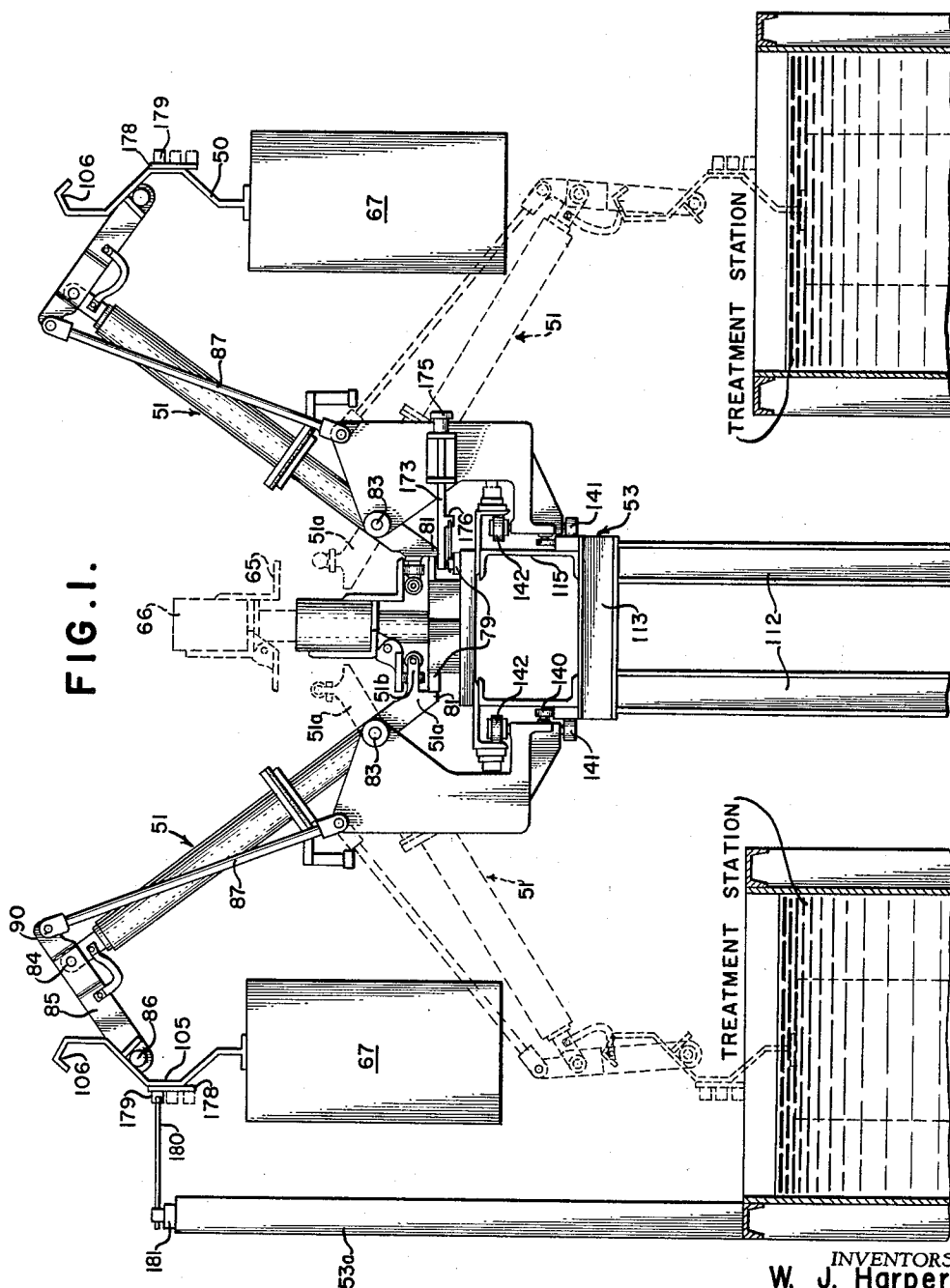
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3,158,249

APPARATUS FOR ELECTROPLATING

Original Filed June 15, 1959

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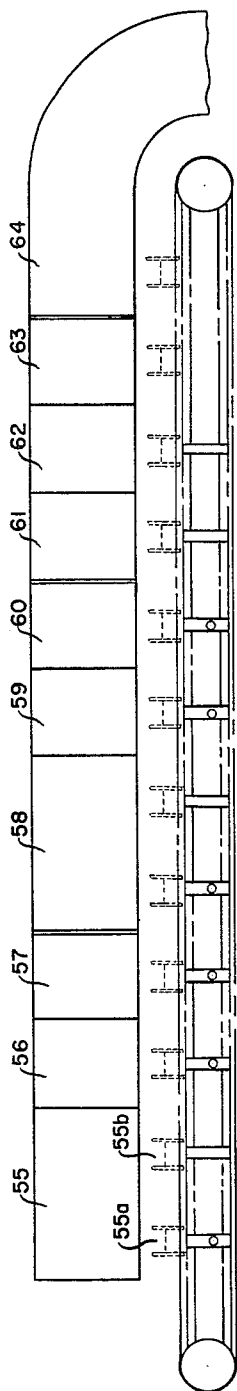


FIG. 2.

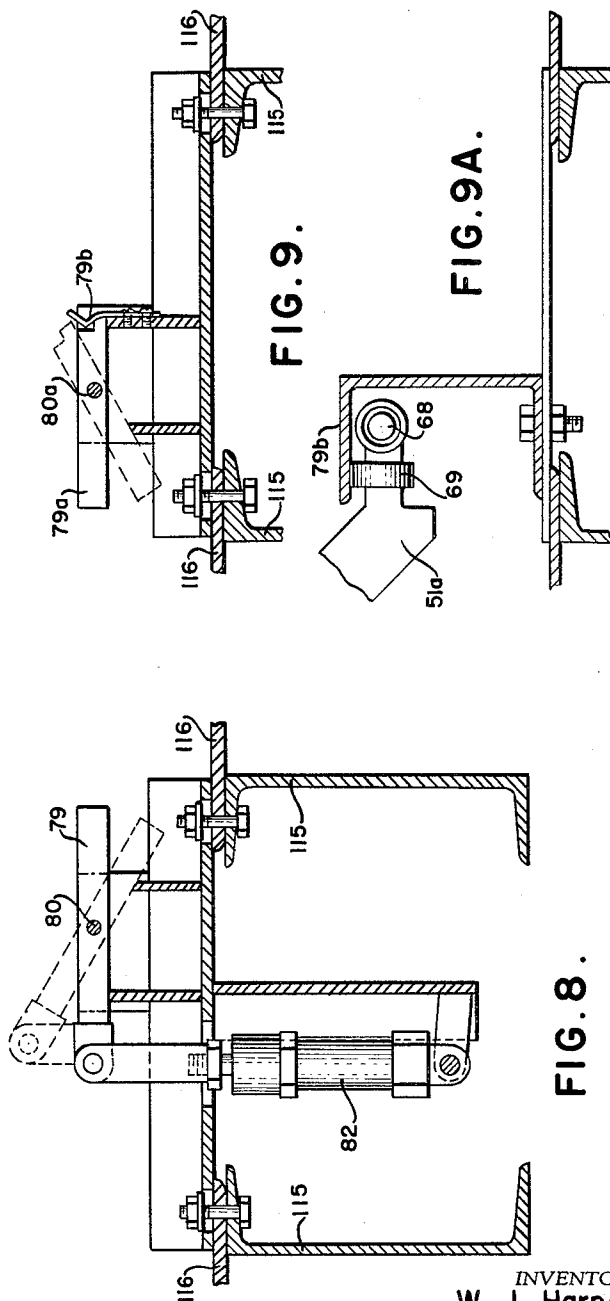


FIG. 9.

FIG. 9A.

FIG. 8.

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# APPARATUS FOR ELECTROPLATING

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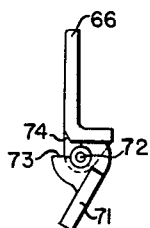
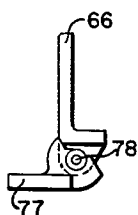


**FIG.4. FIG.5.**

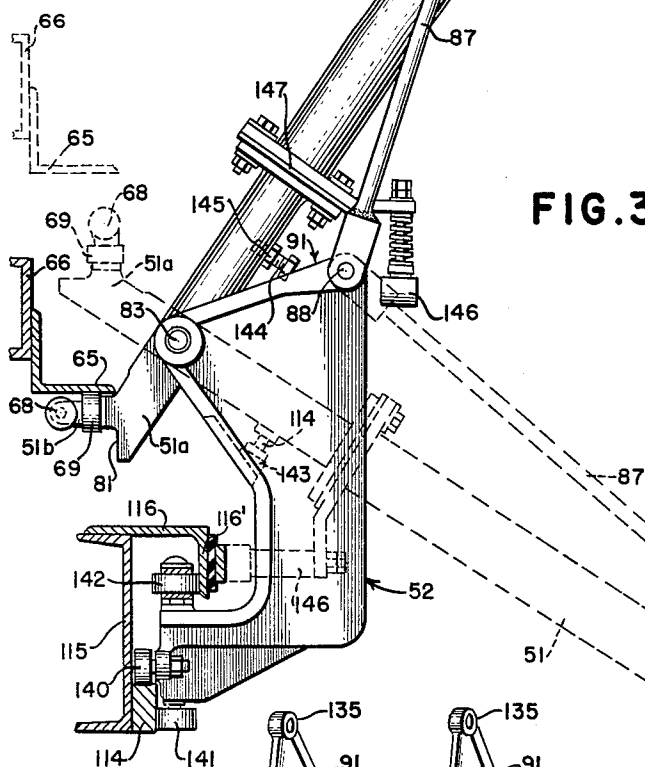


**FIG. 3.**

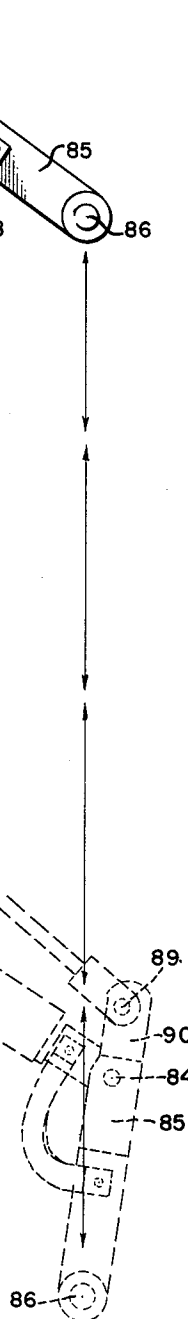
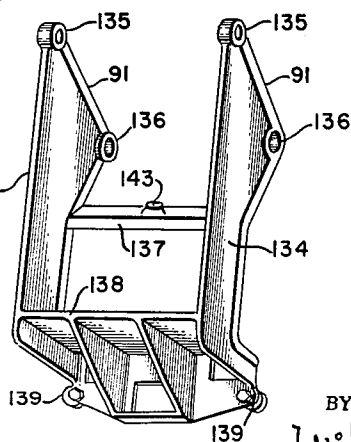


FIG.17.



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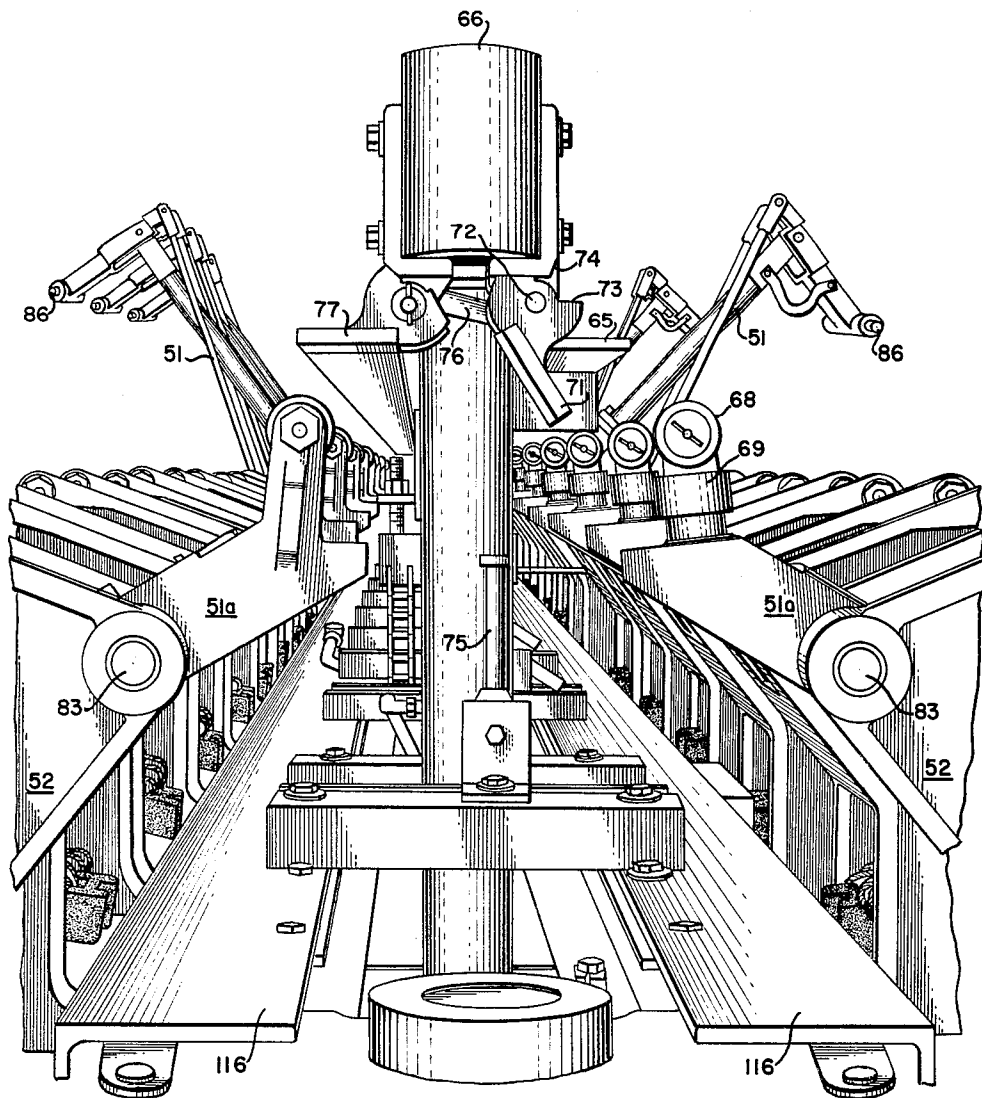


**FIG. 6.**

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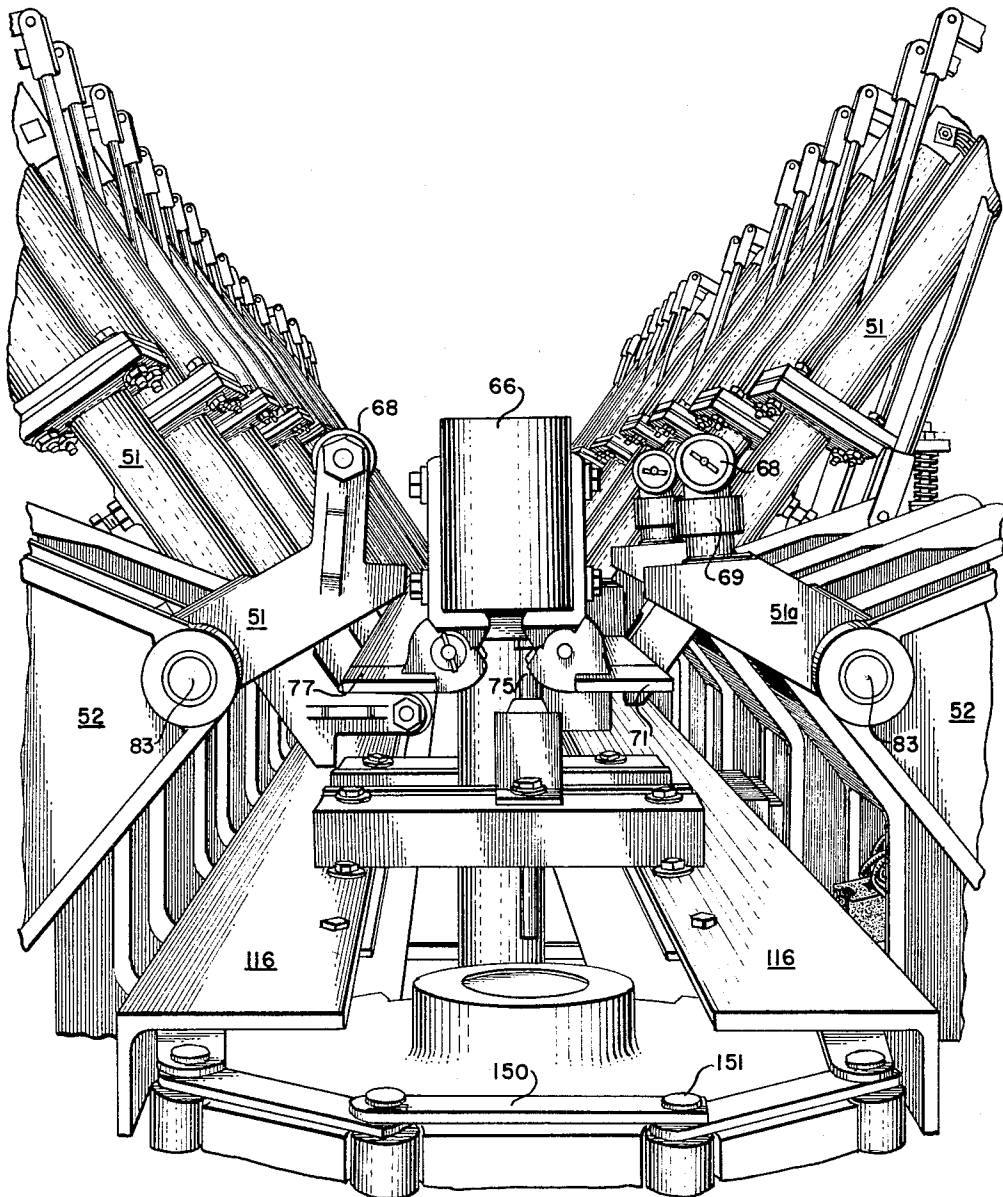


FIG. 7.

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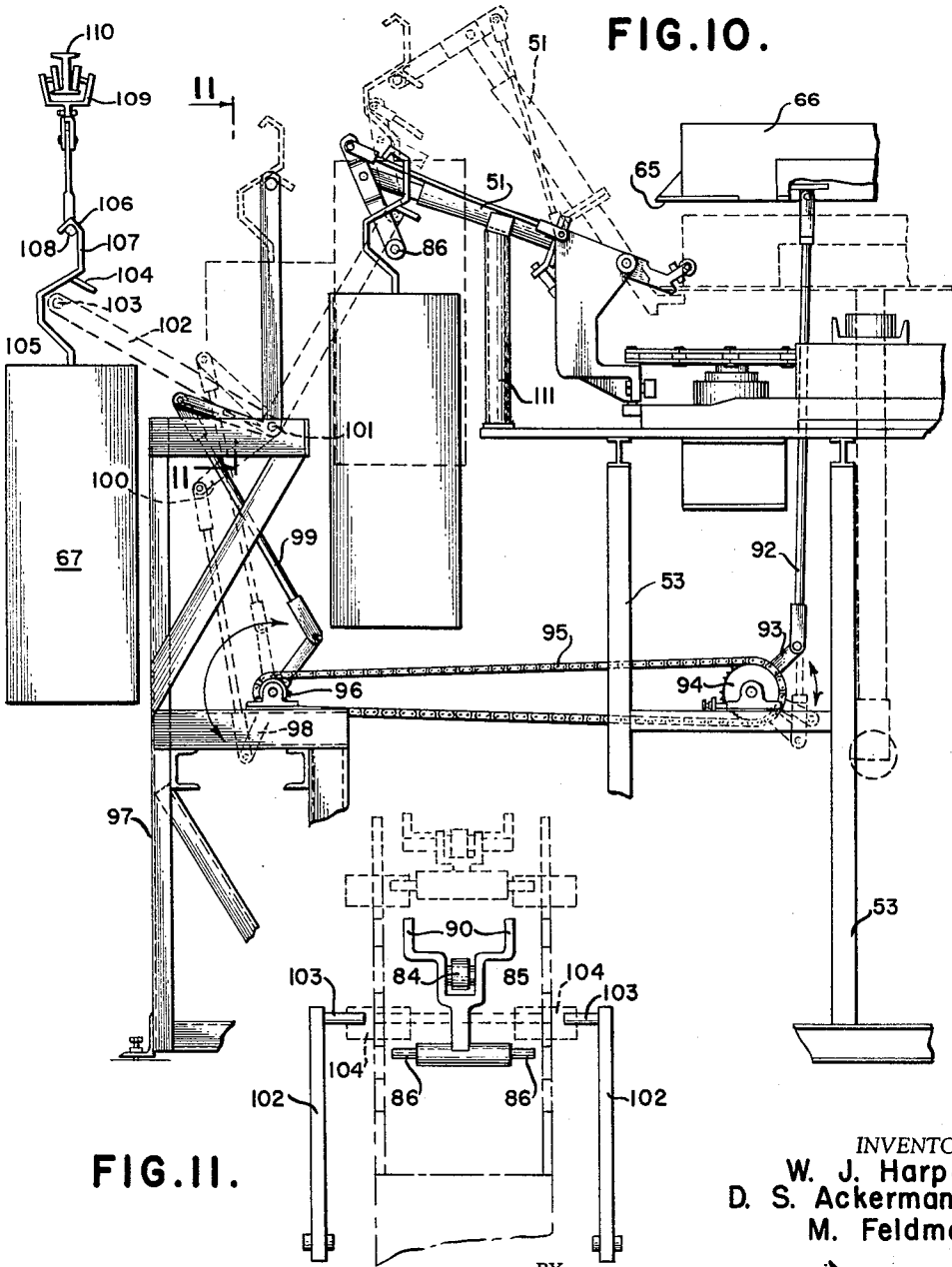
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FIG. 12.

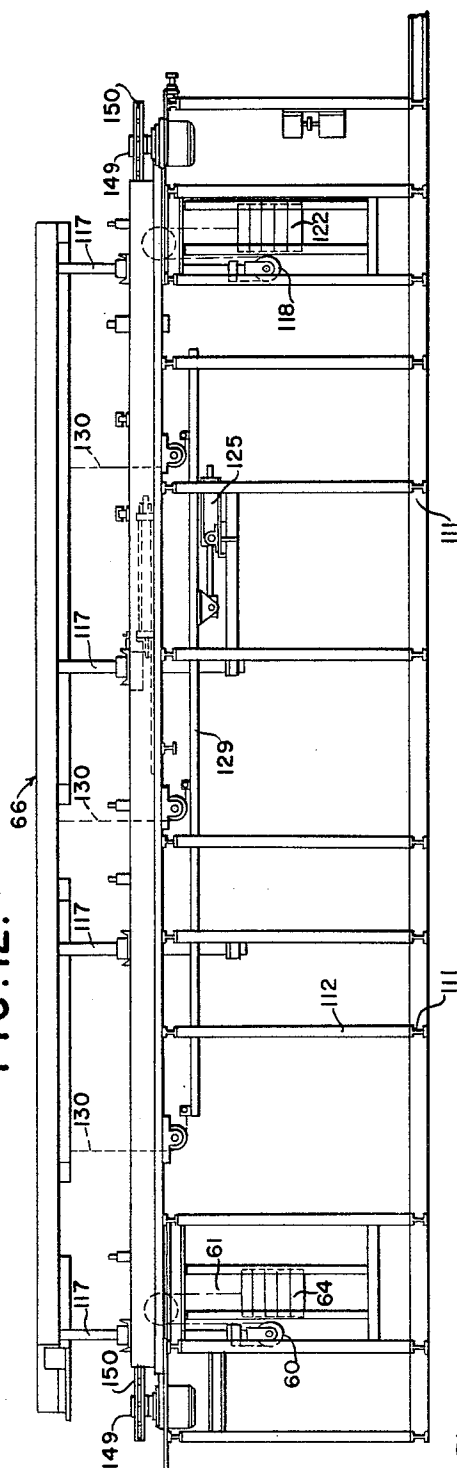
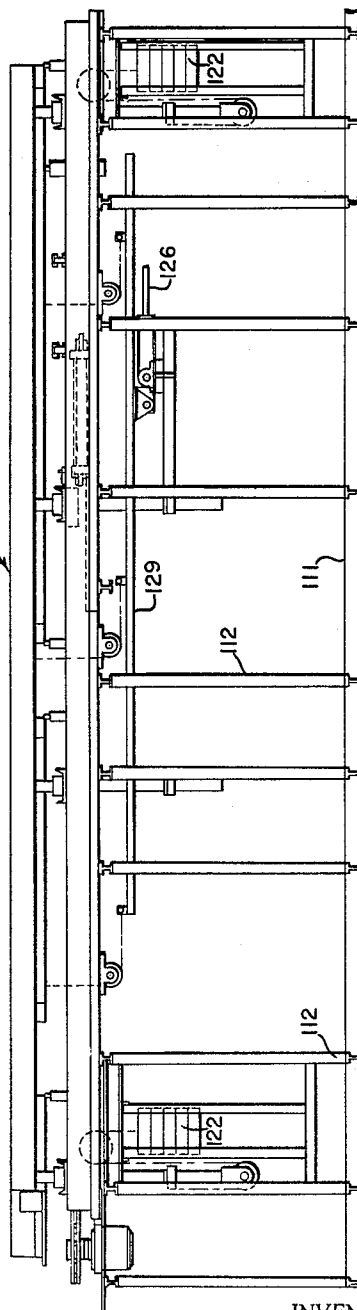


FIG. 13.



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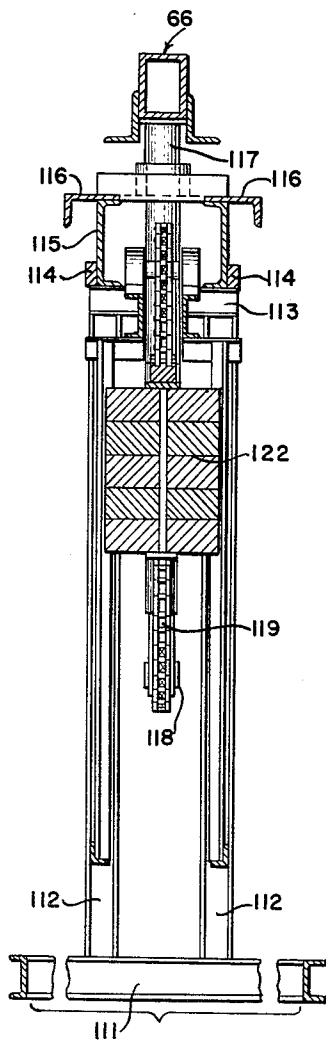


FIG. 14.

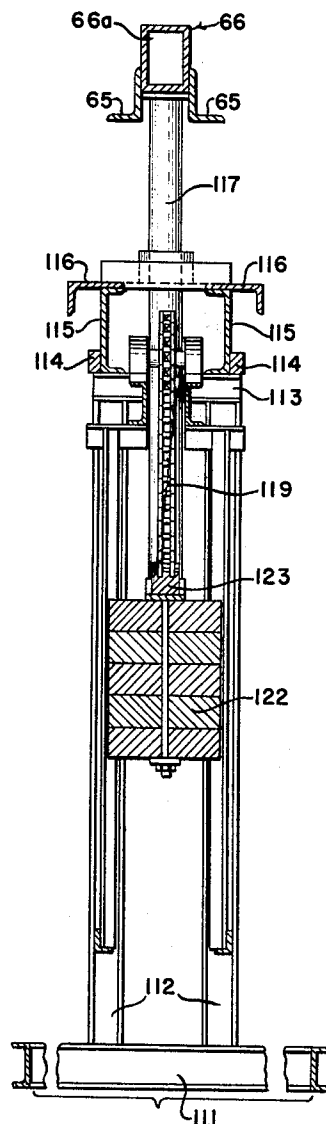


FIG. 15.

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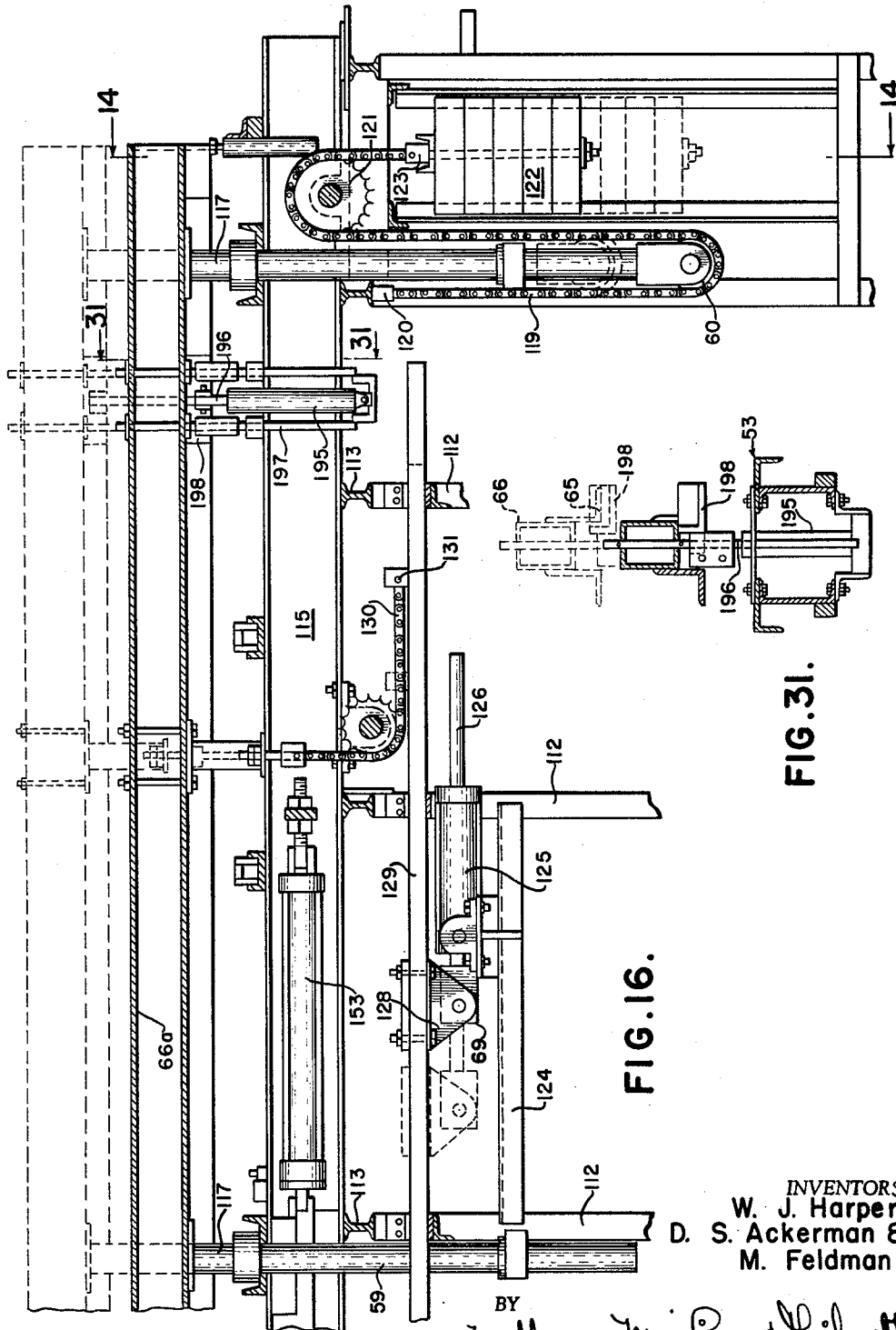


FIG. 31.

FIG. 16.

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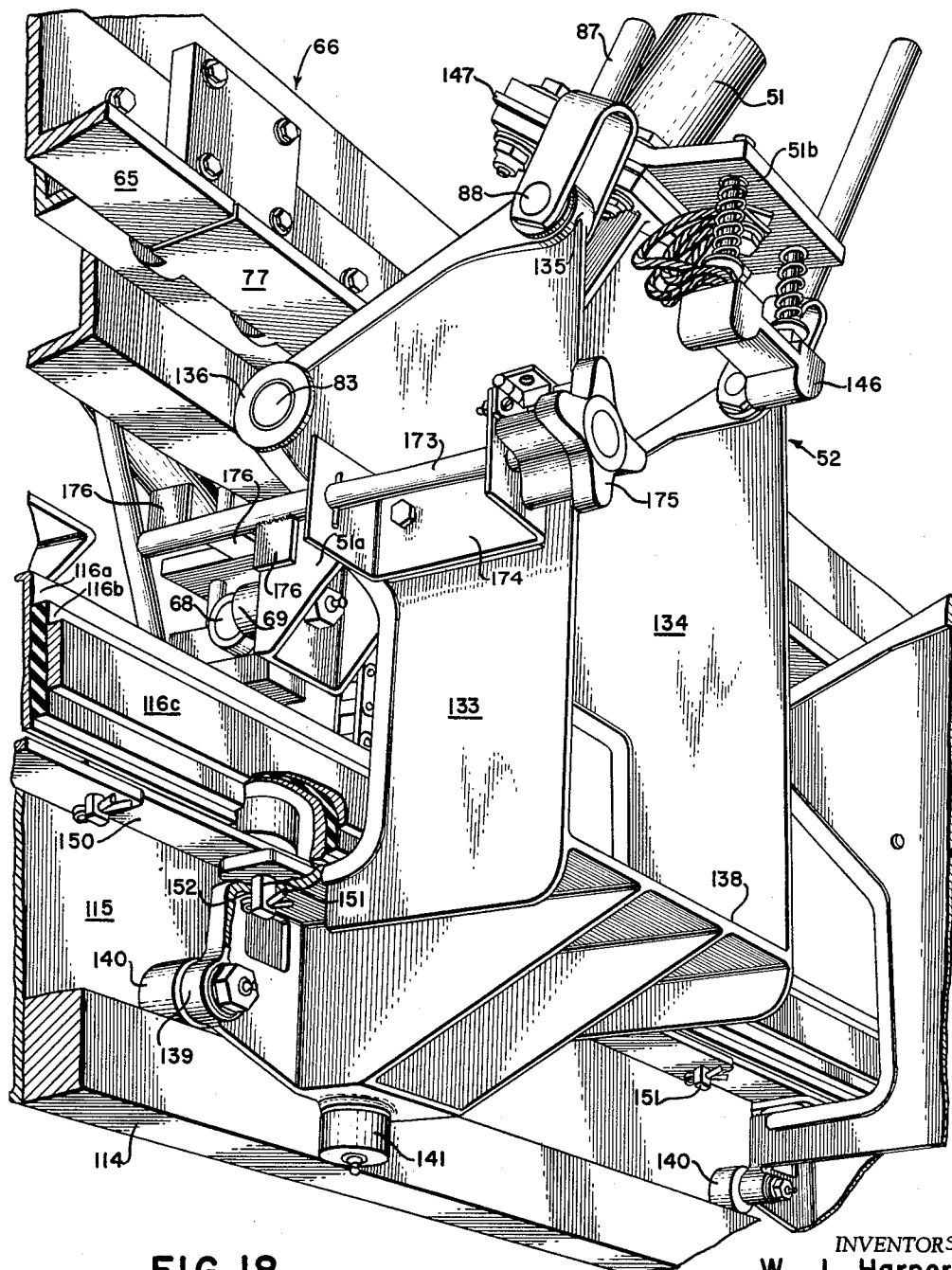


FIG. 18.

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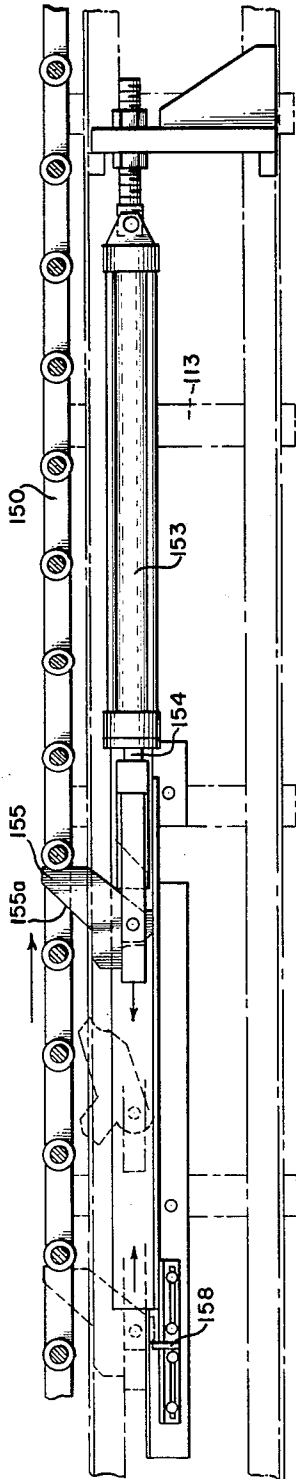


FIG. 19.

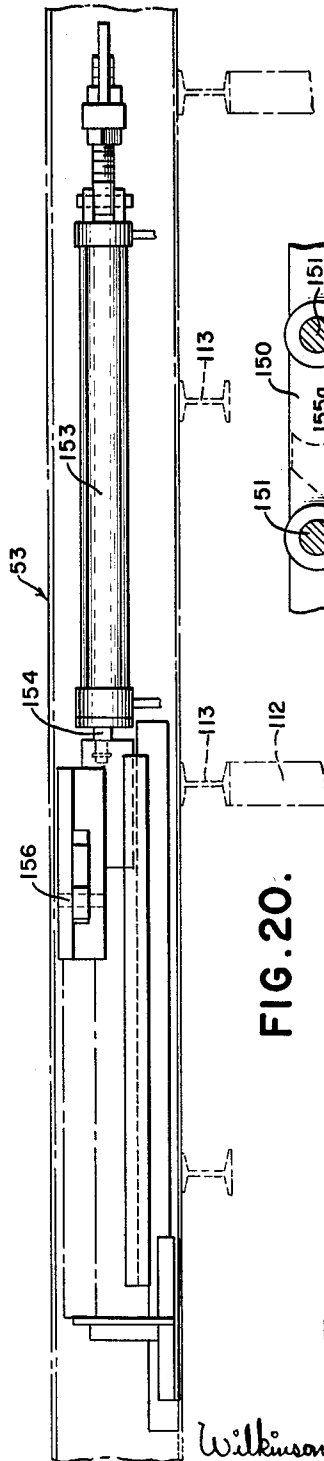


FIG. 20.

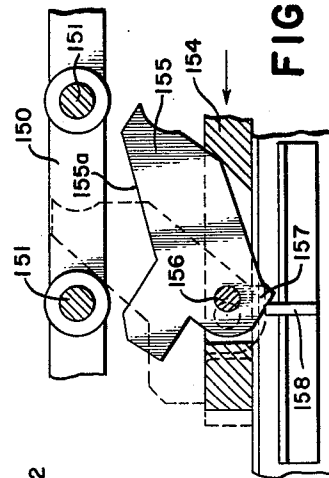


FIG. 21.

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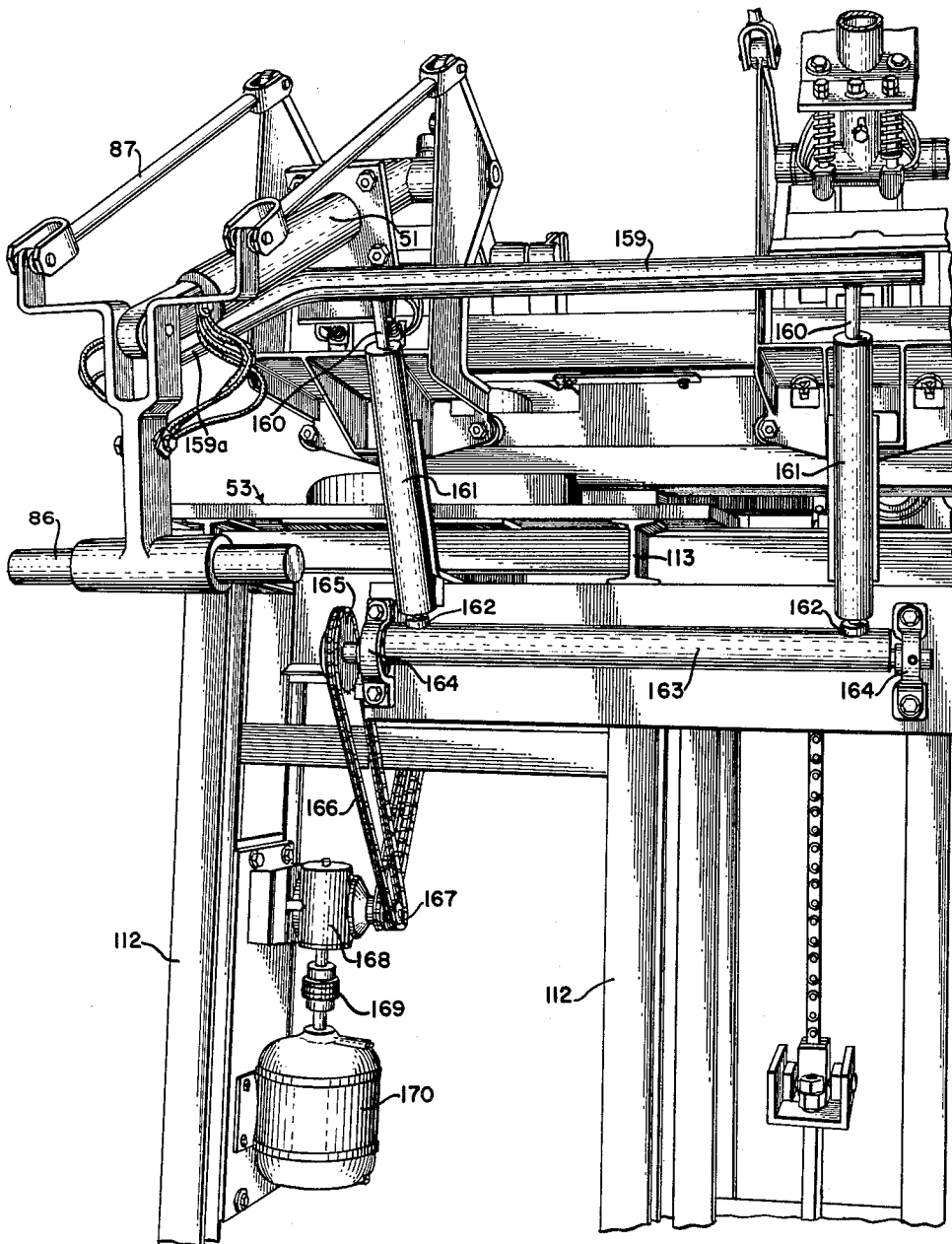


FIG. 22.

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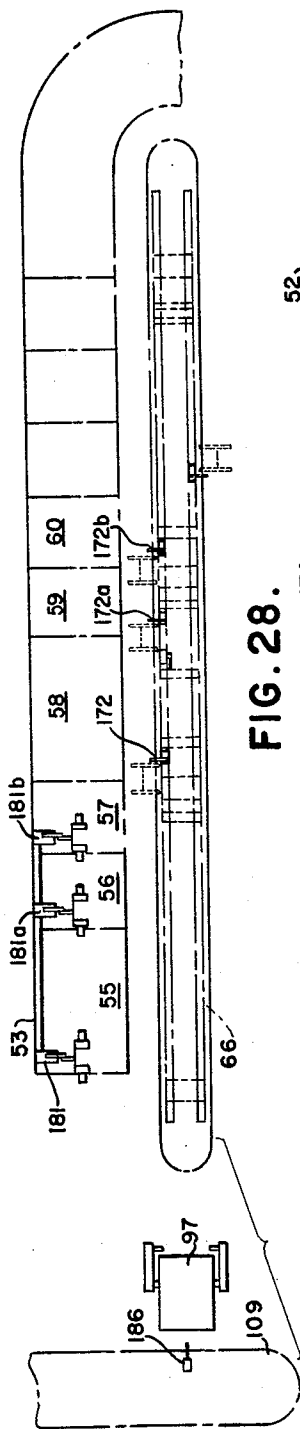


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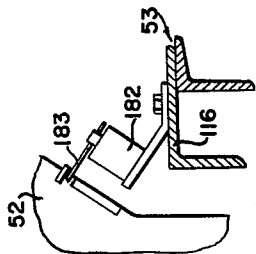


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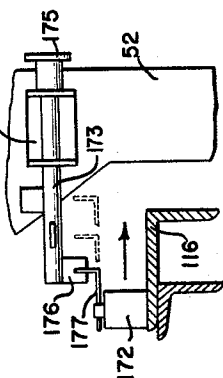


FIG. 24.

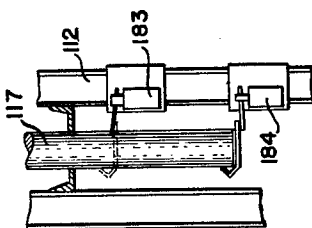


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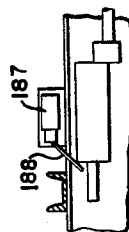


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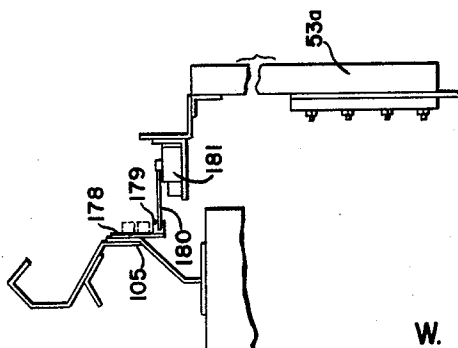


FIG. 23.

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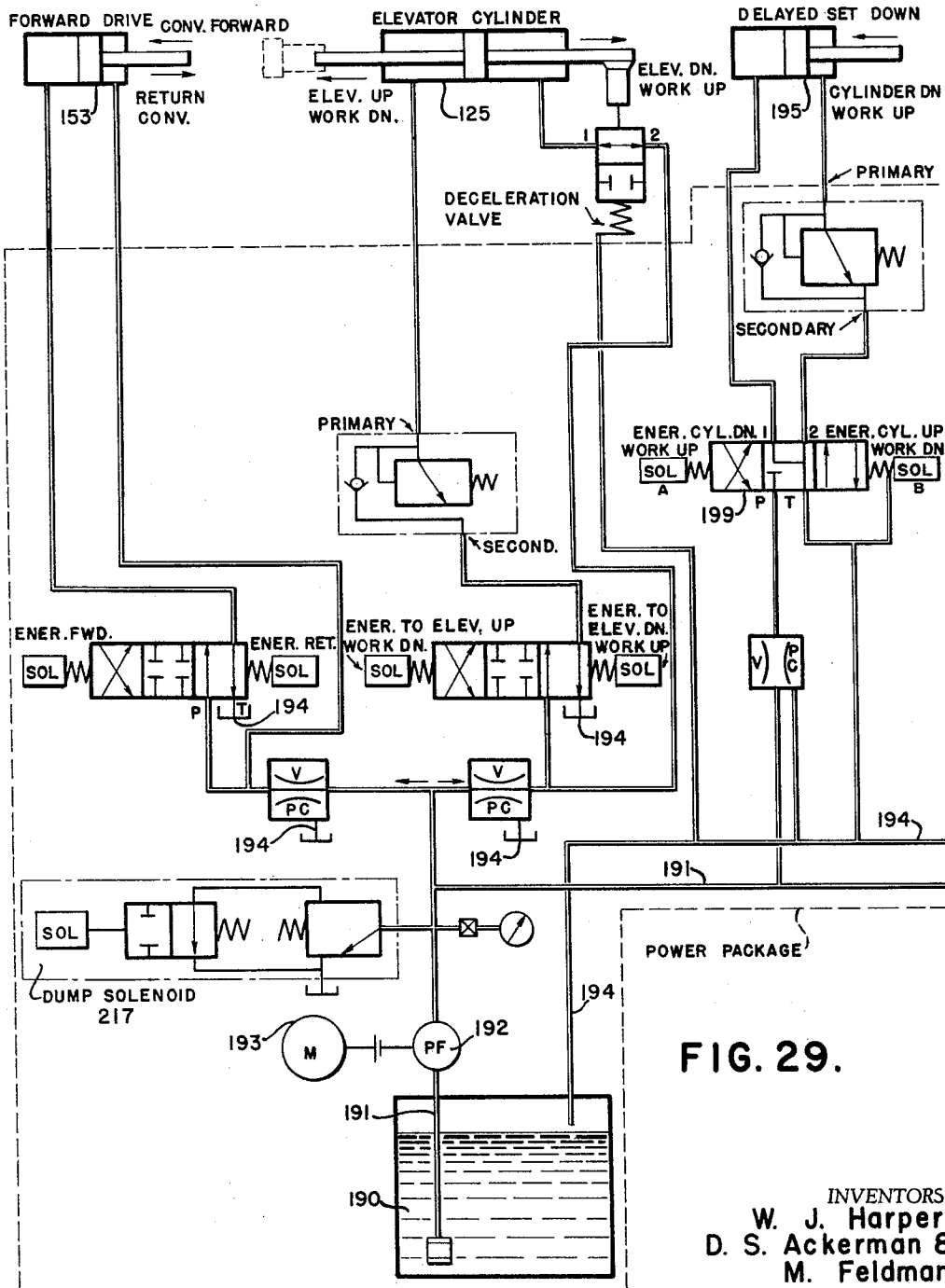
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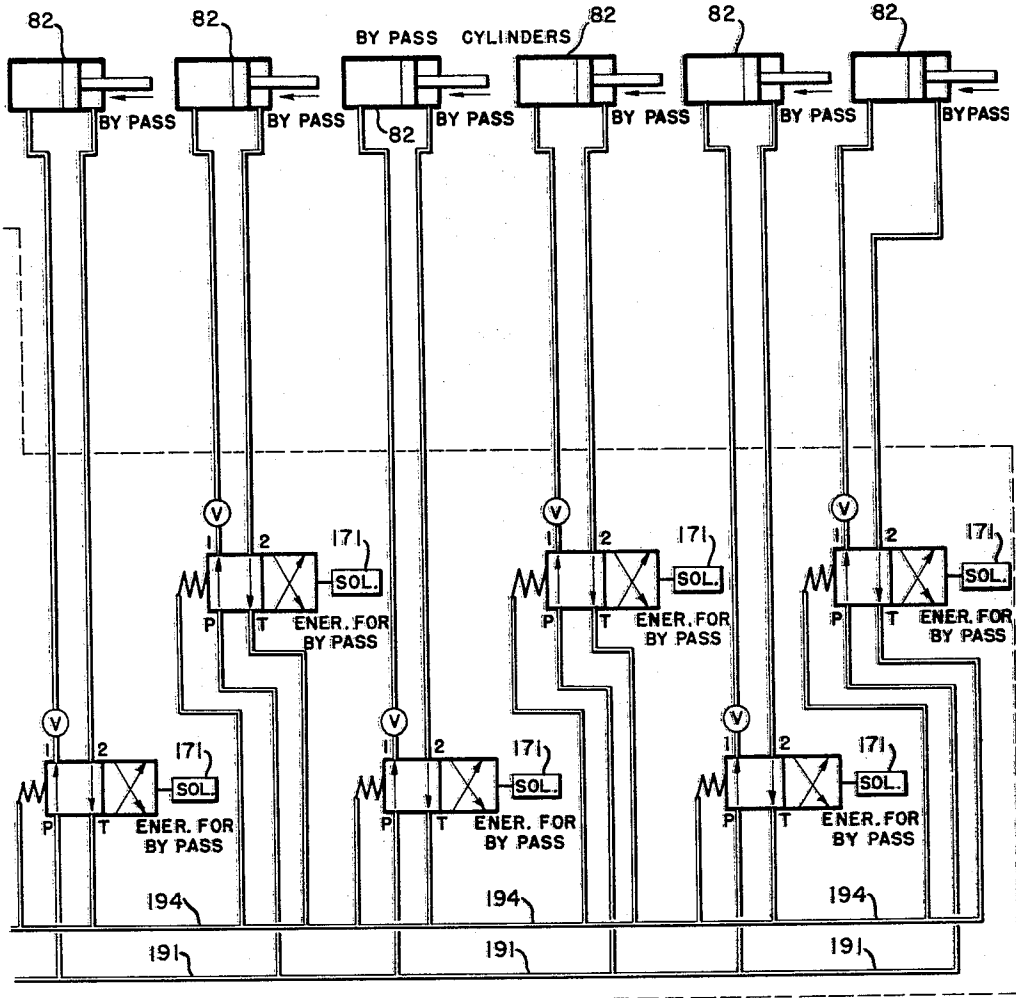


FIG. 30.

LEGEND

|          |          |
|----------|----------|
| FIG. 29. | FIG. 30. |
|----------|----------|

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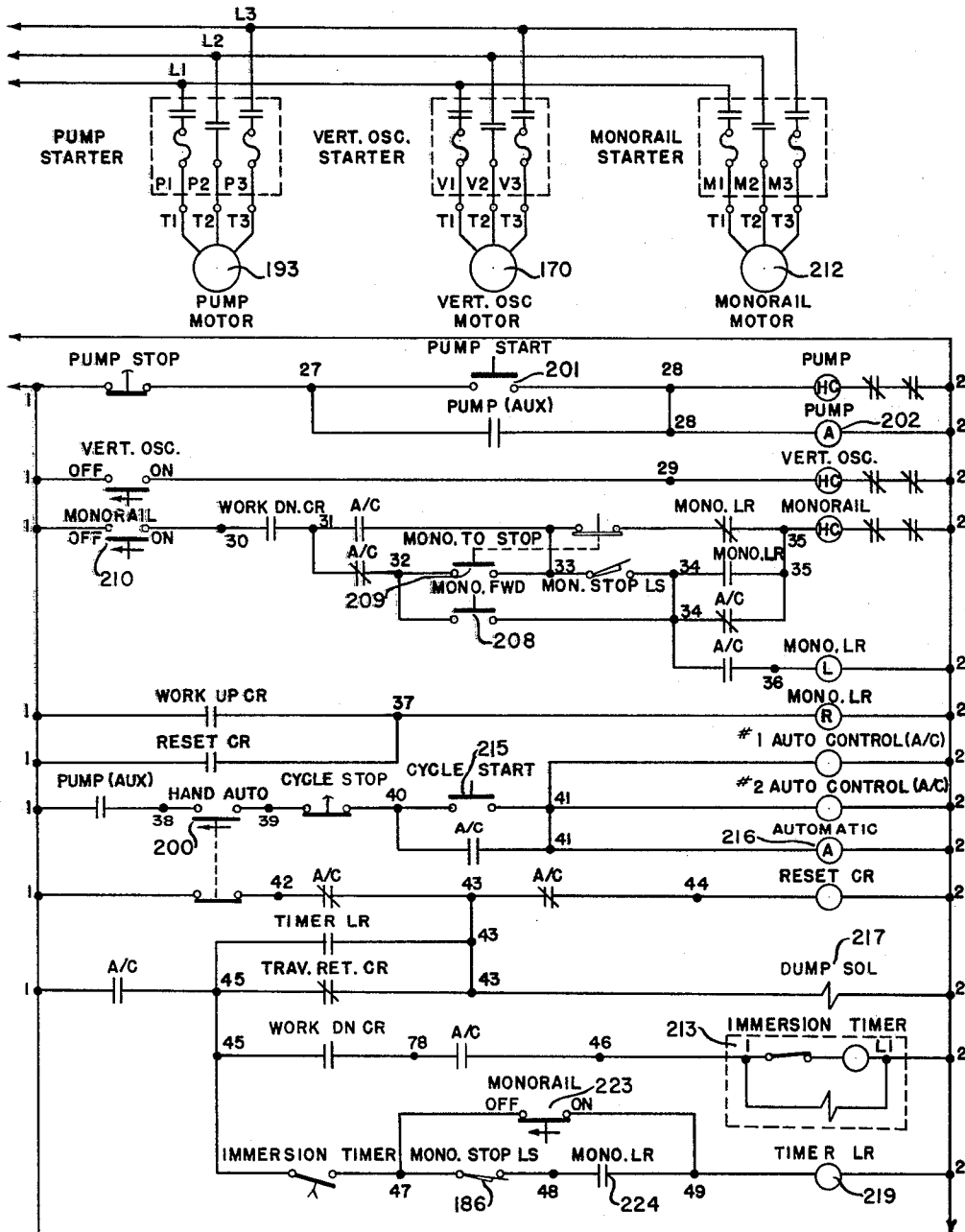


FIG. 32.

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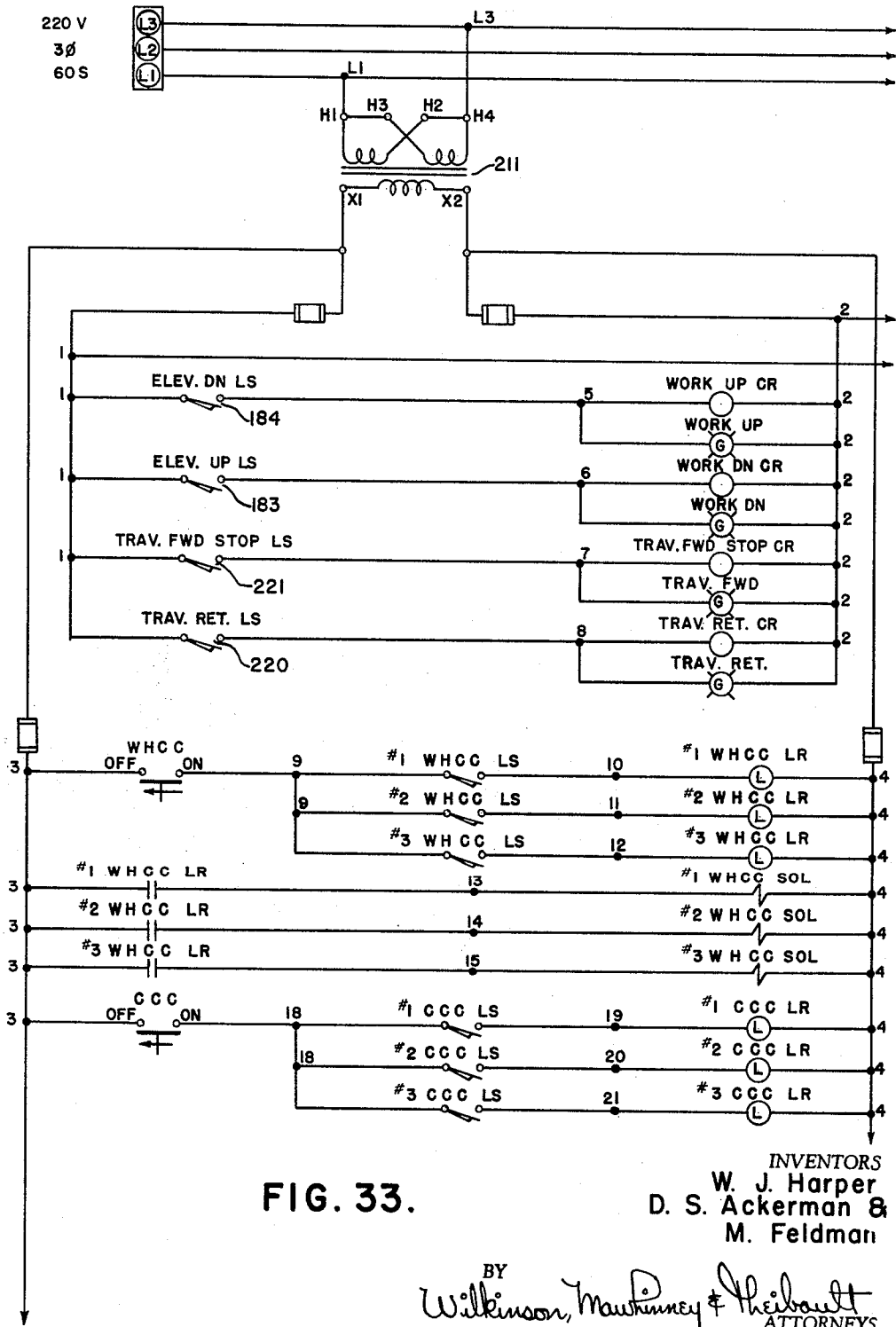


FIG. 33.

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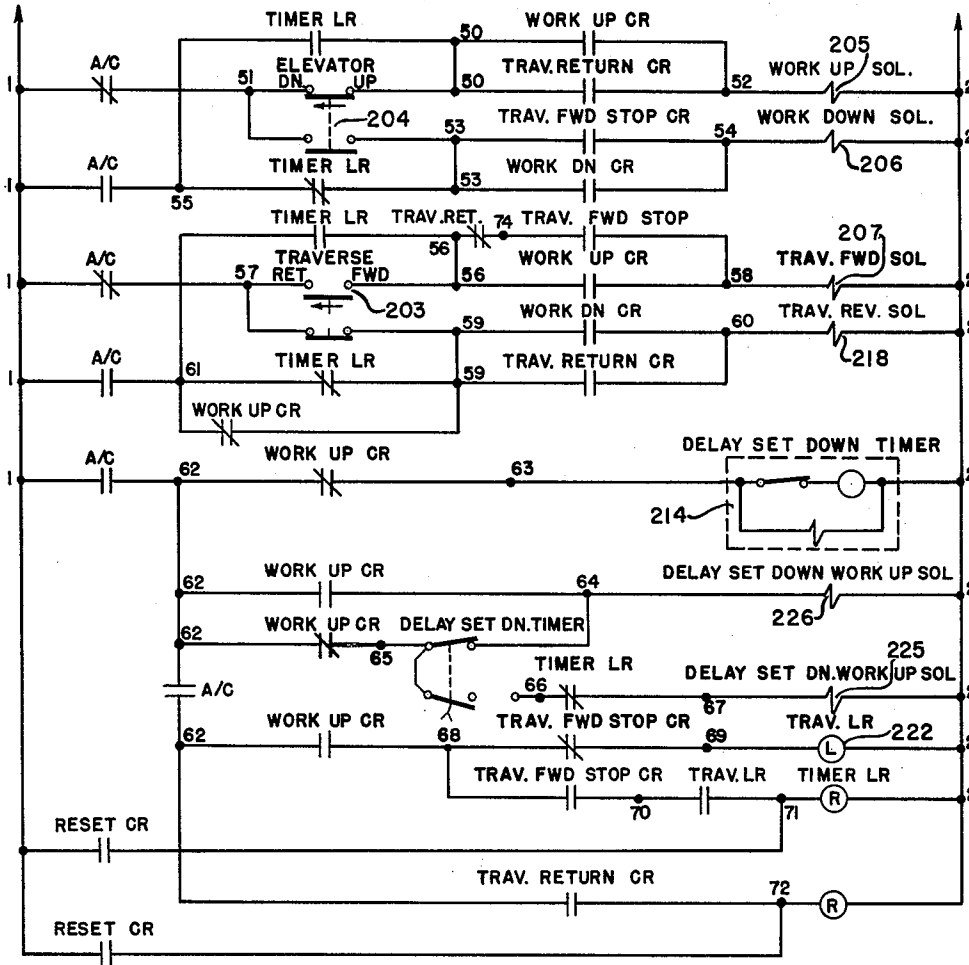


FIG. 34.

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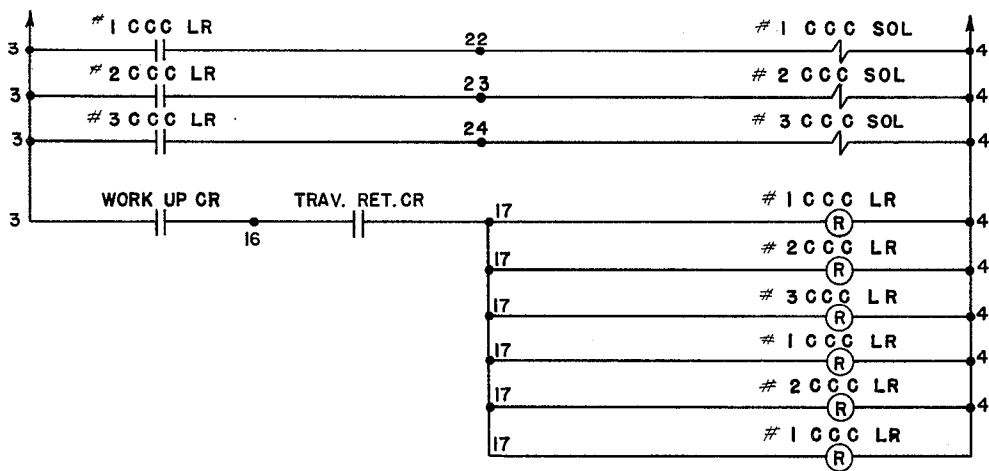


FIG. 35.

LEGEND

|          |          |
|----------|----------|
| FIG. 33. | FIG. 32. |
| FIG. 35. | FIG. 34. |

NOTE

CCC = CARRIER CONTROL CYCLE = CCC

WHCC = WORK HOLDER CONTROL CYCLE = WHCC

CR = CONTROL RELAY

LR = LATCHING RELAY

SOL = SOLENOID

LS = LIMIT SWITCH

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## APPARATUS FOR ELECTROPLATING

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Continuation of application Ser. No. 820,235, June 15, 1959. This application July 25, 1962, Ser. No. 214,785  
23 Claims. (Cl. 198—19)

The present invention relates to apparatus for electroplating and is a continuation of our similarly entitled application, Serial No. 820,235, filed June 15, 1959, and has for an object a flexible and versatile machine for performing electroplating or other treatments by a compact processing conveyor.

Another object of the invention is to provide an apparatus for conveying work to multiple treatment stations with quickly interchangeable cycles at low maintenance cost.

A further object of the invention resides in providing an apparatus for treatments of articles and materials which involves hydraulic or other operation.

A still further object of the invention resides in providing an apparatus for treatments of articles and materials in which the width and length of the machine is substantially reduced, the entire machine is made of permissible lighter materials and in which the machine is lower and generally more compact.

Another object of the invention is to provide a novel form of operation of the work carrying members whereby to lift and lower the same out of and into the treatment stations which involves the use of a substantially vertically moving elevator.

A further object of the invention is to provide a mechanism of simplified mechanical form for operation at an accelerated rate of speed and which will accordingly have an increased capacity.

A still further object of the invention is to provide an apparatus in which the work during its movement up and down out of and into the treatment stations will be carried in a substantially true vertical or right line whereby the work may remain a constant distance from the anode, whereby the plate or etch is uniform in depth, and because the work goes straight down into the treatment tank and comes out straight, the tanks may be made narrower and the overall width of the machine reduced.

Another object of the invention is to provide an apparatus of the character described in which the downward movement of the elevator raises the work carrying arms while upward motion of the elevator permits a downward motion of the work carrying arms, the elevator having a certain overtravel to actuate shifters at transfer points.

A further object of the invention is to provide an apparatus having a novel form of horizontal forward movement resulting in shorter tanks, a shorter overall length of the machine and enables a simple sliding mechanism to advance all of the carriers at each operation through a predetermined spacing, for example of the order of twenty-four inches.

A still further object of the invention is to provide an automatic load-unload mechanism coupled to the apparatus for transferring work to and from a supply system.

Another object of the invention is to provide an apparatus of the kind described having a simple form of oscillating device.

A further object of the invention is to provide a completely automatic and automated apparatus in which selective means is employed for changing pattern cycles to increase the flexibility of the machine to any type or cycle pattern desired.

With the foregoing and other objects in view, the invention will be more fully described hereinafter, and will be more particularly pointed out in the claims appended hereto.

In the drawings, wherein like symbols refer to like or corresponding parts throughout the several views:

FIGURE 1 is a transverse vertical section taken through a machine constructed in accordance with the present invention, showing the work carrying arms raised in solid line position and lowered in the dotted line position.

FIGURE 2 is a top plan schematic layout of one side of the machine constructed in accordance with the present invention.

FIGURE 3 is a side elevational view with parts broken away and parts shown in section of a work carrier arm employed in the machine of the present invention, taken at a magnified scale.

FIGURE 4 is a vertical section taken through a normally open gate employed with the present invention.

FIGURE 5 is a view similar to FIGURE 4 taken through a normally closed gate.

FIGURE 6 is a fragmentary perspective view of an upper portion of the machine of the present invention, showing the elevator in the raised position and the work carrying arms in the lowered position.

FIGURE 7 is a view similar to FIGURE 6 with the elevator in the lowered position and the work carrying arms in the elevated position.

FIGURE 8 is a transverse section taken through the machine static frame showing the hydraulic form of work carrying arm latching device.

FIGURE 9 is a view similar to FIGURE 8, showing a manual work carrying arm latching device.

FIGURE 9A is a view similar to FIGURE 9, showing a fixed elevated rail carried by the machine static frame for retaining the work carrying arms in elevated position.

FIGURE 10 is a side elevational view with parts broken away and parts shown in section of the machine of the present invention, its loader and monorail feed, showing various positions of the transfer of work from the monorail to the machine and vice versa.

FIGURE 11 is a section taken on the line 11—11 in FIGURE 10.

FIGURE 12 is a side elevational view of the machine static frame and elevator with the elevator in the raised position.

FIGURE 13 is a view similar to FIGURE 12 with the elevator in the lowered position.

FIGURE 14 is a transverse section of the static frame taken on the line 14—14 in FIGURE 13 with the elevator in the lowered position.

FIGURE 15 is a view similar to FIGURE 14 with the elevator in the elevated position.

FIGURE 16 is a fragmentary side elevational view taken in an enlarged scale of the elevator and static frame of FIGURE 13, showing the elevator actuating mechanism.

FIGURE 17 is a perspective view of a carriage employed in connection with the present invention.

FIGURE 18 is an underneath perspective view taken at an enlarged scale of a work carrying arm carriage mounted on the static frame.

FIGURE 19 is a top plan view taken at a magnified scale of the horizontal traverse mechanism.

FIGURE 20 is a side elevational view of FIGURE 19.

FIGURE 21 is a fragmentary top plan view taken at an enlarged scale of the traverse mechanism pawl construction.

FIGURE 22 is a fragmentary perspective view of one end of a machine constructed in accordance with the present invention, showing the work arm oscillating mechanism.

FIGURE 23 is a schematic illustration of the work holder signal control system for controlling the work arm latching mechanism.

FIGURE 24 is a schematic view showing the carriage control system for regulating the work carrying arm latch mechanism.

FIGURE 25 is a fragmentary schematic of the elevator start limit switch and work carriage arrangement.

FIGURE 26 is a schematic view of the elevator limit switch mechanism.

FIGURE 27 is a schematic view of the horizontal traverse limit switch mechanism.

FIGURE 28 is a schematic top plan view of the machine of the present invention, showing the locations of the limit switch wands for controlling the work arm latch mechanism.

FIGURES 29 and 30 are hydraulic schematics of the hydraulic system employed in the machine of the present invention.

FIGURE 31 is a transverse section taken on the line 31-31 in FIGURE 16, showing the delayed set down mechanism.

FIGURES 32 through 35, inclusive, are the electrical schematics of the electrical control system of the machine of the present invention.

Referring more particularly to the drawings, FIGURE 1, 50 designates a work holder carried by an arm 51 pivoted for substantially vertically swinging movement on a carriage 52 which is mounted for substantially horizontal traverse movement around a main static frame 53 being advanced intermittently, or step by step, by means of a chain and reciprocating pawl mechanism or other appropriate device which may also be mounted on the static frame 53. The work in the work holder is thus moved horizontally from one treatment station to another of a plurality of such stations 55-64 inclusive, FIGURE 2, which may be for electroplating or other work treating processes and in the form of the invention herein shown such stations are arranged consecutively in a loop formation disposed about the main frame or installed thereon.

The arms 51 are arranged to move up and down and carry the work holders 50 at their outer end portions for the purpose of lowering the work into the tanks or treatment stations and for raising the work thereabove for such traverse movement from one station to another for completing desired cycles of treatment.

The pivoted work carrying arms 51, FIGURES 1 and 3, are preferably levers including inner arms in the nature of triggers 51<sup>a</sup> which are disposed in the paths of depressor bars 65 carried at opposite sides of an elevator 66 which is mounted, as shown in solid and dotted line positions, for vertically reciprocating movement in the main static frame 53, such depressor bars being adapted to travel in substantially vertical paths into which project the triggers 51<sup>a</sup> of the various work carrying arms 51 or levers whereby descent of the elevator will cause the depressor bars to correspondingly depress or move down the triggers, thus elevating the carrier arms 51 and the work carried by the outer end portions thereof whereby such work may clear tank walls or other obstructions or partitions between subsequent treatment stations.

The elevator 66 may be driven down by appropriate mechanism hereinafter more particularly described. Upon each ascending movement of the elevator 66 and its depressor bars 65, the central load will be progressively lifted from the triggers so that the weight of the work carried by the outer ends of the work carrying arms 51 may maintain the triggers up against the lower surfaces of the depressor bars 65 while the work is gravitationally descending into the treatment stations by which action the ascending elevator will control the rate of descent of the work into the treatment stations.

The depressor bars 65 of the elevator 66 subserve an additional function in that in the "down" position of the elevator these bars in effect constitute rails or tracks for

rollers 68, 69 carried by oblique extensions 51<sup>b</sup> of the triggers which roll horizontally along in contact with and are held down by the depressor bars 65 incident to the traverse movement of the carriages and the work carrying arms supported thereby with the work in the elevated position, FIGURE 1, the work thus being transferred from one to another station. The track and roller arrangement will be hereinafter more fully described in a subsequent section of this specification.

The arrangement will preferably be such that the traverse movement will communicate to the carriages 52 and the work carrying arms 51 thereon with the suspended work 67 an intermittent horizontal movement only when the elevator 66 is in the "down" position with the work 67 elevated above the treatment stations or any walls or partitions therebetween. Also, this traverse movement will be communicated to the carriages 52 preferably in increments of linear value equal to the horizontal distances between such stations, for example, the distance between stations 55<sup>a</sup> and 55<sup>b</sup>, FIGURE 2, and it will be understood that where immersion in liquid treating baths is concerned, a single tank may embody multiple stations, as for example tank 55, so that while the mechanism is arranged to move one traverse step at each descending movement of the elevator so as to shift the carriages 52 and work from one station 55<sup>a</sup> to another 55<sup>b</sup> at each such descending movement, an immersion period may be continued by maintaining the articles 67 immersed in a tank 55 having plural treatment stations without requiring the lifting of the work 67 from the liquid bath by the process of selectively eliminating elevator thrust bar action on selected trigger of such work carrying arms 51. This may be accomplished by providing openings or gaps 70 at selected stations in the depressor bars 65 of the elevator 66 directly above and in vertical alignment with triggers of work carrying arms 51 that are to be undisturbed in their lowered position (dotted line position, FIGURES 1 and 3) pending one or more elevator stroke cycles.

However, inasmuch as lateral or horizontal transverse of the carriages 52 takes place only when the elevator 66 and its depressor bars are in the "down" position, it is desirable to close the openings 70 or plug such gaps in order to have horizontal continuity of rails which are the depressor bars 65 for the continuous engagement of the horizontally moving rollers 69 of the triggers, and for this purpose normally open gates 71 are carried by the depressor bars 65 along the inside edges of such openings or gaps 70. It is preferred that these gates 71 be pivotally hung from the depressor bars 65 on pivots or hinges 72 and that springs be associated with such hinges or pintles for biasing the gates 71 to a normally "down" position in which the gaps 70 are open. Complementary stops 73, 74 are provided on these gates and on the elevator so relatively arranged and positioned as to arrest the upward swinging movements of the gates 71 when the same are in alignment with their respective depressor bars 65 for forming a smooth continuous undersurface rail for the rollers 69.

Carried by the main static frame 53 of the machine, as best seen in FIGURES 6 and 7, are spring pressed or yieldable reset plungers 75 in position to be engaged on the descent of the elevator 66 by links 76 pivoted to the elevator and to the gates 71 in such position that such plungers 75 will impart upward thrust to the lower edges of these links 76 causing the gates 71 to swing closed; the plungers 76 being so positioned that the gates 71 will not close until after the same have passed downwardly below the triggers of those work carrying arms 51 which are to be left in the lowered position. The gates thus closed form continuity of track and enable the smooth operation of the ensuing transverse movement.

Such openings 70 and gates 71 may be located at any desired station. For instance, they will be located in the first or primary station 55<sup>a</sup> of multiple station tanks,

such as tank 55, so that the work immersed at such primary station will not again be raised out of the solution by any subsequent acts of the elevator, but will be moved progressively and intermittently along all of the stations in the multiple station tank until the last of such stations, such as station 55<sup>b</sup>, is reached and it again becomes necessary to lift the work 67 out of the tank in order to clear the tank wall preparatory to the next intermittent horizontal traverse of the carriage 52 and arm 51 to the next successive treatment station 56 which will be in the next tank.

It will, therefore, be understood that at each successive treatment station in a multiple station tank there will be openings 70 in the depressor bar 65 and normally open gates 71 opposite each such station, or a sufficiently long opening and single gate of equivalent length spanning the entire linear distance encompassing all such multiple stations in a given treatment tank except the last.

It will further be understood that at the last station in a multiple treatment station tank it will become necessary to reengage the triggers of the work carrying arms 51 with the elevator depressor bars 65 at this point in order that on subsequent descent of the elevator 66, such movement may lower the involved trigger and raise its corresponding arm 51 to enable the work 67 to advance horizontally across the tank walls to a subsequent tank. This action is accomplished by normally closed gates 77 movably mounted in openings or gaps 70 in the depressor bars 65 and closing upwardly against stops under the influence of coil springs wound about the pintles or pivots 78 by which these gates are swivelly mounted in the elevator. In their normally closed positions these gates 77 form continuous sections of the track beneath the depressor bars 65. In the "down" position of the elevator these gates will be held yieldably closed by their springs and in this "down" position a carriage 52 and work carrying arm 51 will be moved horizontally to the last station in a multiple station tank whereupon the trigger of that arm will be directly above such normally closed gate 77. On the ensuing rising movement of the elevator 66 that trigger will engage the normally closed gate 77 and will simply cause such gate to be swung inwardly and downwardly around its pivotal center 73 so that the elevator 66 may pass without effect upwardly beyond this trigger. As soon as the gate 77 clears the trigger, i.e., rises above the same, its biasing spring will swing the gate 77 upwardly and outwardly to its closed position against its stops and, therefore, in the subsequent descending movement of the conveyor the lower end of this gate 77 will encounter such trigger and as the gate cannot swing upwardly such gate being thereupon a solid continuation of the depressor bar 65 will lower the trigger, thus elevating the work carrying arm 51 and the work 67 to enable the same to clear the tank wall on the next subsequent traverse movement of the carriage 52.

These normally closed gates 77 will thus be located at the terminal stations of multiple station treatment tanks, such particularly as plating tanks 64, FIGURE 2, in electroplating machines which, in the loop variety of such machines, extend semi-circularly at one end of the machine and provide a great number of individual treatment stations or intermittent stops for the intermittently driven traverse motion to the end that when work has entered the plating station, such work will remain immersed and free of elevator lifting action until such work has progressed all about the plating tank throughout a desirable immersion period and until the same arrives at the final electroplating station whereupon the trigger involved will arrive in vertical alignment with a normally closed gate 77 with action as heretofore described for removing the work from the plating tank and passing it to subsequent rinsing and other final treatment stations.

The normally open and the normally closed gates 71, 77, with their openings 70 or gaps in the elevator depressor bars 65 will be located at desired stations pursuant

to the general program or pattern of the plating or other treatment cycle so that the machine may be designed and arranged for carrying out progressive treatments in whatever arts those treatments may be required or desired. Normally the depressor bars 65 may be solid and continuous and in some machines it may not be necessary to provide any of the gates, where, for instance, each station is an individual tank and the work is to be immersed in the tanks for similar time periods.

It is also desirable at times, particularly in immersion machines, to suspend the work above the bath after immersion for draining or other purposes and to this end the machine is equipped as to its main static frame 53 with latches 79, FIGURES 1 and 8, movably mounted into an operative and inoperative position as by pivoting the same at 80 so that in one position (solid line) the latches 79 may engage against shoulders 81 of the oblique extensions 51<sup>b</sup> on the triggers when those triggers are in their lowermost positions with their corresponding work arms 51 in the raised positions with the work 67 carried thereby suspended clear of the liquid level. These latches may be operated both into and out of latching position manually, FIGURE 9, by hydraulic mechanism 82, FIGURE 8, electrically, or otherwise, pursuant to forms of mechanism as hereinafter more fully described.

#### *Right Line Motion*

Referring more particularly to FIGURE 3, 83 represents the fulcrum of the work carrying arm 51 to the outer end of which is pivoted at 84 a work carrying lever 85 having a yoke 86, which may be electrified in appropriate cases, for receiving the hooks of the work holder. A stabilizer link 87 is pivoted at 88 to the carriage 52 at one of its ends and at its other end at 89 to an upward extension arm 90 of the lever 85.

As will be observed from the dotted position of the parts in FIGURE 3, in its lowered position these parts form a trapezium in which the sides 51, 87 are non-parallel and converge toward the outer ends, while the sides 83, 88 and 84, 89 are also non-parallel and converge upwardly at differential angles. The vertices of the trapezium are represented at 83, 88, 84 and 89.

The distance 83, 84 is the radius of movement of this trapezium, the fulcrum or vertex 83 being fixed in space as being journalled in the carriage 52. The vertex 88 is also fixed in space by reason of its mounting in the same carriage 52. The vertices 83 and 88 are fixed relatively to one another by reason of their mounting in the same carriage 52 and by reason of the configuration or sloping of the top edge 91 of the carriage 52 the vertex 88 is in a plane vertically above the horizontal plane running through the vertex 83.

The distance 83, 84 is greater than the distance 88, 89 and both the arm 51 and the link 87 are preferably straight-line members of the trapezium. The side 83, 88 is also in a fixed straight line. The side 84, 89 is a straight line but the same has angular movement above the fulcrum 84 and the fulcrum 89 incident to the rising and falling movement of this structure which besides functioning as a straight-line movement mechanism for the work also is in a truss form adding the strength of such construction to rigidify the device, enable it to be made of lighter material and to be adequate for most work loads.

In the operation of this device the raising of the work carrying arm 51 incident to elevator descent causes entrainment of link 87, lever 85 and the work suspending yoke 86 therewith. Incident to this movement and because of the values of the parts as heretofore set forth, the axis of the yoke 86 will be lifted in a vertical right line and will descend in the same rectilinear path. The vertex 84 will, of course, be required to move through an arc the radius of which is 83, 84. However, this curvilinear movement of the outer end of the arm 51 is resolved into a vertical straight-line motion at 85 by reason of the fact that the lever 85 is permitted to swing about its hori-

zontal axis 84 on the outer end of the arm 51. The swinging movement of the lever 85 is accomplished by the thrust and pull of the link 87 acting at the vertex 89 on the extension lever arm 90. Thus the position of the vertex 89 in space will progressively change as the arm 51 is raised and lowered contributed by factors which are involved with the shorter length of the link 87 relatively to the radial length of arm 51, the positioning of vertex 83 with reference to primary center of motion 84 and the length of the side 84, 89. The resultant movement communicated to the lever 85 will be such that its lower portion 86 will be confined to vertical straight-line travel.

In the uppermost position shown in FIGURE 3, it will be seen that the arm 51 has passed the vertex 88 and is now above the same whereas in the lowermost dotted line position the arm 51 is below such vertex 88.

Also in the full line, fully raised position of this figure, the arm 51 has crossed the link 87 so that the geometrical figure has been converted from a trapezium into complementary triangles. However, it may not be necessary in some types of work to raise the linkage to such a high position as to depart from the trapezium relationship of parts. In FIGURE 3 the vertical line dropped from the top full line position of the yoke 85 to the bottom dotted line position thereof indicates the right line movement imposed upon the yoke and consequently the work by this linkage arrangement.

#### Load and Unload Station

Referring more particularly to FIGURES 10 and 11, 92 designates a drive rod connected to be driven by the elevator 66 and pivoted at its lower end to a drive arm 93 for driving a large drive sprocket 94 rotatively mounted in the static frame 53 and entrained with an endless chain 95 also meshed with a smaller driven sprocket 96 which is mounted on a load-unload frame 97.

The sprocket 96 drives a driven arm 98 connected by a link 99 to an oscillating arm 100 fulcrummed to oscillate above the oscillation center 101 in the load-unload frame 97. The shaft 101 constituting the center of oscillation to which the arm 100 is affixed, has also affixed thereto a pair of loader-unloader arms 102 having at their free ends interturned pins 103 which are adapted to receive thereover and support the lower hooks 104 of work holders 105 having also upper hooks 106 connected with the lower hooks 104 by splines 107. The upper hooks 106 are adapted to engage the bar 108 for supporting the work holders 105 from trolleys 109 running on a monorail 110.

In operation, the load-unload frame will be installed at a convenient location relatively to the main static frame 53 and in fact the load-unload frame 97 may if desired be an extension of the main static frame at the location where finished work is to be removed from the load carrying arms 102 and transferred to the monorail system 110 while at the same time new work from the monorail system 110 is to be transferred to the work-vacated arms 51.

Advantage is taken of elevator movement in which to activate the load-unload mechanism thereby eliminating the necessity for powering the load-unload mechanism by separate motor and transmission train at greater expense involving greater weight and requiring additional space and length of machine.

At each descent of the elevator movement the drive rod 92 will be driven down through an appropriate angular distance about the center of rotation of the drive sprocket 94, for instance a distance of 90°. Due to the change in sprocket ratios the smaller driven sprocket 96 will drive the driven arm 98 through an angular distance of approximately 180°. It will be understood that as the elevator 66 rises the drive rod 92 will be lifted and received reverse movement imparted to the chain 95 and to the driven arm 98. Such angular movement of the driven arm 98 will be transferred through the link 99 to the arm 100 and thus will serve to oscillate the loader-unloader arms

102 through the range of movements indicated in full and dotted lines in FIGURE 10.

When, through an indexing movement, lower hooks 104 of a work holder 105 are moved along the monorail 110 with the pins 103 of the arms 102 in the extreme left-hand position of FIGURE 10, the outer portions of the lower hooks will be moved directly above the pins and therefore on subsequent swinging movement of the arms 102 to the right in FIGURE 10, the pins 103 will be raised into engagement with the outer portions of the lower hooks 104 and will lift the upper hooks 106 off the bar 108. The work holder 105 will thus be transferred from the monorail system over to a position in the path of the yoke 86 of a work arm 51.

As shown more particularly in FIGURE 11, this yoke 86 is of a lesser length than the distance between the inner free ends of the pins 103 so that on a rising movement of the arm 51, the yoke pins may ascend into engagement with inner portions of the lower hooks 104 and thus lift the work holder 105 off the pins 103 of the load-unload mechanism. At this point the linkage at 98 is such as to arrive at a short dwell position so as to allow momentary relatively rising movement by the arm 51 while the arms 102 and the pins 103 remain substantially static. The transfer of the work from the load-unload mechanism to the carrier arms 51 of the work machine is thus effected quickly and easily and automatically.

When the load-unload arms 102 are also in this same extreme right hand position of FIGURE 10, they are located to receive the lower hooks 104 of a work carrier having completely treated work so that by relative downward movement of the arm 51, the work holder 86 may drop the lower hooks 104 on to the pins 103 of the arms 102 whereupon on swinging movement of the arms to the left in FIGURE 10 from the extreme right hand position the pins 103 will rise and move to the left and lift the hooks 104 off the pins of the yoke 86. It will be understood that by relative movement between the work holder 86 of the arm 51 and pins 103 of the arms 102, these parts may be shifted into and out of transferring loading and unloading positions or interfitted and removed relatively to one another by motion derived from the up and down movement of the elevator 66.

It will be noted from FIGURE 10 that a rest 111 is mounted upon the main frame in position to receive the arm 51 and to hold it in an intermediate position, that is, from dropping down to its lowermost position incident to elevator upper travel as it is inconvenient to have this arm 51 in its lowermost position and full stroke mechanism of the elevator is essential to drive the load-unload mechanism through its full stroke.

The depressor bar 65 of the elevator 66 in FIGURE 10 is shown to be raised above the trigger 51<sup>a</sup> of the arm 51 which has been deposited upon the rest 110. Thus the elevator 66 can work down from the full line position until the depressor bar 65 encounters the trigger 51<sup>a</sup> before beginning to raise the arm 51 and through this elevator travel the load-unload arms 103 are being swung over from the monorail 110 to the vicinity of the yoke 86 which at this time will begin to rise due to elevator contact with the trigger arm 51 and consequently the interchange of the work holder from arms 103 to yoke 86 will be accomplished above the rest position of the arm 51 as it is desirable to shift between arms 103 and yoke 86 through relative complementary movements interfitted and relatively shifting these parts to perform a smooth operation in lifting of the work holder by the yoke off the pins 103 or in the unloading operation lifting the hooks 104 by the pins 103 off the yoke 86.

#### The Elevator and Static Frame

The static frame 53 consists of longitudinal and transverse structural members 111 which rest upon the floor of a plant or the like in which the machine is employed. Upstanding from these structural members 111 are sup-

port risers 112. The vertical riser members 112 are spaced apart, as best seen in FIGURE 14. The structural risers 112 are secured to the transverse members 111 at their base and to an upper transverse tie member 113. Mounted on the tie member 113 are track members 114, channels 115 and angle iron caps 116. The base members 111, as shown in FIGURE 14, are broken away for purposes of illustration, but in the machine these members extend sufficient distances to each side of the members 112 to support treatment tanks or stations 55-64 in which the work to be treated is inserted.

Referring now to FIGURES 14 and 15, a cross section of the elevator 66 is seen in which a rectangular tube 66<sup>a</sup> has secured at each side thereof the work carrying arm trigger engaging or depressing members 65. The elevator 66 is mounted on guides 117. As illustrated, the end guides 117 carry sprockets 118 rotatably mounted thereon. As best seen in FIGURE 16, chains 119 are roved about the sprockets. One end of each chain 119 is secured to the static frame, as at 120, while the other end of the chain 119 passes over a sprocket 121 journalled in the static frame and is connected to counterweights 122, as at 123. These counterweights bias the elevator 66 to a normally raised or elevated position. This structure for biasing the elevator 66 to a normally raised position is identical at both ends of the machine.

Secured to the static frame 53 between a pair of spaced vertical risers 112 is a support 124 to which is secured a hydraulic cylinder 125 having a plunger or ram 126 operated thereby. The ram 126 has a drive head 127 connecting a clamp 128 which is connected to and reciprocates a rod 129. Elevator drive chains 130 are connected to the rod 129, as at 131, at one end and are connected at the other end to a T-shaped member 132 which is rigidly secured to the member 66<sup>a</sup> of the elevator 66. Reciprocation of the rod 129 to the right hand side of FIGURES 12 and 16 will pull the elevator 66 from the raised position, FIGURES 12 and 15, to the lowered position, FIGURES 13 and 14. FIGURE 16 shows the elevator in solid line in the down or lower position and the elevator in the raised position is shown in dotted line in this same figure. FIGURE 13 shows the structure of FIGURE 12 with the elevator in the lowered position.

#### *Work Carriage and Horizontal Traverse Mechanism*

Referring now to FIGURES 3, 17 and 18, it will be seen that the work carriage 52 consists of a pair of up-standing horizontally spaced-apart side walls 133, 134 having bearing members 135 at their top front portion and having bearing members 136 at their lower rear top portion. The bearing members 135 receive and journal the pivots 88 of the stabilizer links 87 while the bearing members 136 act as bearing supports for the fulcrum 83 of the carrier arm 51. Intermediate the flanges 133, 134 and joining the two is a stop plate 137. The bottom portion of the flanges 133, 134 are connected to a base 138 which is provided with roller bearing members 139 journalling rollers 140 which ride upon the top of the track members 114 and which are connected to the channel members 115 and supported upon the tie members 113, as best seen in FIGURES 14, 15, 3 and 18.

The bottom or lower portion of the base 138 of the carriage 52 has journalled therein a roller 141 which rides against the side of track 114 carried by the static frame 53. The inside top of the base 138 journals a roller 142, which roller rides against and along the inside flange 116<sup>a</sup> of the angle iron cap 116 carried and secured to the top of the inturned channel members 115. The carriage is supported upon and rolls along the static frame on the three rollers 140, 141 and 142. The rollers 141 act in a direction inwardly of the center of the static frame whereas the rollers 142 bear in a direction outwardly of the static frame. The rollers 140 carry the vertical thrust component of the carriage 52. It will

be noted that there are two of the rollers 140 for each carriage and only one of the rollers 141 and 142 for each carriage.

The plate 137 joining the two upstanding flanges 133 and 134 of the carriage carry a limit stop 143 which co-operates with a threaded adjusting bolt 144 carried by the arm 51. A locking nut 154 is provided on the adjusting bolt 144.

As shown in FIGURE 3 in the dotted line position, the lowest point of the yoke 86 may be slightly varied by adjusting the bolt 144 against the stop 143. This may be employed as a vernier setting of height adjustment of the yoke 86 with respect to the treatment station.

When the carriage is employed in connection with electroplating or other electro processing wherein a current must be carried by the carriage from the static frame 53 down to the yoke 86, the following will be necessary. The downturned flange 116<sup>a</sup> on the static frame will have secured to its outside surface insulating material 116<sup>b</sup> upon which will be mounted or otherwise secured a cathode or bipolar conductor 116<sup>c</sup>. Current from this conductor 116<sup>c</sup> is picked up when the arm 51 is in the lowered position by contact shoes 146 being resiliently pressed in electrical contacting engagement with the conductor 116<sup>c</sup>. The current then travels from a plate 51<sup>b</sup> down the arm 51 across a pigtail connection 148 to the work carrying lever 35 onto the yoke 86. When this carriage and arm are to be electrified, it will be appreciated by those skilled in the art that insulating material 147 will be employed between the outer portion of the arm 51 and the inner portion 51<sup>a</sup> as well as washers and insulated bearings about the pivots 88 of the stabilizer links 87 to insulate the grounded portion of the carriage frame from the electrified portion.

Referring now to FIGURES 7, 12 and 19 through 21, inclusive, the static frame 53 has journalled about vertical axes therein a pair of sprockets 149 at opposite ends of the frame, best seen in FIGURE 12, over which sprockets is trained an endless horizontal traverse link chain 150 which consists of links joined by pivot shafts 151. The chain 150 receives its horizontal motion from a dog or pawl 155 which is pivoted at 156 to a slide member 154 which is reciprocated by a hydraulic cylinder 153. The pawl 155 has a sloping shoulder 155<sup>a</sup> which, when thrust in a direction opposite to the desired direction of advance of the carriage 52 horizontally along the static frame 53, will rotate about the pivot 156 to clear the driving tooth from engagement with the pivot links 151 of the chain 150.

As best seen in FIGURE 19, the pawl 155 has completed advancement of the chain 150 in a direction to the right hand side of this figure. Upon reversing reciprocation of the drive rod 154, the pawl will rotate out of engagement with the chain 150 until a tailpiece 157 of the pawl 155 engages a limit stop 158 carried by the static frame, at which time the limit stop 158 causes the pawl to rotate about the pivot 156 to assume the dotted line position shown in FIGURE 21 and to again ready itself for engagement with the pivots 151 to upon signal and receipt of hydraulic fluid to the cylinder 153, the rod 154 will then drive to the right in FIGURE 19 compelling the dog to engage the chain and move the chain a horizontal distance of one treatment station.

The carriages are joined or connected to the horizontal traverse drive chain 150, as best seen in FIGURE 18, by inserting the pivot shafts 151 of the drive chain through openings 152 in the base of the carriage casting and pinning the same in place. The carriage 52 is connected to the drive chain 150 at each side thereof, i.e., two positive driving connections between each carriage 52 and the horizontal traverse chain 150.

#### *Vertical Oscillation Mechanism*

Referring more particularly to FIGURE 22, 159 represents a vibratory bar having a downturned end 159<sup>a</sup>,

such bar being affixed to the upper ends of rods 160 movably mounted through sleeves 161 welded or otherwise affixed to the static frame 53.

Shoes 162 on the lower ends of the rods ride on the surface of an eccentric shaft 163 journalled horizontally in bearings 164 mounted to the static frame. A sprocket 165 affixed to the shaft 163 is engaged and driven by a chain 166 receiving its motion from a second sprocket 167 driven by a gear reducer 168 on the frame coupled through a flexible coupling 169 to a motor 170 also carried by the static frame 53.

In operation the circuit is closed through the motor 170 to energize the mechanism whereby the eccentric shaft 163 is driven at an appropriate r.p.m. In so doing, the rods 160 will be given an up and down motion communicating to the horizontal or longitudinal bar 159 and its portion 159<sup>a</sup> a rapid vibration.

A two-inch stroke thirty times a minute has been found satisfactory to cause the device to vibrate gas bubbles from the work inasmuch as the work carrying arms 51 are shown to rest upon the bar 159 and to slide down the slight inclination by gravity on which the end 159<sup>a</sup> of the bar is turned. Only certain sections and stations or portions thereof will require this vibration, but the bar 159 may be made of any desired length and located at desirable points throughout the loop.

#### *Cyclic Control of the Latching Devices*

Referring now to FIGURES 1, 8, 18 and 23 through 28, when it is desired to retain certain selected ones of the carrier arms 51 in elevated position, i.e., to withhold the work on that particular arm from being lowered at a particular station, upon raising of the elevator, the latching device of FIGURE 8 may be employed. The latch 79 is actuated between the solid and dotted line positions of FIGURE 8 by a hydraulic unit 82 which is under the control of an electrical solenoid 171. The solenoid 171 is under the control of a limit switch 172 carried by the static frame 53. When it is desired to control the cycle with the carriage 52, the unit illustrated in FIGURE 18 may be employed. This unit consists of a shaft 183 journalled in a U-shaped member 174 which is secured to one side of the carriage 52. The shaft 172 has a selector knob 175 at the outer end. The end of the shaft 173 extending inwardly of the machine beyond the carriage 52 has a plurality of signal flags 176 which are variably spaced axially along the shaft 173 as well as circumferentially thereabout. When it is desired, for example, to leave the arm 51 in the elevated position at treatment station 57, FIGURE 2, the limit switch 172 has its wand 177 set at a particular distance toward the carriage, for instance, as shown in FIGURE 24; whereby upon horizontal traverse of the carriage 52 to a point where at station 57 the C flag 176 engages the wand 177 of the limit switch 172 which will actuate the solenoid 171 controlling the hydraulic cylinder 82 at that station causing the latch 79 to assume the solid line position of FIGURE 8 and to thereby seat behind the shoulder 81 of the trigger portion 51<sup>a</sup> of the work carrier arm 51 elevated at station 57. This positioning of the latch 79 will retain the arm 51 at station 57 in the elevated position until released by the next down cycle of the elevator 66.

It will be appreciated from FIGURES 18 and 24 that particular stations may be skipped or omitted by selected work carrying arms 51 dependent upon the setting of the knob 175 on the carriage 52, the number of flags on shaft 173 and the number of limit switches on the static frame 53 positioned to be engaged by the flags.

Another form of control for the latch devices is illustrated in FIGURES 1, 8 and 23 wherein the work holders 165 are provided with index tabs 178 having signal flags 179 at different vertical elevations thereon. In the form shown in FIGURE 23 the signal flag for operating a limit switch is shown in solid lines at 179 while other flags for

different carriers are shown in dotted line. When the carriage 52 moves the arm 51 to a selected station, at which point it is desired to withhold the arm 51 from lowering its work into that particular treatment station and the work holder 165 has the flag shown in FIGURE 23, this flag 179 will actuate the wand 180 of a limit switch 181 which is carried by an outer portion of the static frame 53<sup>a</sup>, as best seen in FIGURE 1. Actuation of this limit switch 181 has an effect similar to that heretofore described for the actuation of the solenoid 171 which controlled the hydraulic cylinder 82 for bringing the latching device 79 into restraining engagement with the shoulder 81 on the trigger portion 51<sup>a</sup> of the selected work carrying arm 51.

A machine as herein illustrated and described may employ either or both of the signal control systems for the latch devices as just described. The machine may be equipped with any desired number of signal flags and limit switches with wands of varying length to cooperate with the desired signal flag.

As best seen in FIGURE 25, a carrier actuated elevator start limit switch 182 is secured to the angle iron cap 116 on the static frame 53 with its wand 183 positioned to be engaged by the carriage 52 to start elevation of the elevator 66 when the carriage 52 has completed its horizontal travel.

FIGURE 26 illustrates the elevator control limit switch arrangement in which limit switch 183 is the elevator up limit switch, while limit switch 184 is the elevator down limit switch. Both switches 183 and 184 are secured to the risers 112 of the static frame 53 and are positioned to be engaged by projections 185 on the elevator guide 117 to control the uppermost and lowermost positions of drive of the elevator 66.

FIGURE 27 shows the horizontal traverse limit switch 187 positioned with its wand 188 to be engaged by the drive rod 154 when the traverse chain drive has completed a full driving stroke to return the rod 154 and its drive pawl 155 to a potential drive stroke position shown in dotted lines at the left-hand end of FIGURE 19.

In the form of machine illustrated where all motions are hydraulically actuated, that is, elevator drive, horizontal traverse, work carrying arm latches and delayed set down, it will be appreciated that, as shown in the hydraulic schematic, the hydraulic valve controlling the actuation is under the control of a solenoid, as for example 171, which is in circuit under the electrical control of the limit switches described above.

As shown in FIGURE 9, the latch means 79<sup>a</sup> may be placed into operating position, shown in solid line, or non-operating position, shown in dotted line, manually and will be retained in appropriate position by a leaf spring 79<sup>b</sup>.

The general arrangement of apparatus herein illustrated can best be seen in FIGURE 28 in which the monorail 109 which feeds work to be treated and carries away treated work is shown positioned adjacent the loader 97 with respect to the elevator 66 and static frame 53. A limit switch 186 is shown in this figure for controlling the advancement of the monorail feed, which switch is actuated upon the transfer of work onto and off of the monorail by the loader 97. Limit switches 181<sup>a</sup>, 181<sup>b</sup> are shown in position at stations 55, 56 and 57, respectively, to be actuated by the tabs on work carriers brought into these stations, which results in latching the arms 51 above the treatment tanks when the elevator 66 is in the raised position. Limit switches 172, 172<sup>a</sup> and 172<sup>b</sup> are shown in position to be actuated by the flags 176 of the carriage control form of the invention, FIGURE 24, at tanks 58, 59 and 60, respectively.

When it is desired to hold several arms 51 elevated above one or more treatment stations, the depressor bar 65 is provided with an opening 70 of the desired length, which opening is filled when the elevator is in the lower position by a fixed rail section 79<sup>b</sup>, best seen in FIGURE

9A, which is secured on the static frame 53 so that the rollers 69 of the trigger portions 51<sup>a</sup> of the work carrying arms 51 will roll smoothly from the depressor bars 65 of the elevator 66 against the underside of the fixed rail section 79<sup>b</sup> carried by the static frame 53 when the elevator 66 is in the lowered or down position.

#### Hydraulic Power

The machine as best seen in FIGURES 29 and 30 is provided with a hydraulic reservoir 190 having a main supply line 191 which is pressurized by a pump 192 driven by a motor 193. The line 191 supplies pressure fluid for actuating all the hydraulic drive cylinders. Each drive cylinder is of the solenoid control type whereby the solenoid is under the control of an electrical limit switch. Each hydraulic control valve is connected to a tank return line 194 for returning dumped fluid to the reservoir 190.

#### Delayed Set Down

Referring now to FIGURES 16 and 31, the delayed set down mechanism as illustrated consists of a delayed set down cylinder 195 mounted in the static frame 53, as seen in FIGURE 31, and has extending above it a delayed set down drive rod 196, the upper end of which is connected to drive a delayed set down gate 198. This gate 198 fills an opening in the depressor bar 65 at whatever station it is desired to insert the delayed set down mechanism. This mechanism may be employed at any station along the machine where it is desired to lower the work at a later point in time than companion work or to pick work up in advance of the other work, i.e., prior to the lowering of the elevator. The delayed set down gate 198 rides on guides 197. The delayed set down cylinder 195 is shown in the hydraulic circuit, FIGURE 29, as being controlled by a solenoid actuated valve 199, the solenoid of which has in circuit therewith a timer for controlling the point in a treatment cycle when the delayed set down mechanism will be employed either as a delayed set down or an advanced pickup.

#### Machine Control Circuitry

Referring now to FIGURES 32 through 35, inclusive, the manual operation of the electrical system of the machine will first be described. The hand automatic selector switch 200 is placed in the automatic position and the pump start button 201 is pressed. This will energize the pump starter and cause the pump light 202 to come on. Before turning the hand automatic selector switch to hand position, the traverse forward-off-down switch 203 and the work up-off-down jog selector switch 204 are turned to the off or center position. The hand-auto selector switch 200 is then turned to the hand position. The work motion is then selected, either up or down or the traverse motion forward and its return are selected as desired. However, the motions should be selected in normal sequence in operation to prevent mechanical jams. The normal sequence of operation is first, elevator down (work up); second traverse forward; third, elevator up (work down), and fourth, traverse return. In order to prevent elevator cylinder 125 or traverse cylinder 153 drift, the elevator selector switch 204 should be left in the up position during forward traverse. When all manual motions are complete the selector switches should be returned to the neutral or center position. It is important to note that any time the machine is not in automatic operation and the hand auto selector switch 200 is turned to the hand position, that the control panel is automatically clear (except for the latch release for retaining work carrying arms in the elevated position). This means that before automatic operation can be resumed, the machine operator must return the machine back to its normal starting position (elevator 66 up and traverse cylinder 153 returned to its drive engaging position).

In both manual and automatic operation the following

interlocks are provided. The work up solenoid 205 cannot be energized unless the traverse cylinder 153 is in the return position or unless the work is already up.

The work down solenoid 206 cannot be energized unless the traverse forward stop limit switch is actuated or unless the work is already down. The traverse forward solenoid 207 cannot be energized unless the work up (elevator down limit switch) limit switch 184 is actuated or unless the traverse forward stop limit switch 187 is actuated.

The traverse return solenoid, FIGURE 29, cannot be actuated unless the work down limit switch 183 is actuated or unless the traverse return limit switch 187 is actuated.

To advance the monorail off the monorail stop limit switch 186, the monorail forward push button 208 is depressed. The monorail 109 will advance as long as this button is held in the closed position. To move the monorail to a stop position, the monorail stop button 209 is depressed. The monorail will advance until the monorail stop limit switch 186 is actuated. In manual operation and in automatic operation, the monorail cannot advance unless the elevator 66 is up (the work being down). Also provided is a monorail off-on selector switch 210.

For automatic operation the machine is set up as follows. The main line power switch is thrown to the on position energizing the 200 volt, three phase, 60 cycle bus shown at the top of FIGURE 33. This provides the current and voltage necessary for a transformer 211 which provides a low voltage (110-60 cycle) signal system out of its secondary, while the main motors such as the pump motor 193, vertical oscillating motor 170 and the monorail drive motor 212 are driven by the higher line voltage. The hand auto selector switch 200 is turned to the automatic position and the hydraulic pump is started by depressing the pump start switch 201. The auxiliary equipment selector switches are turned to on or off position as desired. The machine is returned to the normal starting position with the elevator down 66 and the work carrying arms 51 up, and the elevator motor and traverse selector switches are turned to the neutral or center position. The hand-auto selector switch 200 is turned to the "on" position. The immersion timer 213, FIGURE 32, and the delayed set down timer 214, FIGURE 34, are set for the desired cycle. The cycle start button 215 is depressed and released, at which time the automatic light 216 will go on and automatic operation is in process.

The immersion timer 213 starts timing. The dump solenoid 217 is de-energized removing hydraulic pressure from all cylinders. The traverse return solenoid 218 is energized. The work down solenoid 206 is energized. When the immersion timer 213 times out, timer LR latch coil 219 is energized (if the traverse cylinder 153 is in the returned position). This causes the dump solenoid 217 to be energized providing hydraulic pressure for all cylinders. The work up solenoid 205 is energized and the work down solenoid 206 is de-energized. The elevator 66 moves downwardly in a direction to raise the work carrying arms 51 out of and above the treatment stations. The work down limit switch 183 is released and at the end of the work up travel, the work up limit switch 184 is tripped. This causes the traverse return solenoid 218 to be de-energized and the traverse forward solenoid 207 to be energized. The traverse cylinder 153 starts to move forward. The traverse return limit switch 220 is released. The traverse forward stop limit switch 221 is released. When the traverse forward stop limit switch 221 is released, the latch coil of traverse LR relay 222 is energized. At the end of the forward stroke the drive cylinder 153, the traverse forward stop limit switch 221 is tripped again. This causes the release coil of the timer LR219 to be energized. When timer LR219 is released, the work up solenoid 205 is de-energized and the work down solenoid 206 is energized causing the elevator 66 to move in a direction away from the static frame 63 to permit the work carrying arms 51 to descend into the treatment sta-

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tions. The elevator up limit switch 183 is released and when the elevator 66 reaches the end of its travel, the work down limit switch 183 is tripped. This causes the immersion timer 213 to start timing again. At the same time the traverse return solenoid 213 is energized causing the traverse cylinder 153 to move in the return direction. At the end of the return stroke, the traverse return limit switch 220 is tripped which energizes the release coil of traverse LR222 (FIGURE 34). This also causes the dump solenoid 217 to be de-energized which in turn removes all hydraulic pressure for the remainder of the dwell period. When the immersion timer 213 times out, the automatic cycle will repeat.

The monorail moves one index during each basic cycle of the machine. The sequence is as follows. If the monorail selector switch 223 is in the "on" position, the monorail will start to move forward as soon as the work is down (elevator up). As it moves forward, the monorail stop limit switch 186 is released which energizes the latch coil of the monorail LR224. At the end of the monorail index, the monorail limit switch 186 is tripped and the monorail motor 212 stops. If the monorail selector switch 223 is turned in the "on" position, the monorail must have completed one index before work can move up (elevator 66 to down position). During the automatic cycle the release coil of monorail LR224 is energized when the work is up (elevator down).

The delayed set down mechanism will operate as follows. During the dwell period the delayed set down work up solenoid 225 (FIGURE 34) is energized. The delayed set down timer 214 starts timing as soon as the work up limit switch 184 is released. When the delayed set down timer 214 times out, the delayed set down work up solenoid 225 is energized causing the delayed set down hydraulic cylinder 195 to move in the direction to bring the work into the treatment station. This can best be seen in FIGURE 31 wherein the delayed set down mechanism is shown descending from the dotted line position to the solid line position. When the immersion timer 213 times out, the delayed set down work down solenoid 225 is de-energized. This allows the delayed set down hydraulic cylinder 195 to move freely with the elevator during the elevator down travel. As soon as the work is up (elevator 66 down), the delayed set down work up solenoid 226 is energized again. The cycle repeats.

While we have described herein the best forms of the invention known to us at the present time, we reserve the right to all modifications falling within the scope of the following appended claims.

What is claimed is:

1. For use with a machine having treatment stations,
  - (a) a horizontal conveyor and elevating means,
  - (b) a work carrier and right line lift mechanism comprising a carriage adapted to be connected to and driven by said horizontal conveyor,
  - (c) a work carrying side arm pivoted proximate its inner end to said carriage and having its outer end movable toward and away from said treatment station,
  - (d) said work carrying arm having a portion proximate its pivoted inner end positioned to be engaged by said elevating means,
  - (e) work hanger means connected to the outer end of said arm, and
  - (f) conversion means connected between said work hanger means and said carriage to impart a substantially right line path of lift to the work hanger means upon arcuate elevation of the arm about its pivot incident to its being actuated by said elevating means.
2. For use with a treatment station adjacent a static frame and elevator means associated therewith,
  - (a) a right line lift side arm comprising a carriage adapted to be carried by said static frame,
  - (b) a side arm pivoted on said carriage for movement through a vertical plane,

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- (c) a major portion of said arm extending from its pivot toward the treatment station and a minor portion adapted to be engaged by said elevating means to elevate said arm about its pivot,
- (d) a work carrying member pivoted to the free end of the major portion of said side arm,
- (e) and a stabilizing link pivotally connected to said carriage and to said work carrying member,
- (f) said pivots on the carriage of said side arm and stabilizing link being fixed pivots while the pivots at the free end of said side arm between said side arm and said work carrying member and said work carrying member and said stabilizing member are movable through a vertical plane whereby work carried by the free end of said work carrying member is elevated at said treatment station through substantially a right line lift.
3. In an apparatus as claimed in claim 2 in which
  - (g) said work carrying arm and stabilizer link converge outwardly from the connection with the apparatus toward the work carrying lever and the pivotal connections of said work carrying arm and link with the apparatus and with said lever form vertices of a trapezium.
4. In an apparatus of the kind claimed in claim 2 characterized by the fact that
  - (g) the arm is biased by the work load to the lower position with the work in the treatment station,
  - (h) said arm freely engaging the elevating means whereby on upward elevating travel said arm will rise only under the restriction of the rate of elevating upward movement.
5. In an apparatus as claimed in claim 2 further comprising
  - (g) means for imposing horizontal traverse on the arm in which an elevator acts as a track along which a triggering means slides.
6. In an apparatus as claimed in claim 5 in which
  - (h) said elevating means is an elevator having at least one location a gap adapted to be vertically aligned with a trigger arm to permit elevator descent without elevating the corresponding work carrying arm,
  - (i) said elevator having a normally open gate, and
  - (j) means on the apparatus positioned to close the gate on the downward descent of the gate below the level of the trigger arm to complete the continuity of the elevator across the gap.
7. In an apparatus as claimed in claim 2 characterized by the fact that
  - (g) said elevating means is an elevator provided with a gap with which the minor portion of said side arm is adapted to vertically register, and
  - (h) a normally closed gate on the elevator bridging said gap and mounted to freely open on upward movement of the elevator to permit free passage of a trigger arm but on subsequent downward elevator travel to engage and depress said trigger arm.
8. In an apparatus as claimed in claim 2 further comprising
  - (g) adjustable latch means on the static frame positioned to engage in one position a portion of said side arm in its elevated position to hold the involved work carrying arm elevated.
9. In an apparatus as claimed in claim 3 characterized by the fact that
  - (h) in an upper position of the work carrying arm the same passes the vertex formed by the link with the apparatus and also crosses the link to convert the trapezium into substantially complementary triangles.
10. In an apparatus as claimed in claim 2 further comprising
  - (g) a load and unload mechanism connected to be driven by said elevator and positioned to transfer work to and from the work carrying arm.

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11. In an apparatus as claimed in claim 10 further comprising
  - (h) drive means for operating said load and unload mechanism operatively associated with said elevator.
12. In an apparatus as claimed in claim 11 in which
  - (i) said drive means comprises a work supply system, and
  - (j) a movable member movable between said system and said work carrying arm for transferring work to and from said system and work carrying arm.
13. In an apparatus as claimed in claim 12 in which
  - (k) said drive means includes means for creating a low velocity period in the movement of said member incident to its transfer association with said work carrying arm.
14. A work treating machine comprising
  - (a) a static frame including treatment stations,
  - (b) carriages mounted on said static frame for horizontal movement therealong,
  - (c) work carrying side arms pivoted to said carriages proximate their inner ends and having their outer ends directed toward treatment stations,
  - (d) elevating means positioned to engage said side arms proximate their pivoted inner ends to raise and lower said arms,
  - (e) said arms having portions proximate their pivots positioned to be engaged by said elevating means to elevate the outer ends of said arms from the treatment stations, and
  - (f) selective means carried by said elevator for omitting selective ones of said arms from being elevated from the treatment stations.
15. A machine as claimed in claim 14 further comprising
  - (g) work carrying arm elevating control means carried by said static frame and positioned to selectively engage a portion of said work carrying arms to retain the selected work carrying arms in the elevated position with the work raised clear of the treatment stations when the elevating means is out of contact with the work carrying arms.
16. For use with a work treating machine having treatment stations,
  - (a) a horizontal conveyor having work carriages thereon with work carrying arms pivoted thereto,
  - (b) said arms having inner elevating and lowering portions and outer work carrying and treatment station directed portions,
  - (c) an elevating means for moving said arms to a raised and lowered position,
  - (d) carrier arm elevating means engaging means carried by said elevating means positioned to engage portions of said arms upon lowering of said elevating means to raise the outer ends of said arms,
  - (e) gate means carried by said elevating means engaging means biased to an open position to by-pass an elevating and lowering portion of a carrier arm upon lowering of said elevator,
  - (f) gate means carried by said elevating means engaging means biased to a closed position to engage the elevating means portion of the arms upon lowering of the elevator, and
  - (g) control means positioned to engage selective ones of said gates to direct the gates to open and closed positions in accordance with the predetermined sequence of a treatment cycle whereby upon lowering of said elevating means selected arms will be raised from the treatment stations while others will remain in the stations for a given cycle of said elevating means movement.
17. For use with a work treating machine having treatment stations,
  - (a) a horizontal conveyor having work carriages thereon with work carrying arms pivoted thereto,

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- (b) said arms having inner trigger portions and outer work carrying and treatment station directed portions,
  - (c) an elevator comprising means for raising said elevator between an upper and lower position,
  - (d) carrying arm trigger engaging means carried by said elevator positioned to engage the trigger portions of said arms upon lowering of said elevator to raise the outer ends of said arms,
  - (e) gate means carried by said trigger engaging means biased to an open position to by-pass a trigger portion of a carrier arm upon lowering of said elevator, and
  - (f) control means positioned to engage selective ones of said gates to direct the gates to closed positions in accordance with the predetermined sequence of a treatment cycle whereby upon lowering of the elevator selected arms will be raised from the treatment stations while others will remain in the stations for a given cycle of elevator movement.
18. For use with a work treating machine having treatment stations,
  - (a) a horizontal conveyor having work carriages thereon with work carrying arms pivoted thereto,
  - (b) said arms having inner trigger portions and outer work carrying treatment station directed portions,
  - (c) an elevator movable between a raised and lowered position,
  - (d) carrying arm trigger engaging means carried by said elevator positioned to engage the trigger portions of said arms upon lowering of said elevator to raise the outer ends of said arms,
  - (e) gate means carried by said trigger engaging means biased to a closed position to engage the trigger portion of said arms upon lowering of the elevator, and
  - (f) control means positioned to engage selective ones of said gates to direct the gates to open positions in accordance with the predetermined sequence of a treatment cycle whereby upon lowering of the elevator selective arms will be raised from the treatment stations while others will remain in the stations for a given cycle of elevator movement.
19. A work treating machine comprising a static frame including treatment stations,
  - (a) an elevator mounted on said static frame for movement up and down on said frame,
  - (b) work carriages mounted on said static frame for horizontal movement therealong,
  - (c) traverse drive means on said static frame connected to intermittently advance said work carriages one station of horizontal travel along said treatment stations,
  - (d) work carrying arms pivoted to said work carriages for arcuate movement toward and away from the treatment stations,
  - (e) trigger means on said work carrying arms positioned to be engaged by said elevator upon lowering thereof to elevate the work carrying arms from the treatment stations, and
  - (f) selective means carried by said static frame positioned to engage and retain the trigger portions of carrying arms on work carriages advanced thereto by said horizontal traverse means for retaining selective ones of said arms in the elevated position above the treatment stations upon disengagement of said elevator with said trigger portions of said arms.
20. A work treating machine comprising a static frame including treatment stations,
  - (a) an elevator mounted on said static frame for movement up and down,
  - (b) work carriages mounted on said static frame for horizontal movement therealong,
  - (c) work carrying side arms pivoted to said work carriages proximate their inner ends and having their outer ends extending toward the treatment stations,

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- (d) said arms having portions extending beyond their pivotal connection to said work carriages adapted to receive work to be treated thereon,
  - (e) a loader positioned to receive work, and
  - (f) drive means between said loader and elevator 5 whereby movement of said elevator actuates said loader to feed a piece of work to and from one of said arms on a work carriage of said machine.
21. In a work treating machine,
- (a) a static frame including treatment stations, 10
  - (b) an elevator movable up and down in said frame,
  - (c) work carriages carried by said frame for movement horizontally therealong,
  - (d) work carrying arms pivoted to said work carriages having a portion of said arms extending inwardly of said pivot toward the elevator and positioned to be engaged by the elevator on downward movement thereof, 15
  - (e) said arms having work carrying portions extending toward the treatment stations, 20
  - (f) latching means carried by said static frame positioned to selectively engage predetermined ones of said inner portions of said work carrying arms to retain the work carrying arms in the elevated position when said elevator is removed from engagement with the inner portion of said arms, and 25
  - (g) signal means, one element of which is carried by said work carrier and another element of which is carried by said static frame for selecting certain ones of said latching means for retaining certain pre-selected ones of said work carrying arms in the elevated position when said elevator is removed from contact with the inner portions of said work carrying arms. 30

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22. In a work treating machine,
- (a) a static frame including treatment stations,
  - (b) an elevator movable up and down in said frame,
  - (c) work carriages carried by said frame for movement horizontally therealong,
  - (d) work carrying arms pivoted to said work carriers having portions of said arms extending inwardly of said pivot toward the elevator and positioned to be engaged by the elevator on downward movement thereof,
  - (e) said arms having work carrying portions extending toward the treatment stations,
  - (f) latching means carried by said static frame positioned to selectively engage predetermined ones of said inner portions of said work carrying arms to retain the work carrying arms in the elevated position when said elevator is removed from engagement with the inner portions of said arms, and
  - (g) signal means, one component of which is carried by the work rack carrying the work being treated in the treatment station and another component of which is carried by said static frame and which is connected to actuate pre-selected ones of said latching means for retaining pre-selected ones of said work carrying arms in the elevated position when said elevator is out of engagement with the inner portions of said work carrying arms.
23. An apparatus for electroplating as herein described and illustrated in the drawings.

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