Oct. 11, 1966 E. T. BARRINGER ETAL 3,278,409

ELECTROPLATING MACHINE

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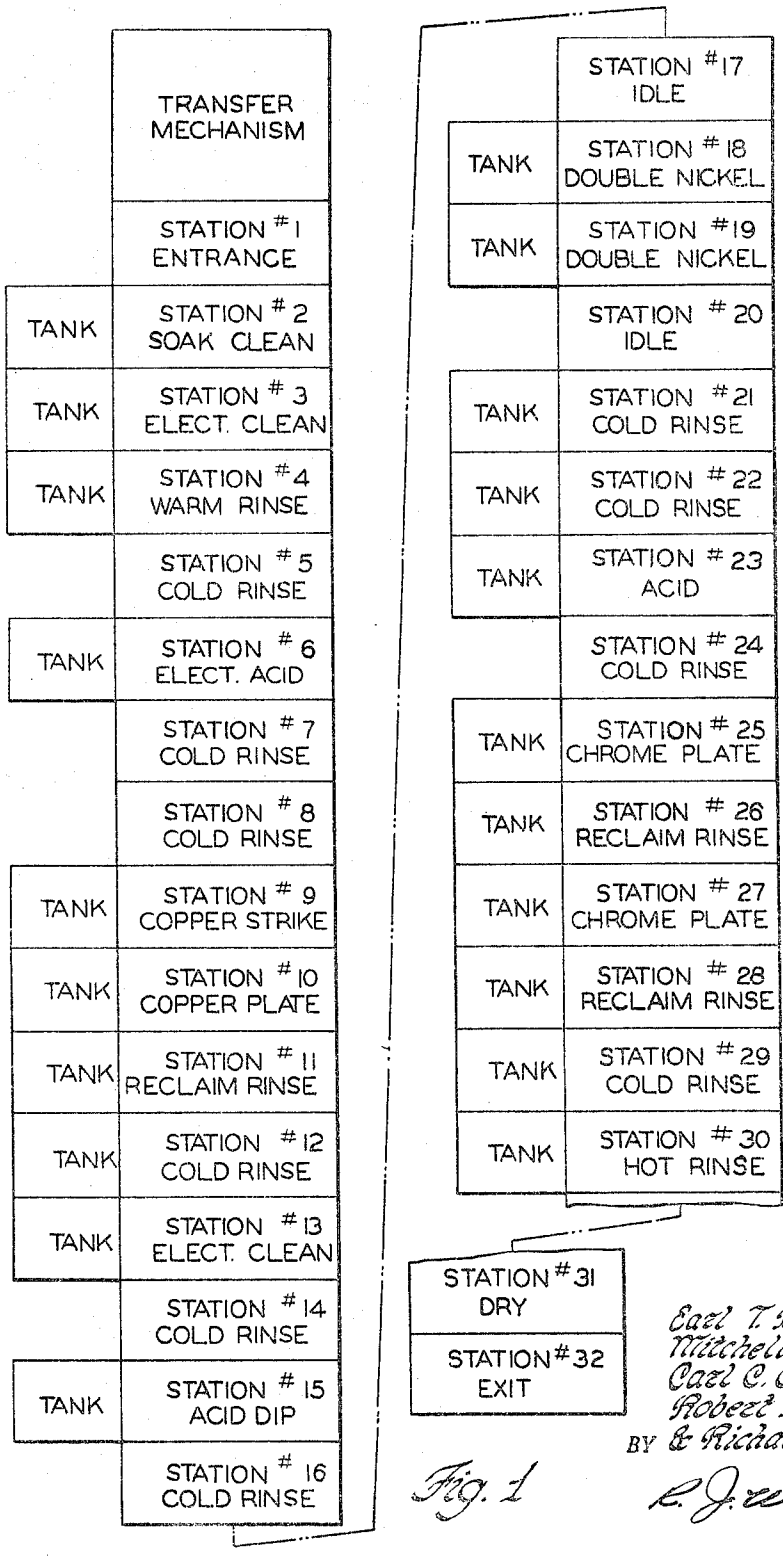


Fig. 1

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ELECTROPLATING MACHINE

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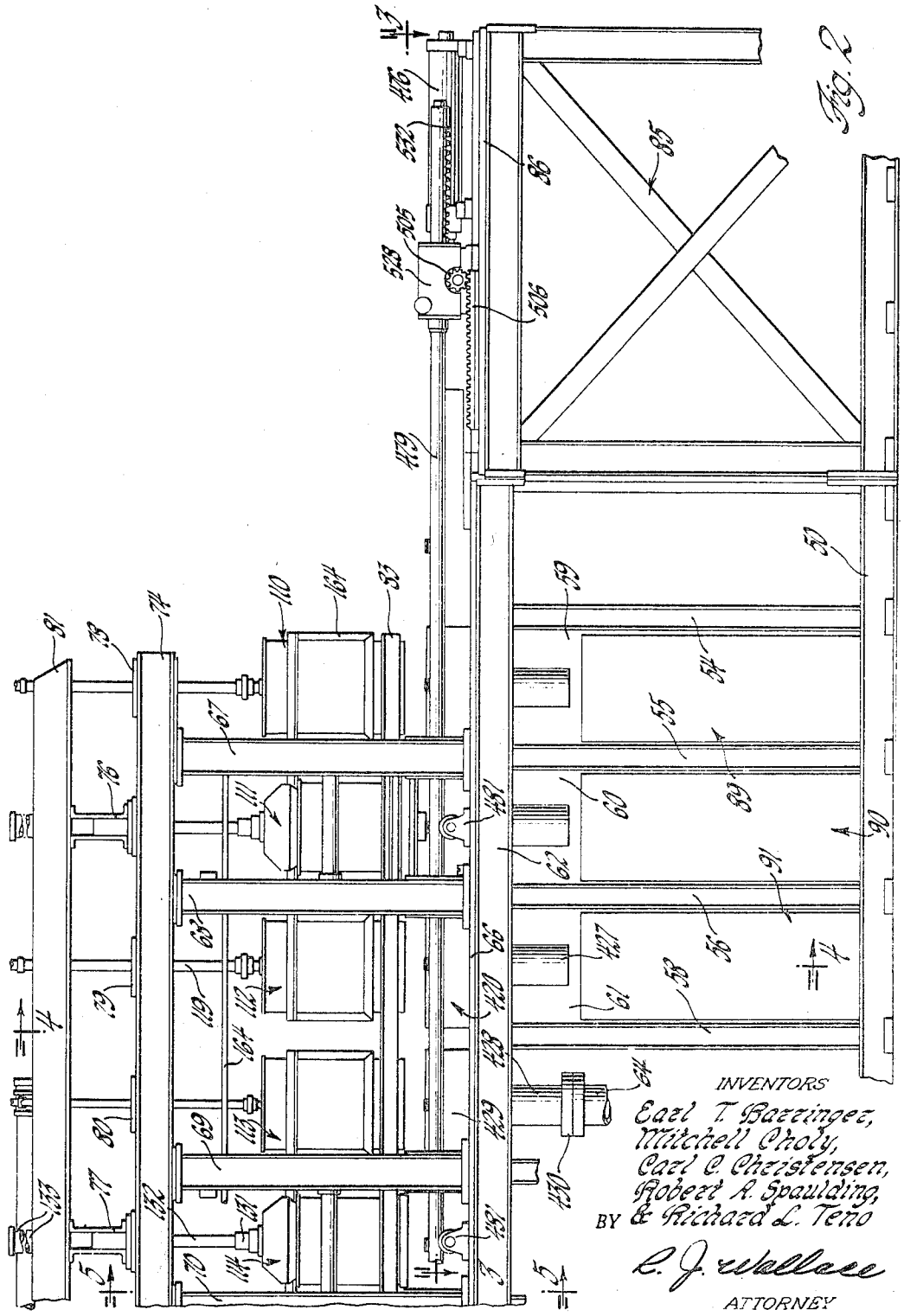


Fig. 2

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ELECTROPLATING MACHINE

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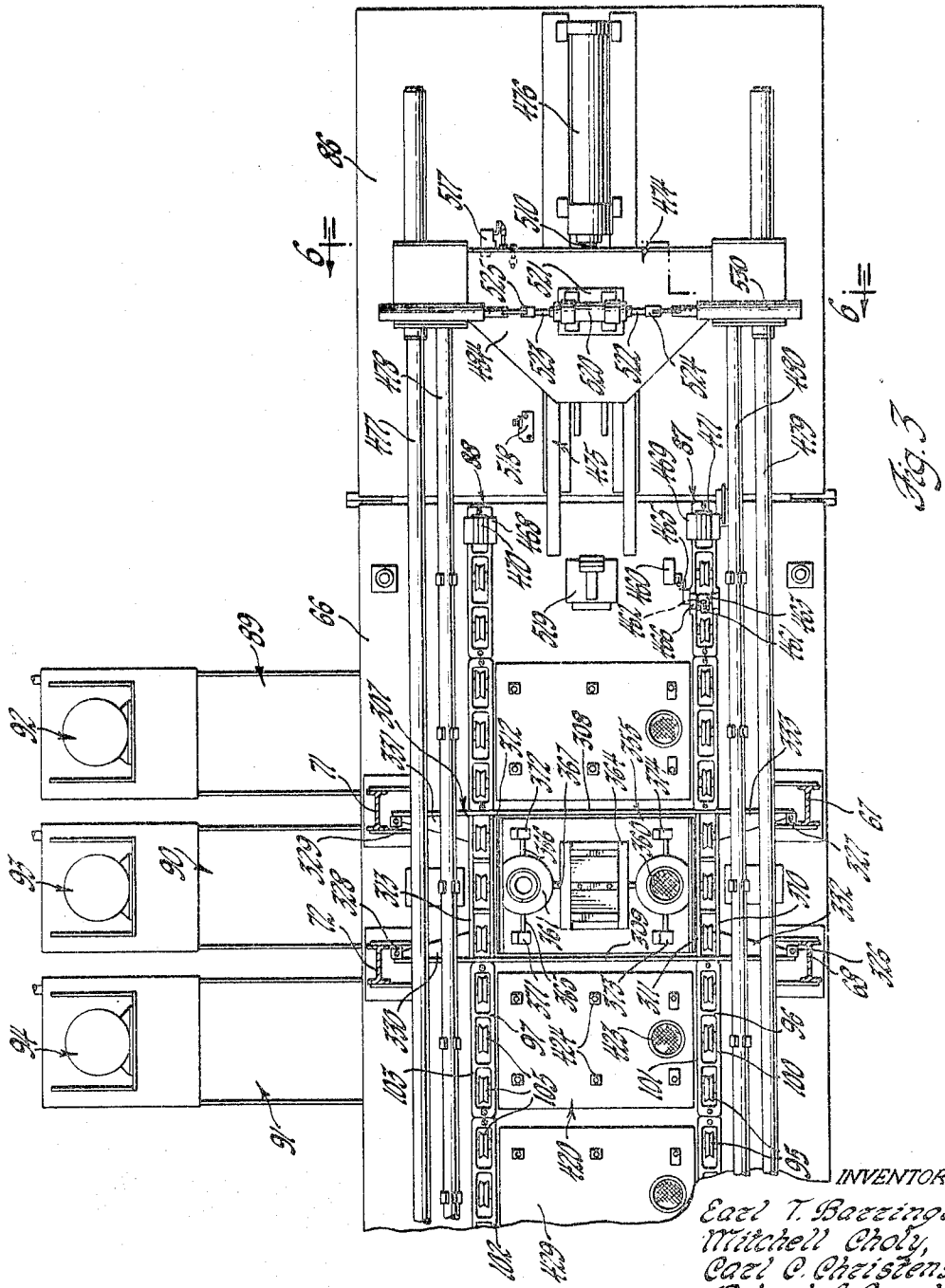


Fig. 1

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ELECTROPLATING MACHINE

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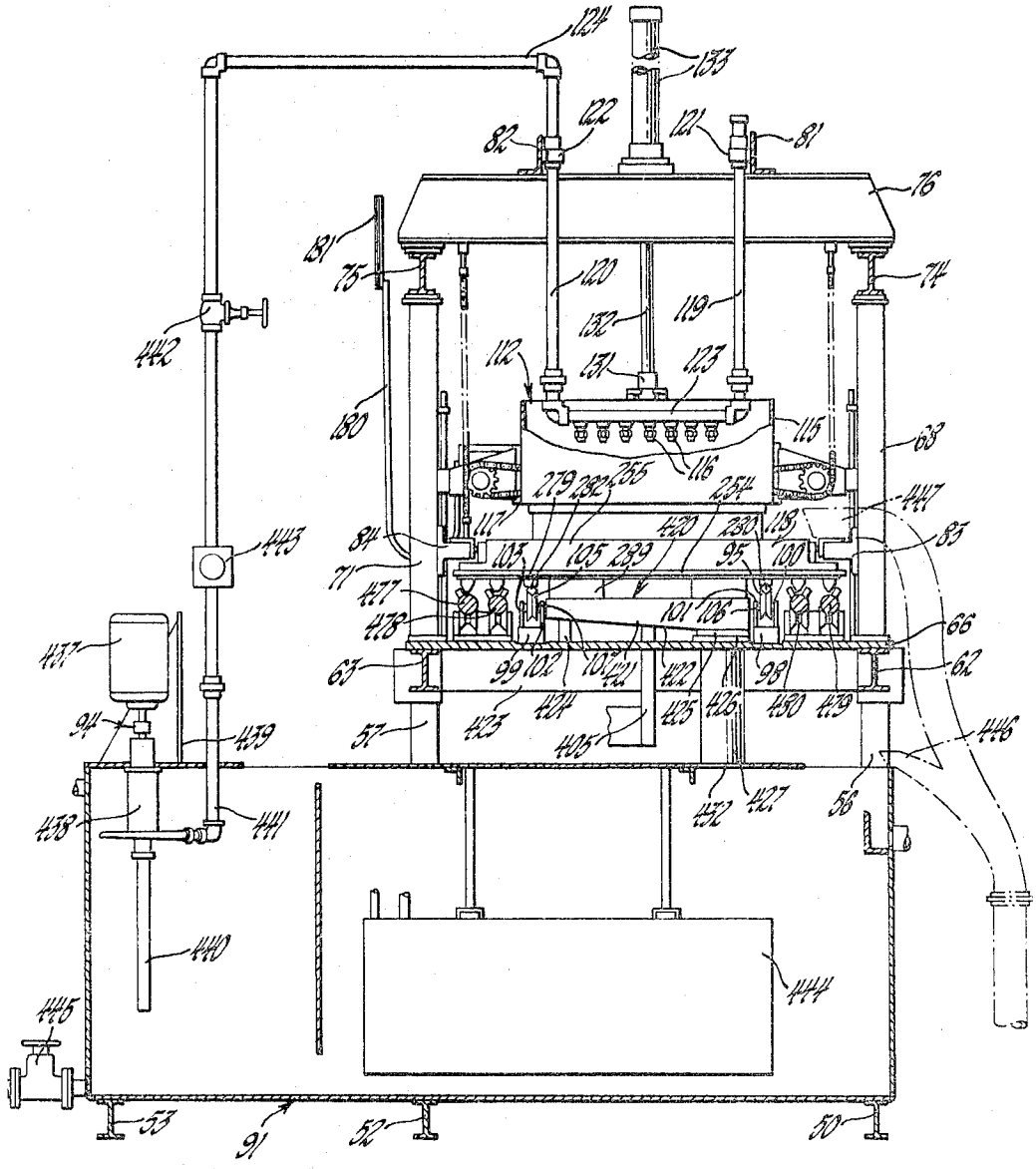


Fig. 4

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ELECTROPLATING MACHINE

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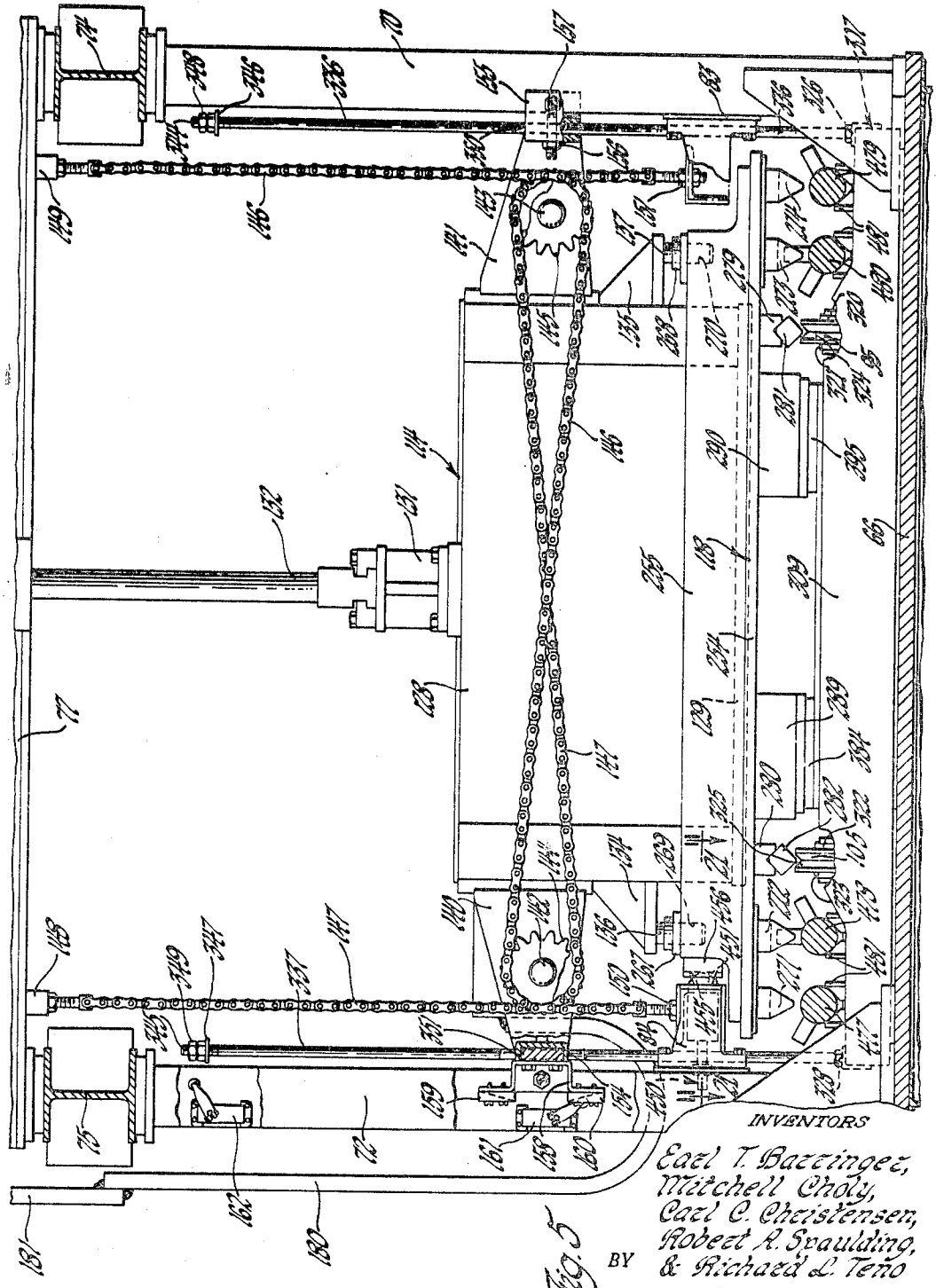


Fig. 5

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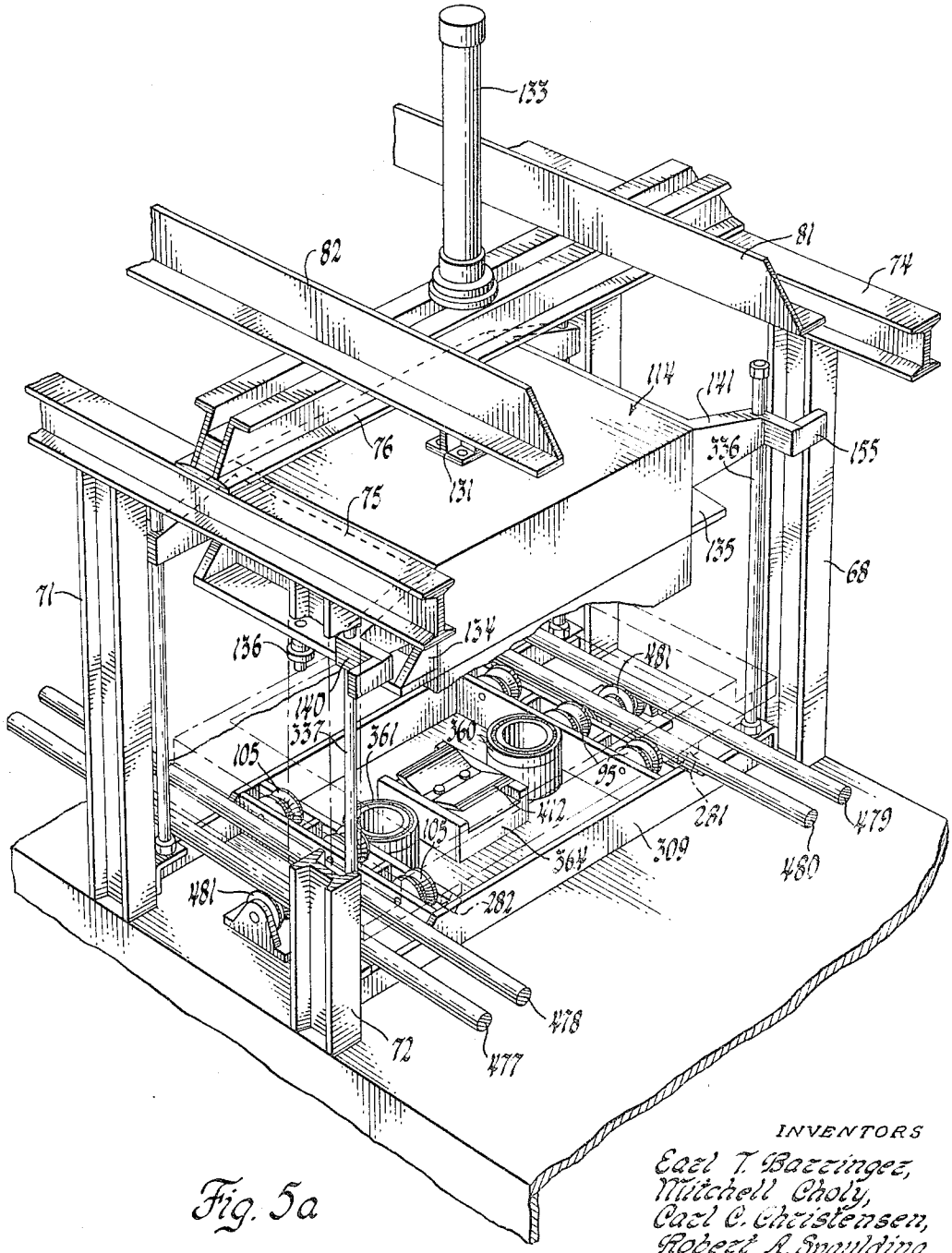


Fig. 5a

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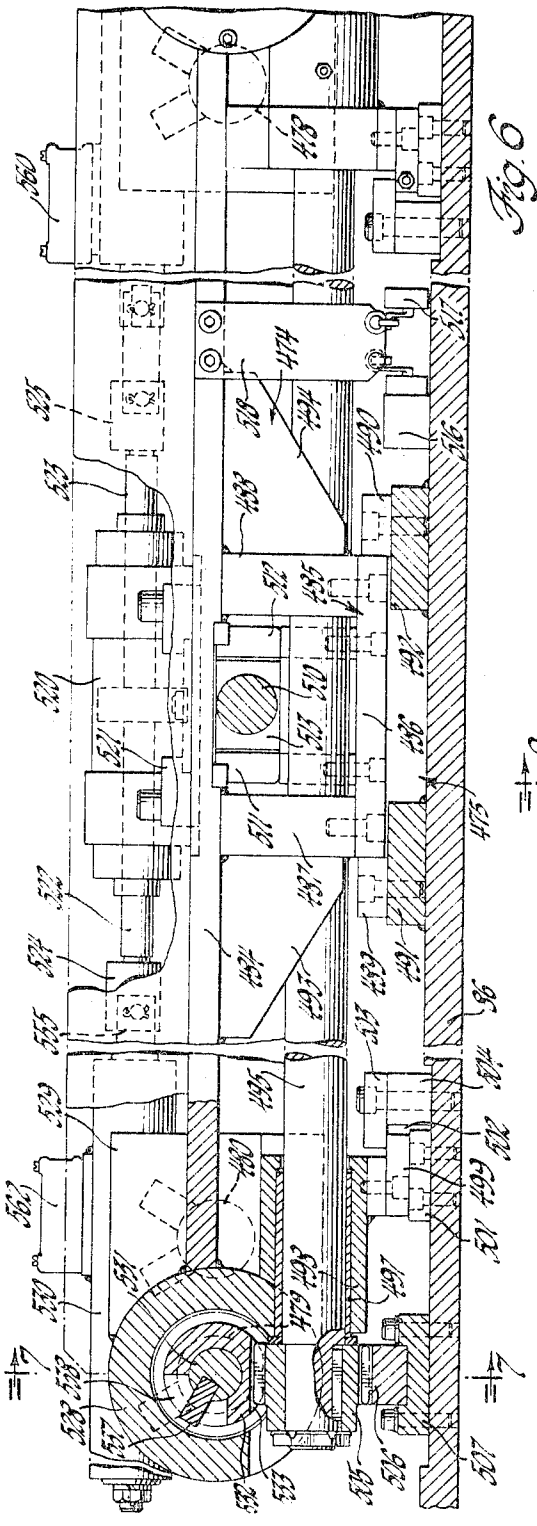


Fig. 6

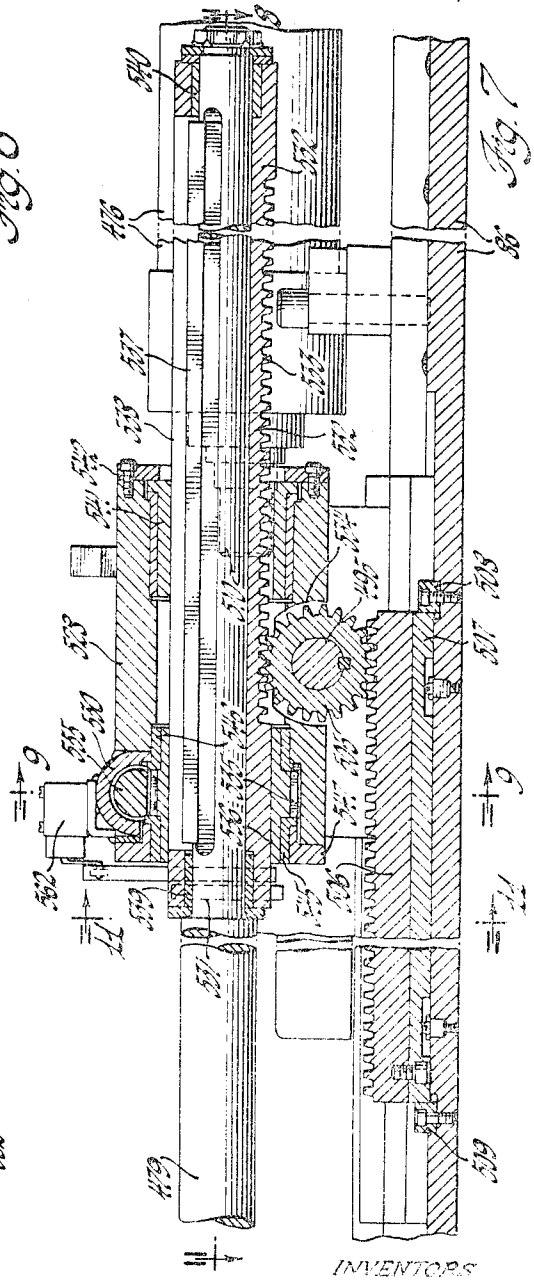


Fig. 7

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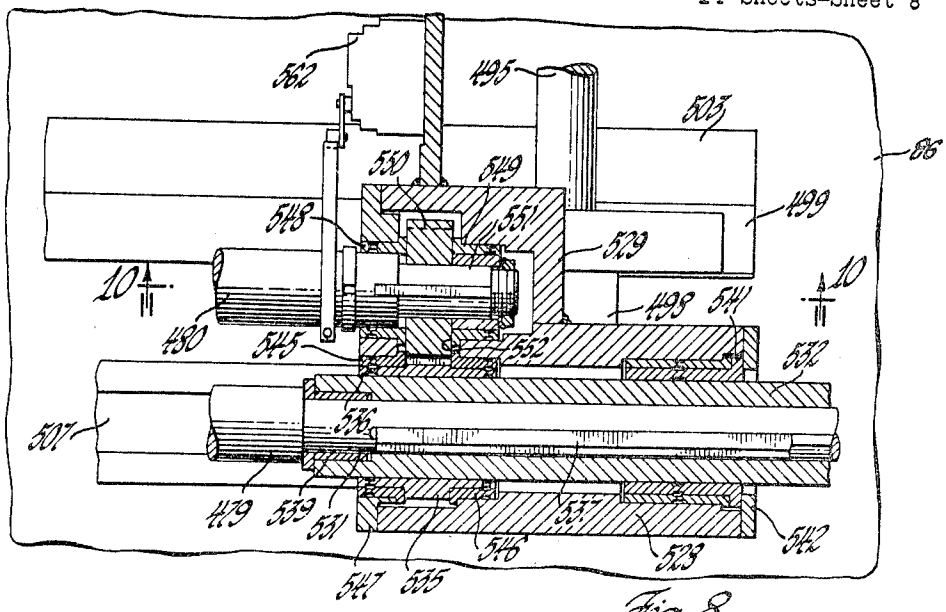


Fig. 8

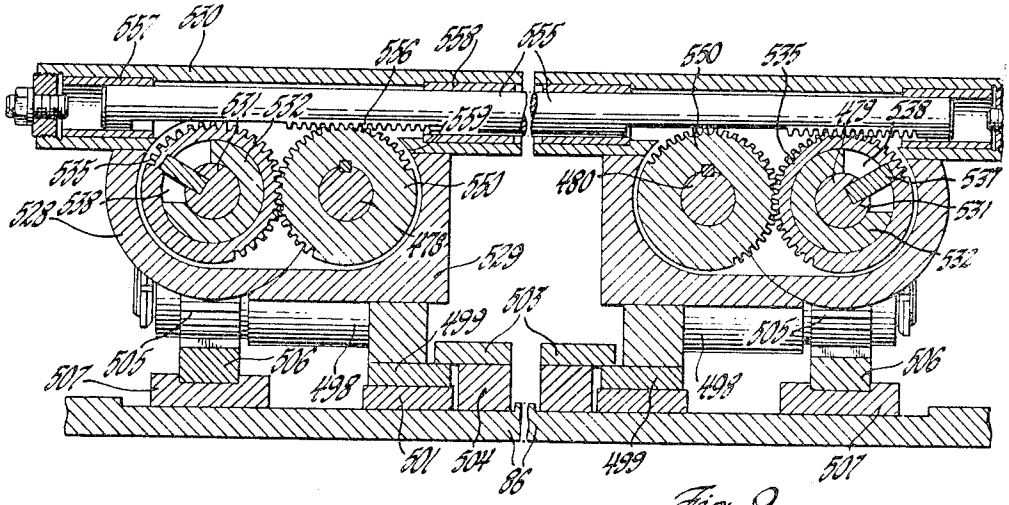


Fig. 9

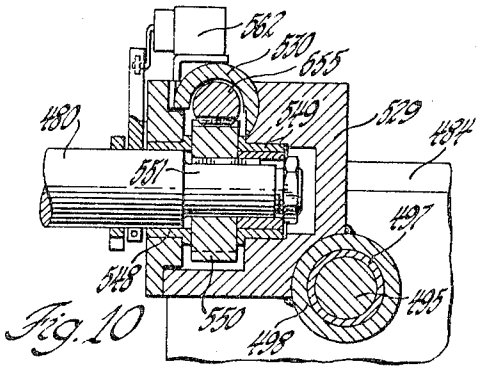


Fig. 10

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ELECTROPLATING MACHINE

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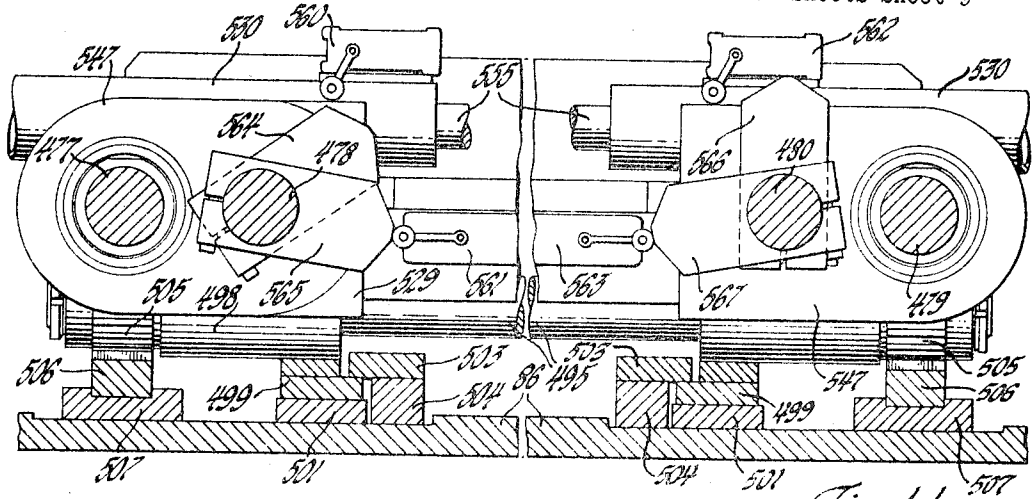


Fig. 11

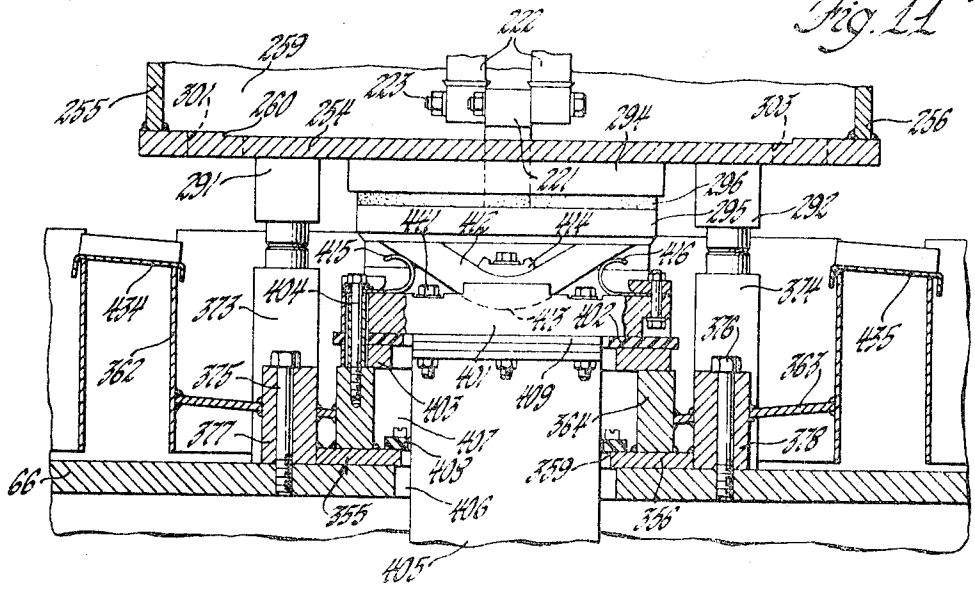


Fig. 12

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ELECTROPLATING MACHINE

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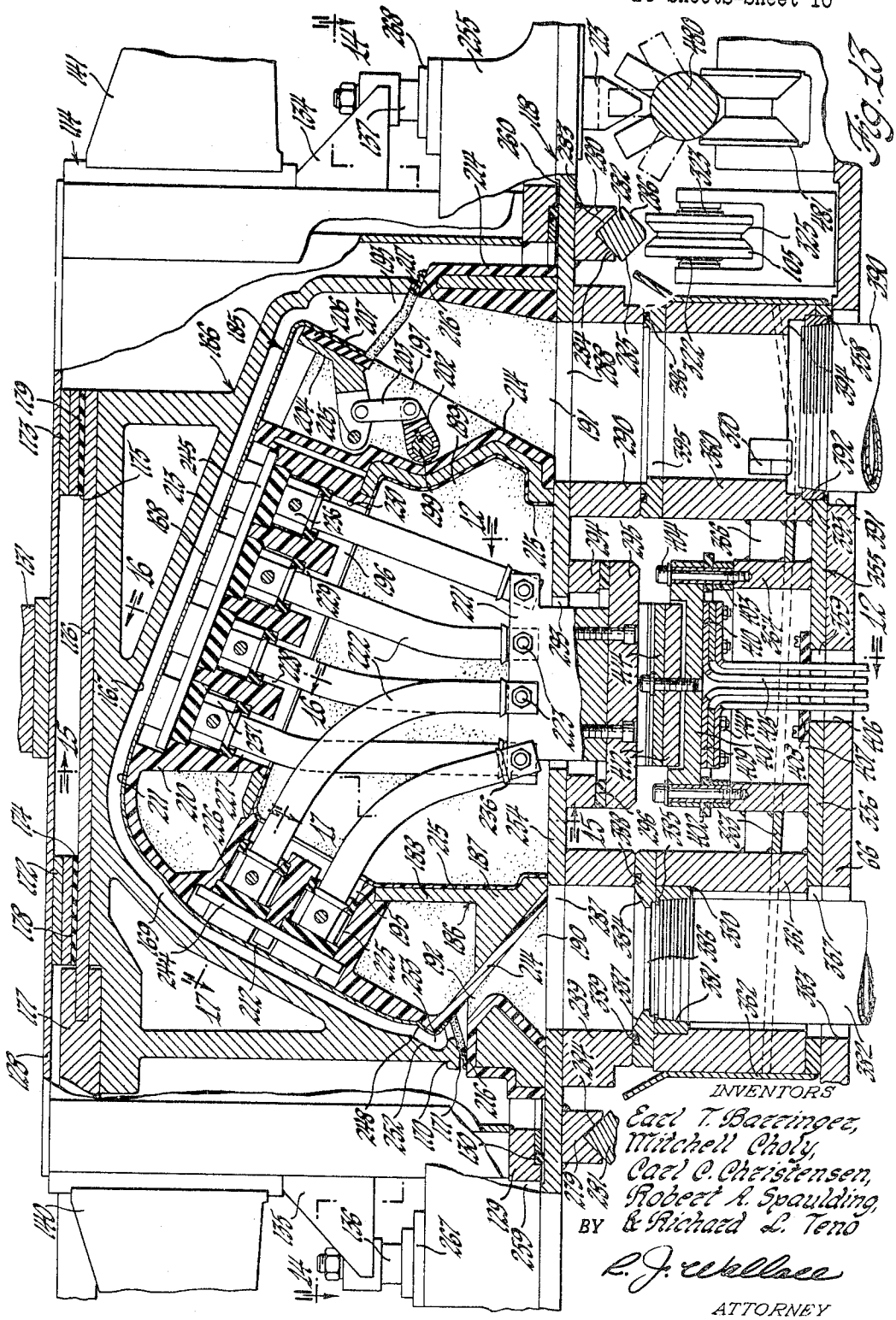


Fig. 27

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ELECTROPLATING MACHINE

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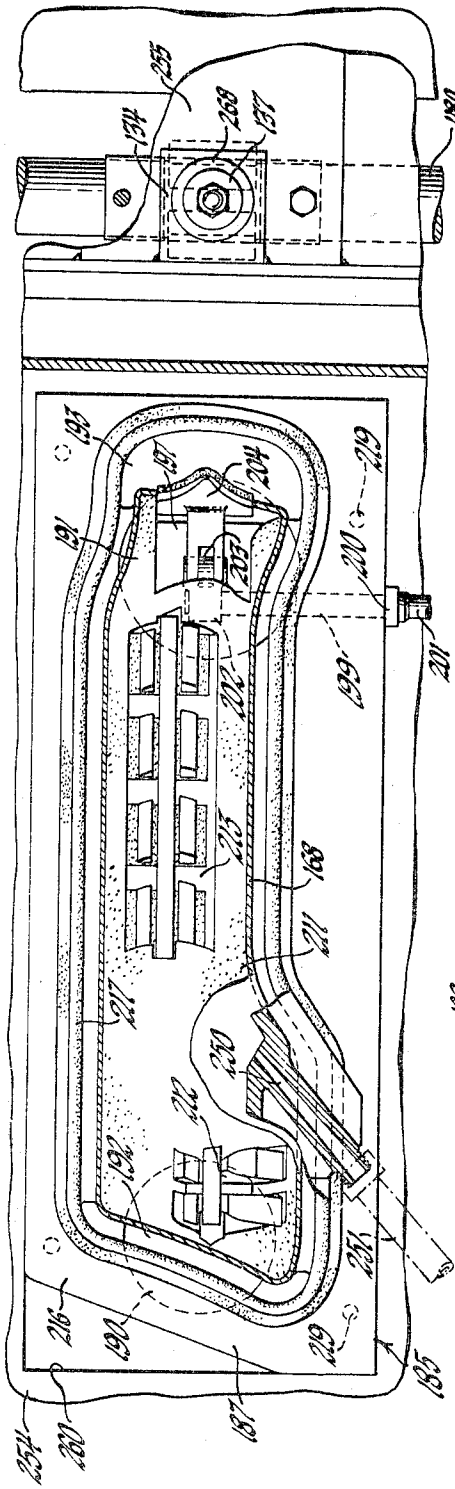


Fig. 14

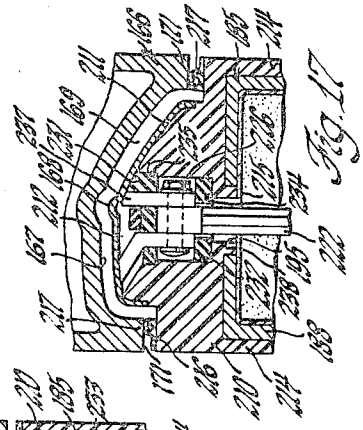


Fig. 17

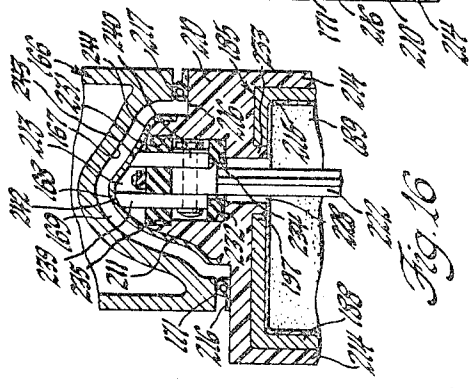


Fig. 16

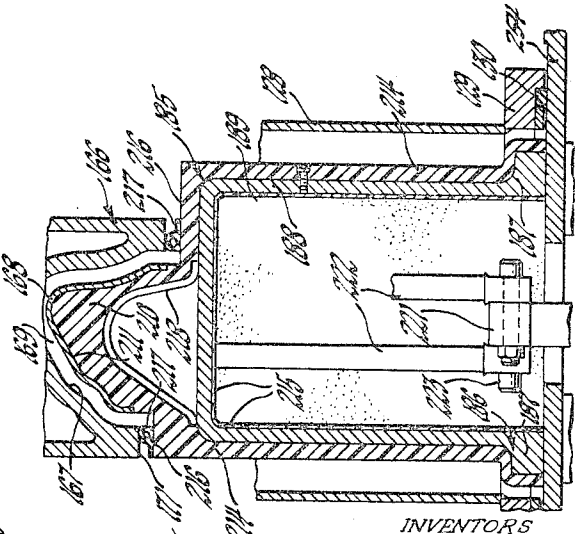


Fig. 15

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ELECTROPLATING MACHINE

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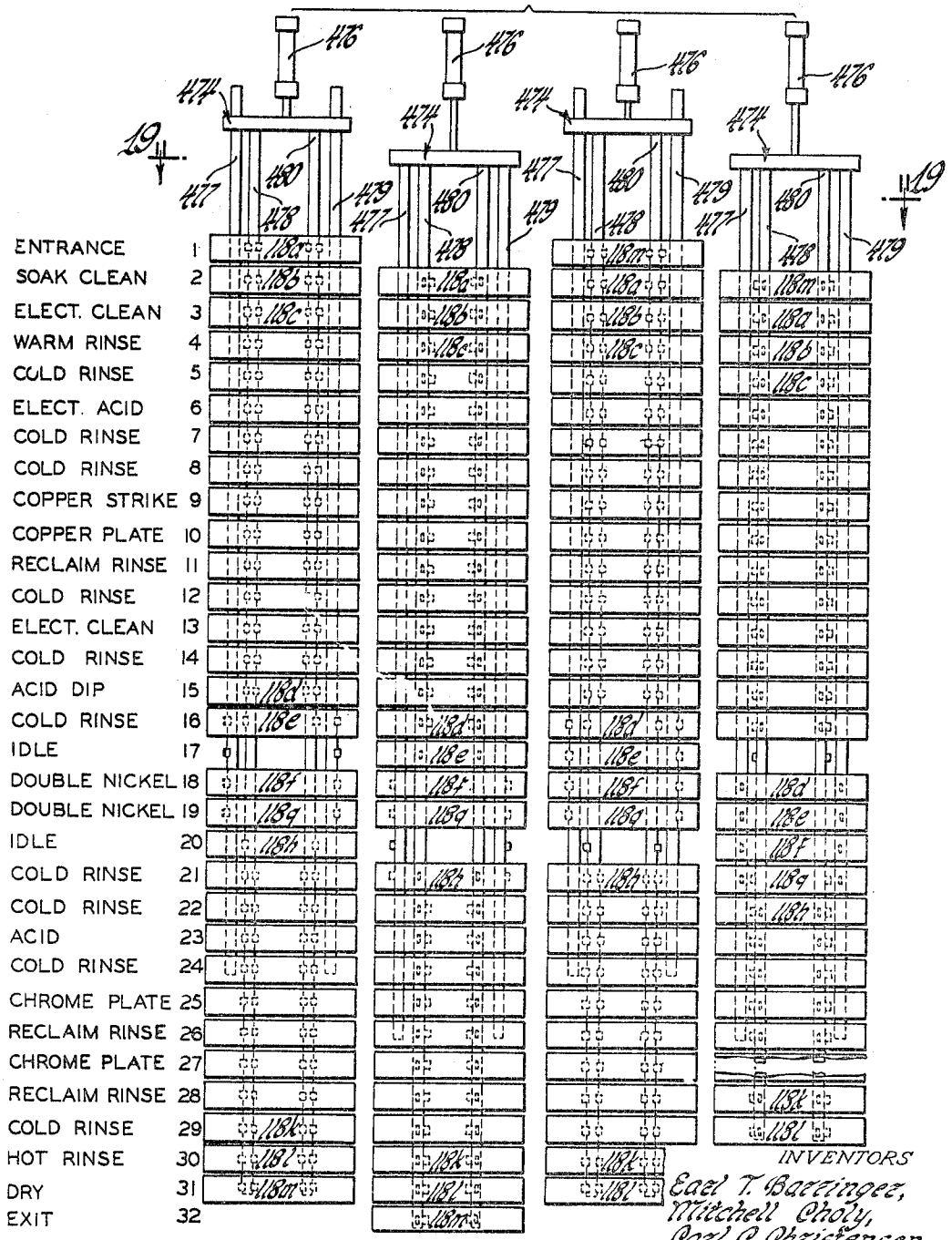


Fig. 18

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ELECTROPLATING MACHINE

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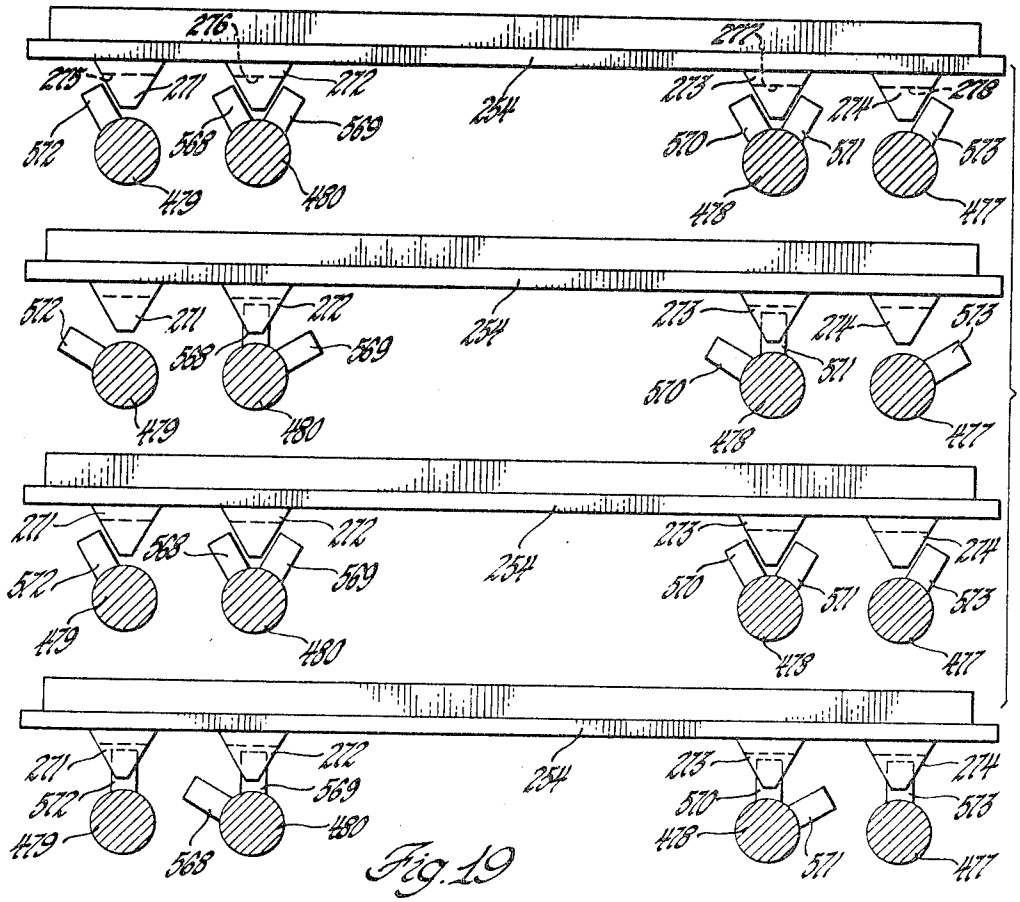


Fig. 19

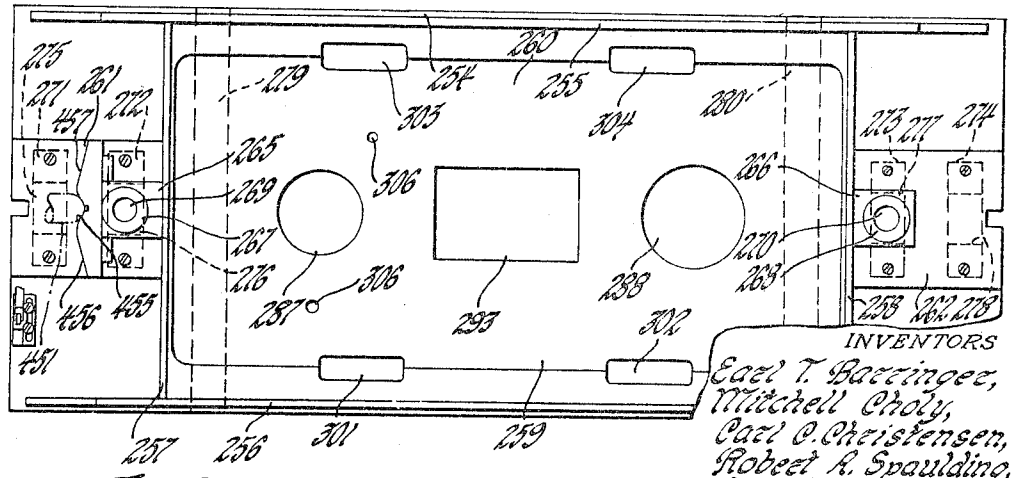


Fig. 20

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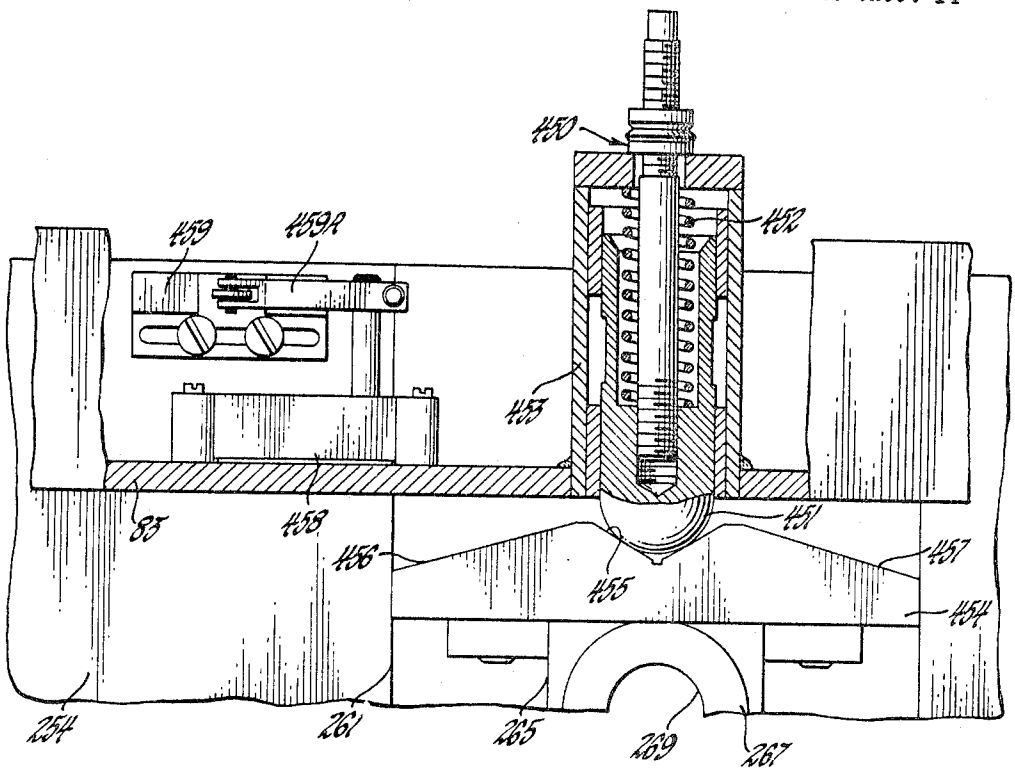


Fig. 21

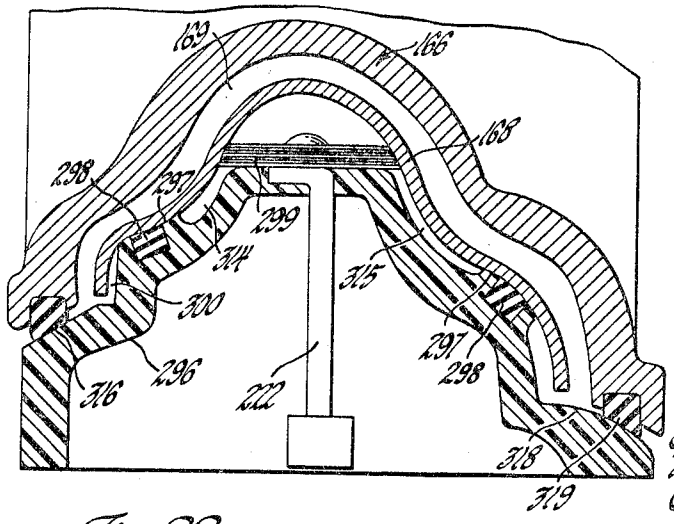


Fig. 22

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United States Patent Office 3,278,409 Patented Oct. 11, 1966

3,278,409

ELECTROPLATING MACHINE

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Filed July 25, 1962, Ser. No. 212,321
9 Claims. (Cl. 204—198)

This invention relates to electroplating machines and more particularly to a process and apparatus for circulating an electroplating electrolyte from a reservoir through a composite movable plating cell.

The invention is specifically directed to a means for expeditiously securing a source of electroplating solution to the pallet portion of the composite movable plating cell described and claimed in United States patent application Serial No. 212,318, entitled "High Speed Plating Method and Apparatus," which is assigned to the assignee of the present invention and which has been concurrently filed herewith.

The plating machine disclosed in the aforementioned United States patent application Serial No. 212,318 is an in-line plating machine in which a plating cell, or cell part, is shuttled through a series of processing stations to treat the part. In its preferred embodiment, the plating cell is formed of two parts, a work carrier and a cover part, with only the work carrier being shuttled through the machine. A nonshuttled mating cover part is used at each processing station to form a complete cell with the shuttled work carrier for processing of the work. Thus, the work carrier forms a cell with the cover part present at each successive processing station. Hence, the treatment, or plating, cell moves progressively through the machine.

More specifically, the work carrier is preferably in the form of a palletized plating fixture which is movable on a conveyor means from station to station in the machine. The palletized plating fixture is designed to accommodate individual workpieces and to retain the individual workpieces in a predetermined position throughout the plating process. Individual workpieces are supported during each portion of plating operation within individual plating cells to which various plating solutions and plating preparation solutions may be alternately applied without removal of the workpiece from the particular palletized plating fixture within which it is originally received. The prior commercially available part conveying apparatus, requiring immersion of workpieces within particular tanks, is replaced so that the necessary operations are performed within individual plating cells at each of the work stations. In this manner, cleaning solutions and plating solutions are forced through the plating cell at the various stations without any repositioning of the workpiece relative to its initial position in the palletized plating fixture. A predetermined spatial relationship between anode means and each workpiece is maintained throughout the plating process.

It is an object of the invention to provide a rapid, reliable, effective process and apparatus for communicating the pressively moved plating cell with a source of processing solution.

This and other objects of the invention are attained by locating both a processing solution source conduit and a reservoir return drain at the processing station so as to register with solution inlet and outlet parts, respectively, in the plating cell. The cell and cell conveyor segment are lowered into positive engagement with the source conduit and drain to obtain processing solution flow through the cell. In the two part cell, the cell cover at the processing station forms a support for a section of the work carrier conveyor. As the cover is lowered, so is the segment of the conveyor it supports, to allow the work carrier to engage the source conduit and reservoir return drain.

Other objects, features and advantages of the invention will become more apparent from the following detailed description, wherein reference is made to the accompanying drawings, in which:

FIGURE 1 shows a diagrammatic view of an illustrative plating process station sequence for copper, nickel and chrome plating an automobile bumper part or the like;

FIGURE 2 contains a side elevational view of a portion of a plating machine embodying individual plating process stations shown in FIGURE 1;

FIGURE 3 shows a plan view, partly in section, of the portion of the plating machine shown in FIGURE 2 and taken along the line 3—3;

FIGURE 4 shows a cross-sectional view taken along the line 4—4 in FIGURE 2;

FIGURE 5 contains an enlarged cross-sectional view taken along the line 5—5 in FIGURE 2;

FIGURE 5*a* shows a schematic elevational view in perspective of the conveyor frame section and associated housing shown in FIGURE 5;

FIGURE 6 also contains an enlarged cross-sectional view. This view shows the conveyor driven mechanism provided for the machine taken along the line 6—6 in FIGURE 3;

FIGURE 7 shows an enlarged cross-sectional view of the conveyor mechanism taken along the line 7—7 in FIGURE 6;

FIGURE 8 illustrates a detail plan view, partly in section, of a portion of the conveyor mechanism shown in FIGURE 6;

FIGURE 9 shows a cross-sectional view taken along the line 9—9 in FIGURE 7;

FIGURE 10 shows a cross-sectional view taken along the line 10—10 in FIGURE 8;

FIGURE 11 shows a cross-sectional view taken along the line 11—11 in FIGURE 7;

FIGURE 12 shows an enlarged sectional partial view of a palletized plating fixture in processing position as shown at station 2 in FIGURE 2;

FIGURE 13 also has an enlarged cross-sectional view of a plating cell formed at station 2 in FIGURE 2;

FIGURE 14 contains a cross-sectional view of a portion of the apparatus shown in FIGURE 13 and taken along the line 14—14 in FIGURE 13;

FIGURE 15 illustrates a cross-sectional view of a portion of the apparatus shown in FIGURE 13 and taken along the line 15—15;

FIGURE 16 shows a cross-sectional view taken along the line 16—16 and showing a portion of the apparatus in FIGURE 13;

FIGURE 17 shows a cross-sectional view of a portion of the apparatus shown in FIGURE 13 and taken along the line 17—17;

FIGURE 18 diagrammatically illustrates the method of transferring palletized plating cells from station to station;

FIGURE 19 diagrammatically illustrates the method of transferring palletized plating cells from station to station;

FIGURE 20 contains a plan view of a pallet for a plating cell;

FIGURE 21 illustrates an enlarged sectional view of a portion of the apparatus shown in FIGURE 5 and taken along the line 21—21; and

FIGURE 22 shows a cross-sectional view of an alternative embodiment of the cathode fixture shown in FIGURE 13.

MACHINE OPERATION

Serving as a specific example of the invention is the following description of the operation and structure of a machine in which it is incorporated. This is a plating machine having a plurality of aligned processing stations through which a palletized plating fixture is to be moved by conveyor means provided on the machine. Processing means are provided at each of the stations to direct plating solution, cleansing solution or other processing materials into processing contact with an individual workpiece mounted in each of the palletized plating fixtures. At some stations a plating cell is formed by association of an anode fixture with the palletized plating fixture to form a sealed cell in which electrolytic processing can be accomplished. In order to minimize the number of anode fixtures required, other types of fixtures, for forming a sealed cell, are provided at certain processing stations where non-electrical processing is accomplished. Thus, instead of providing a single palletized plating cell of anode type construction, which would be moved from station to station; the preferred embodiment of this invention comprises a palletized plating fixture associated with various cover fixtures at the different processing stations to form various types of processing cells depending on the processing operation at a particular station. In the apparatus shown for illustrative purposes, thirty-two working stations are provided. However, it is to be understood that the number of processing stations may be varied and the position of various stations relative to one another may also be varied depending on the particular workpiece being processed, and on the particular type and sequence of processing desired to be applied to a particular workpiece or part. A sufficient number of palletized plating fixtures are utilized to provide a plating cell for each of the work stations when the machine is in operation and to provide a sufficient number of palletized plating fixtures in addition to the number of work stations so that a continuous plating operation may be maintained. In other words, several palletized plating fixtures at any particular time in the complete plating cycle will be in the process of having the workpiece contained therein unloaded subsequent to the plating operation and loaded prior to re-entry into the plating machine to begin another plating process. Conveyor means are provided to carry each palletized plating fixture from the final station of the plating machine to an unloading station whereat an operator, or suitable automatic mechanism, may be utilized to remove the finished workpiece; and whereat, another workpiece may be mounted on the palletized plating fixture. The conveyor mechanism thereafter carries the palletized plating cell from the loading station to the first station of the machine whereat the palletized plating fixtures are fed onto a pallet conveyor mechanism which is actuable to move the palletized plating fixtures step by step from station to station. In some cases, the normal step by step movement of the palletized plating fixtures between successive stations is changed so that a station may be skipped or the formation of a cell at a particular station may be maintained for longer than a standard or normal processing period between transfer movement. In this manner, stations which require a longer processing time, compared to the other stations, may be accommodated without disrupting a standard stop period between transfer movement. The particular process solutions at each station are pumped or otherwise delivered under pressure within the processing cell formed thereat to contact the workpiece carried by the palletized plating fixture in a predetermined manner and to accomplish a predetermined result during the standard stop time. At each work station, a particular process solution is applied to the part within the plating cell and subsequently removed from the plating cell before the palletized plating fixture is transferred to the next work station. A plurality of tanks

are provided adjacent each work station and suitable pumping means may be provided to convey the fluid from the tanks to the plating cells. In addition, at some stations, a processing material such as rinse water is applied from a central source through retractable shroud housing type fixtures provided at such working stations to form a processing cell with the palletized plating fixture. Suitable tanks are provided below the processing cell to collect rinse water or the like delivered through the retractable heads. The processing cycle is arranged so that suitable rinsing stations separate processing stations in which activated processing solutions are used. In this manner, the palletized plating fixtures are completely washed and cleaned between applications of plating solutions so that a solution applied at a particular station is completely washed or rinsed away before the palletized plating fixture arrives at another plating or similar process station. The operation of the machine is continuous and the different process solutions are applied to the individual parts supported within the processing cells in a manner in which the application of plating solution to the individual workpiece can be rigidly controlled and in which the position of an anode fixture relative to the surface of the workpiece to be plated is also rigidly controlled and maintained. The capacity of the machine is limited only by the time each individual workpiece must remain at a particular processing station. In order to increase the plating rate of the machine as a whole, special methods of applying the plating solutions are provided which increase the plating rate substantially relative to previously known methods of plating similar parts on a mass production basis. In this manner, although individual workpieces are plated as compared to plating of a multiplicity of workpieces at a particular station as known in the prior art, the plating rate capable of being achieved with the machine and methods provided by this invention is greatly increased over the plating rate which could be achieved in previous apparatus. In addition, plating quality is also increased. The control of the plating cycle is facilitated by providing work stations that are equally spaced from one another and by providing equal stop intervals for the palletized plating cells at each of the work stations. In general, each of the palletized plating fixtures is moved an equal distance between each station and remains at each station an equal time. Any necessary deviations from the standard stop time are accommodated by the special transfer mechanism provided which permits an increased process time at particular process stations, such as a plating station, without disrupting the continuous overall operation of the machine.

The preferred plating process is embodied in a machine comprising thirty-two separate in-line stations and transfer mechanism to successively move individual palletized plating fixtures from station to station. As shown in FIGURE 1, several of the stations are provided with individual solution tanks from which various process solutions are applied to processing cells formed by association of cover heads at each station with the palletized plating fixtures. The process sequence for a particular part comprises the preliminary steps of loading the part or workpiece on a cathode mounting fixture which is associated with a pallet to form a palletized plating fixture, and moving the palletized plating fixture to machine entrance station No. 1 whereat the palletized plating fixture is associated with transfer mechanism which controls movement of the palletized plating fixtures from station to station through the machine. As previousely discussed, an individual palletized plating fixture will be located at each processing station during normal full scale production runs. The transfer mechanism moves each individual palletized plating fixture simultaneously from station to station and a standard stop time is utilized for forming a processing cell and applying processing solution at each station. After a palletized plating cell has been loaded with a part and positioned at entrance station No. 1 dur-

the part is passed in one end of the chamber and out the other. The velocity of the solution flowing through the chamber in this manner is equal to about 7.1 feet per second for each 100 gallons being pumped through per minute (g.p.m.). Hence, for a rate of flow of 200 g.p.m. the solution velocity in the chamber is about 14.2 feet per second, for 400 g.p.m. the solution velocity is about 28.4 feet per second, for 600 g.p.m. the solution velocity in the chamber is about 42.6 feet per second, etc. Thus, the process shown in FIGURE 1 also involves:

Station 1

An automatic loading station whereat the palletized plating fixture is automatically loaded on the machine transfer mechanism.

Station 2

A spray cleaning station whereat foreign matter, such as oil, dirt, buffing compound, etc., on the surface of the part to be plated is removed. The cleaning solution applied will usually be an alkaline type of cleaner of conventional composition comprising alkali, such as caustic soda, phosphate, carbonate, etc., emulsifiers, wetting agents and other soil removing aids. The stop interval is 30 seconds and the cleaning solution is pumped to the part at a rate of approximately 200 g.p.m. at a temperature of approximately between 100° F. and 200° F.

Station 3

An electrolytic cleaning station whereat electrolysis is used to aid in removing foreign matter on the part which was not removed at station 2. The part is electrified and an alkaline type cleaning solution is pumped to the part at approximately 300 g.p.m. and at a temperature of between approximately 100° F. and 200° F. The stop interval is 30 seconds.

Station 4

A warm water rinse station whereat residual alkali film remaining on the part is removed by spraying water over the part at a rate of approximately 100 gallons per minute at a temperature of approximately 100° F. to 200° F. The stop interval is 30 seconds.

Station 5

A cold water rinse station whereat additional residual alkalies are removed from the part by spraying tap water at line pressure over the part. The stop interval is 30 seconds.

Station 6

An electrolytic acid station which may be optionally used as an acid dip to neutralize any residual alkaline film or as an electrolytic acid for electrolytic polishing of the part. Sulfuric acid or other suitable acid solution, which may vary from less than 1% to more than 50% concentration, is used in our preferred process. It is pumped to the part at an approximate rate of 300 gallons per minute and an approximate temperature of 75° F. to 200° F. A current density, anodic or cathodic, of about 10 a.s.f. can be concurrently imposed on the part. This station can also be used for electropolishing, if desired. The stop interval is 30 seconds.

Station 7 and 8

Cold rinse stations whereat any residual acid solution is removed by tap water at line pressure. The stop interval is 30 seconds at each station.

Station 9

A copper strike station whereat a "flash" of copper is deposited on the part to provide a base for subsequent operations that will promote adhesion. A conventional cyanide copper solution is pumped to the part at an approximate rate of 600 g.p.m. and at an approximate temperature of between 100° F. and 200° F. The part is electrified. The stop interval is 30 seconds.

Station 10

A copper plate station whereat sufficient copper is deposited to provide a suitable surface for subsequent bright nickel plating. The part is energized and may be cathodic or periodic reverse plating may be used. The solution is pumped to the part at an approximate rate of 600 gallons per minute and at a temperature of approximately 120° F. to 190° F. The stop interval is 30 seconds.

Stations 11 and 12

Cold water rinse stations whereat any cyanide alkaline film residue on the part is removed by tap water pumped at an approximate rate of 100 gallons per minute. The stop interval is 30 seconds at each station.

Station 13

An electrolytic cleaning station which provides a supplementary cleaning to insure a clean surface prior to nickel plating. The part is electrified and an alkaline type cleaning solution is pumped to the part at a rate of approximately 300 gallons per minute and at a temperature of approximately 150° F. to 200° F. The stop interval is 30 seconds.

Station 14

A cold water rinse station identical to station 5.

Station 15

An acid cleaning station whereat any alkaline film residue remaining from station 13 is removed. An acid solution of sulfuric acid, hydrochloric acid, or any other suitable acid, is pumped to the part at an approximate rate of 100 gallons per minute and at approximately room temperature to 200° F. The stop interval is 30 seconds.

Station 16

A cold water rinse station identical to station 7.

Station 17

An idle station whereat the part may be located for a stop interval of 30 seconds without any processing to accommodate a stop interval of 60 seconds at stations 18 and 19.

Stations 18 and 19

Nickel plating stations whereat a nickel plating solution is pumped over the part at an approximate rate of 600 gallons per minute and at an approximate temperature of 100° F. to 200° F. The part is cathodically energized. The stop interval is 30 seconds or 60 seconds depending on whether a coating of one or two types of nickel is to be applied. In the latter instance, a solution for depositing semi-bright nickel is used at station 18 and a solution for depositing bright nickel is used at station 19.

Station 20

An idle station to accommodate stop intervals of 60 seconds at stations 18 and 19.

Stations 21 and 22

Cold water rinse stations whereat residual nickel plating solution on the part is removed by tap water sprayed thereon at an approximate rate of 100 gallons per minute. The stop interval is 30 seconds.

Station 23

An acid dip station, whereat the nickel surface on the part is activated prior to chromium plating by application of an acid solution, such as sulfuric acid, and other conventional additives which form an activated nickel surface. The acid solution is sprayed over the part at an approximate rate of 100 gallons per minute at room temperature. The stop interval is 30 seconds.

Station 24

A cold water rinse station, whereat residual acid solution is removed. The station is identical to station 5.

ing a standard stop time, the next movement of the transfer mechanism carries the loaded palletized plating cell from station 1 to cleaning station 2. When the palletized plating cell is in position at station No. 2, a shroud housing is positioned around the workpiece and a cleansing solution is pumped from an adjacent tank to spray apparatus in the shroud housing from which the cleansing solution is sprayed over the workpiece. The cleansing solution flows over the workpiece and returns to the tank through a drain opening extending through the palletized plating fixture and a collection sink provided thereunder. The application of the cleansing solution is completed within the standard stop time and the shroud housing is disassociated from the palletized plating fixture before the next movement of the transfer mechanism which carries the palletized plating fixture from station No. 2 to electrical cleaning station No. 3. The apparatus provided at station No. 2 and the operation thereof is similar to the apparatus provided at stations Nos. 4, 5, 7, 8, 11, 12, 14, 15, 16, 21, 22, 23, 24, 26, 28, 29, 30 and 31. Therefore, only the process variations are hereinafter described in detail.

After the palletized plating fixture is properly positioned at station No. 3, an anode housing is positioned in sealing engagement therewith to form a processing cell and the palletized plating fixture is simultaneously positioned in sealed engagement with a solution applying passage and a solution receiving sink. At the same time, an electrical connection is obtained between the cathode mounting fixture and an electrical source provided at station No. 3. The anode fixture may be permanently electrically connected since it is permanently located at station No. 3. Cleansing solution is then pumped at a high rate of flow from an adjacent tank through the solution applying passage and into a flow cavity formed between a contoured lower surface of an anode fixture within the anode housing and a parallel closely spaced surface of the workpiece on the palletized plating fixture. The flow cavity encompasses the entire surface to be plated of the workpiece and the cleansing solution flows completely over the outer surface of the workpiece. The anode fixture is electrically energized and the workpiece is electrically energized through contact with the cathode mounting fixture during the cleansing process. The cleansing solution flows through an outlet port extending between the palletized plating fixture and the solution receiving sink to the adjacent tank. At the end of the solution applying cycle and before the elapse of the standard stop time, the pumping of cleansing solution is discontinued and the palletized plating fixture is disengaged from the solution applying passage, the solution receiving sink, the electrical source and the anode housing to prepare the palletized plating fixture for transfer to the next station when the standard stop time has elapsed. It is to be understood that the shroud housings and anode housings at the various stations are simultaneously raised and lowered during the standard stop time and therefore no further reference to the positioning of the housings need be made in this brief description of the processing steps. The apparatus provided at station No. 3 and the operation thereof is similar to the apparatus provided at the subsequent electrical processing stations Nos. 6, 9, 10, 13, 18, 19, 25 and 27 whereat anode housings are provided. Accordingly, only the process variations are hereinafter described in detail.

The next movement of the transfer mechanism carries the palletized plating fixture from station No. 3 to warm rinsing station No. 4. After a shroud housing is associated with the palletized plating fixture, warm rinsing solution is pumped from an adjacent tank containing a heating element and applied to the workpiece. Before the stop time elapses, the solution application is discontinued and the shroud housing is disassociated from the plating fixture. The next movement of the transfer mechanism carries the palletized plating fixture from station No. 4 to cold rinsing station No. 5. Station No. 5 is identical to station No. 4 except that the solution is maintained at a lower temperature. The cold rinse solution may be supplied directly from a central water source and drained to a sewer connection rather than being pumped from and collected in an adjacent tank as at station No. 2 The processing at stations 7, 8, 12, 16, 21, 22 and 29 is similar.

At station No. 6, an anode housing is associated with the palletized plating fixture and an acid solution of suitable composition is applied to the workpiece at a suitable rate of flow and current density.

The palletized plating fixture then passes through successive cold rinse stations Nos. 7 and 8 which are provided to insure a thorough removal of the cleansing acid applied to the palletized plating fixture at station No. 6 without disrupting the standard stop time. In other words, when a longer processing time is required than the standard stop time, a plurality of similar stations may be provided to enable the application of processing solution for the required processing time without unnecessarily increasing the stop time at other processing stations which require a lesser processing time.

Station No. 9 is a copper strike station whereat a processing solution of suitable composition is applied at a suitable flow rate and current density.

Station 10 is a copper plate station whereat the workpiece is copper plated by the application of a processing solution of suitable composition at a suitable flow rate and current density.

Station 11 is a reclaim rinse station whereat copper is reclaimed from the rinse solution.

After a cold rinse at station No. 14, the palletized plating fixture is moved to acid dip station No. 15 whereat an acid solution of suitable composition is sprayed over the workpiece to additionally clean the copper plated workpiece.

After a cold rinse at station No. 16 to remove acid, the palletized plating cell is moved to either station No. 17 or No. 18 depending on whether station No. 17 is empty. Thus, by the provision of another idle station No. 20, the palletized plating cells can remain at stations Nos. 18 and 19 for two standard stop periods and each palletized plating cell stops only at one or the other of stations 18 and 19. At nickel plating stations No. 18 and 19, a nickel plating solution of suitable composition is applied to the workpieces at a suitable flow rate and current density for a suitable period of time.

The palletized plating fixture is next moved to cold rinse station No. 21 from station No. 19 or from idle station No. 20 depending on the machine cycle. A second cold rinse station No. 22 insures complete rinsing of the nickel plating solution.

An acid solution of suitable composition is applied to the nickel plated workpiece at station No. 23 to prepare the nickel surface for a chrome plating operation. The acid is washed away at station No. 24.

The chrome plate is applied at stations No. 25 and No. 27 at suitable flow rates and current densities. Some of the chrome plating solution is reclaimed at rinse stations Nos. 26 and 28.

The chrome plated workpiece is then washed and rinsed at rinse stations Nos. 29 and 30, and dried at station No. 31 prior to association of the palletized plating fixture with overhead conveyor means or the like at exit station No. 32 for movement of the palletized plating fixture to an unloading station and thereafter to the loading station and back to station No. 1 as previously described.

In summation and by way of further detail, the process shown in FIGURE 1 has been practiced on the left corner bar, or wing, of the 1961 Chevrolet front bumper. The conforming anode used in treating this part is spaced approximately one-half inch from the surface of the wing to form a rather extended treatment chamber therebetween. As previously indicated, the solution used to treat

Station 25

A chromium plating station, whereat the chromium plating solution is pumped over the part at approximately 400 gallons per minute and at an approximate temperature of 100° F. to 200° F. The part is cathodically energized. The stop interval is 30 seconds.

Station 26

A reclaim rinse station, whereat residual chromium plating solution adhering to the part is removed by room temperature rinse water that is reclaimed. The stop interval is 30 seconds.

Station 27

A chromium plating station identical to station 25.

Stations 28 and 29

Cold water rinse stations whereat residual chromium plating solution is removed. The stations are identical to station 11.

Station 30

A hot water rinse station whereat the rinse water is heated to an approximate temperature of 180° F. to facilitate subsequent drying of the part. The station is otherwise identical to stations 28 and 29.

Station 31

A part drying station whereat hot air is blown over the part. The stop interval is 30 seconds.

Station 32

An unloading station whereat the palletized plating fixture is removed from the transfer mechanism and connected to a conveyor for removal to a part unloading station. The stop interval is 30 seconds.

GENERAL MACHINE STRUCTURE

Since the machine apparatus is duplicated at many stations, only the first five stations are shown. Furthermore, the various stations are, in general, provided with one or two types of processing apparatus. One type of apparatus is provided at stations where the processing step requires no electrical energization of any of the parts and such stations may be referred to as non-electrical stations. The other type of apparatus is provided at stations where the processing step requires cathodic energization of the workpiece and the energization of an anode member. Such stations may be classified as electrical stations. Nonelectrical stations include a shroud housing in which spray apparatus is mounted and electrical stations include an anode housing in which an anode fixture is mounted. The two types of stations are hereinafter referred to, respectively, as shroud stations and anode stations, and one of each type of station will be described in detail by reference to the details of the apparatus at shroud station No. 4 and the details of the apparatus at anode station No. 3, which are exemplary.

Referring now to FIGURES 2, 3 and 4, stations 1, 2, 3, 4 and 5 of the plating machine are shown in detail, and it is to be understood that the other stations are similarly constructed. The machine comprises a frame of structural steel construction having a lower tank section which supports process solution tanks, an intermediate section which supports conveyor apparatus and an upper section which supports plating cell forming housings. As shown in FIGURES 2 and 4, the frame comprises a base formed by spaced horizontally extending lower structural members **50, 52, 53**. A plurality of lower vertical structural members **54, 55, 56, 57, 58** extend upwardly from the base and form two spaced longitudinal rows of similarly positioned members. The vertical structural members in each row are spaced to define tank accommodating compartments **59, 60, 61** for each of the processing stations. Intermediate horizontally extending structural members **62, 63** are secured to the upper ends of the vertical structural members af each row and support a conveyor platform plate **66** which extends the length of the machine. A row of upper vertically extending structural members **67, 68, 69, 70** extends longitudinally along one edge of the conveyor platform **66** and another parallel row of identically located structural members **71, 72** extends longitudinally along the opposite edge of the conveyor platform **66**. It is to be understood that similar upper vertical members extend the length of the machine. Upper horizontally extending support members **74, 75** are supported on the tops of the upper vertical structural members. Cross support structural members **76, 77** and cross support plates **78, 79, 80** extend transversely between the longitudinally extending structural members **74, 75**. In addition, bracket plate members **81, 82** are secured to the top of the cross supports **76, 77** and extend longitudinally of the frame. As shown in FIGURES 4 and 5, bracket support plates **83, 84** may be secured to the inner side surfaces of the upper vertical members and extend longitudinally of the frame. A transfer mechanism support frame **85** is positioned adjacent one end of the machine frame and supports a transfer mechanism support platform **86** in substantial alignment with the conveyor platform **66**.

Solution tanks, such as tanks **89, 90, 91**, illustrated at stations 2, 3 and 4, are provided at some of the stations and are seated in the tank compartments. Conventional pump mechanisms **92, 93, 94** are mounted adjacent each of the tanks as shown in FIGURE 3. At some of the stations, such as station No. 5, an outlet pipe **64** is provided in place of a tank to conduct processing solution to a central drain system. In addition, at the several plating stations, electrolyte regenerating tanks (not shown), are also provided adjacent the apparatus and are connected by suitable piping to the tanks provided beneath each station.

Referring now to FIGURE 3, a longitudinally extending conveyor track is centrally located on the support platform **66** and comprises spaced rows **87, 88** of horizontally aligned roller members **95, 105**. The rollers at each nonelectrical station may be mounted on individual support frames **96, 97** which are directly connected to the support platform **66**. The rollers at each electrical station are specially mounted and will be hereinafter described in detail. The rollers **95, 105** and roller frame sections **96, 97** of adjacent work stations are parallelly aligned so that a continuous roller conveyor is provided for the palletized plating fixtures. For purposes of illustration, each section of rollers is shown to comprise three individual roller members. Referring now to FIGURE 4, the spaced sections of rollers at each of the nonelectrical stations, such as station No. 4, comprise base plates **98, 99** which are secured to the support platform **66** in any suitable manner. Spaced side support plates **100, 101** and **102, 103**, are secured to the base plates **98, 99** and extend upwardly therefrom. Suitable cross supports may be provided to divide each roller frame section into three roller compartments as shown in FIGURE 3. Support shafts **106, 107** are centrally located in each roller compartment and rotatably support the roller members **95, 105**. As shown in detail in FIGURE 13, the roller members have a V-shaped peripheral cross section which is configured to receive mating portions of each palletized plating fixture during movement of the palletized plating fixtures from station to station.

Referring again to FIGURE 2, at each station where a processing solution is applied to a workpiece on a palletized plating fixture, solution controlling and confining housings **110, 111, 112, 113, 114** are vertically movably supported for movement between a retracted upper position during transfer of palletized plating fixtures from station to station and an extended lower position of sealing engagement with the palletized plating fixtures to form a processing cell during application of processing solution to the workpieces. Anode type housings **111,**

114 are provided at electrical stations Nos. 3 and 6, and spray type housings 110, 112, 113 are provided at non-electrical stations Nos. 2, 4 and 5.

Referring now to FIGURE 4, each of the spray housings comprises a rectangular casing 115 formed from sheet metal or the like and containing a plurality of spray nozzles 116. The lower portion of the casing is open and provided with a peripheral rim 117 which is adapted to be sealingly engaged with an upper surface of each of the palletized plating fixtures 118. The workpiece mounted on the palletized plating fixture is centrally positioned within the rectangular casing 115 adjacent the spray nozzles 116 when the spray housing is in the extended position. The spray housings are vertically movably supported on pipe members, 119, 120 which extend upwardly through support brackets 121, 122 fixed to the angle plates 81, 82 or other adjacent portions of the frame. A spray nozzle pipe 123 is connected to the lower ends of the pipe members. The pipe 123 is connected to a solution source through suitable piping 124 which is integrally connected to one of the support tubes 120.

ELECTROLYSIS CELL AND ASSOCIATED PARTS

While the spray housing and pallet form a treatment cell, the cell thus formed differs from the electrolysis cell. The former has processing solution introduced through the housing, which does not involve the present invention. On the other hand, the latter type cell, the electrolysis cell, has processing solution introduced through the pallet. An anode housing forms the cover member in the electrolysis cell.

Electrolysis cell cover

Referring now to FIGURES 5 and 13 where the anode housing 114 at station No. 5 is illustrated, each of the anode housings comprises an outer rectangular casing 128 formed of welded sheet steel or the like and having a lower peripheral rim portion 129 which may be provided with a seal or gasket 130 for sealing engagement with an upper surface of each of the palletized plating fixtures 118. A coupling block 131 is secured to the top of the outer casing 128 and is adapted to be connected to a piston rod 132 which is reciprocably actuable by a hydraulic cylinder 133 or other suitable power driven motor means mounted on top of one of the cross support beams 77 as shown in FIGURES 2 and 4. Locating pin support brackets 134, 135 are suitably fastened to opposite sides of the outer casing 128 and support centrally located guide pins 136, 137 which serve to locate the anode housing 114 relative to the palletized plating fixture 118.

In order to stabilize movement of the anode housing 114 between the retracted position adjacent the upper cross support 77 and the extended position of cell forming engagement with the palletized plating fixture 118, sprocket wheel support brackets 140, 141 are suitably fastened to opposite sides of the outer casing 128. Each support bracket 140, 141 is provided with transversely extending horizontal shafts 142, 143 which are parallelly aligned and equally vertically spaced. Both ends of each shaft extend outwardly beyond the support brackets and rotatably support double sprocket wheel assemblies 144, 145. Only the apparatus on one side of the anode housing 114 is shown and hereinafter described in detail. It is to be understood that similar apparatus is provided on the other side of the anode housing. Thus, four sprocket wheels are mounted on each shaft in clusters 144, 145 of two sprocket wheels which are located at each of the corners of the casing 128. Two of four guide and support chains 146, 147 are provided on each side of the anode housing and each are connected at one end to one of four upper chain support brackets 148, 149 mounted on one of the upper cross supports. The other end of each chain is connected to one of four lower chain brackets 150, 151 mounted on the adjacent bracket plates 83, 84. Each chain is connected to the upper chain support bracket on one side of the anode housing and is connected to the lower chain support bracket on the opposite side of the anode housing. Each chain extends downwardly from the associated upper chain support bracket, winds around the lower surface of a first sprocket wheel located therebelow, extends across the anode housing to the opposite side thereof, winds around the upper surface of a second sprocket wheel aligned with the first sprocket wheel, and extends downwardly to the associated lower chain support bracket. Guide sleeve brackets 154, 155 are attached to the outer ends of the sprocket wheel brackets. A guide sleeve bracket is provided at each corner of the anode housing 114 for a purpose to be hereinafter described. In order to provide additional stabilization for the anode housing 114 adjustable guide bolts 156, 157 may be threadedly mounted on some of the guide sleeve brackets 155 and may be adjusted to position the ends thereof in close proximity to flanges of the adjacent upper vertical beam 70 to prevent lateral movement of the anode housing. A limit switch actuating arm support bracket 158 is mounted on the guide sleeve bracket 154 and carries actuating arms 159, 160 which are adapted to actuate limit switches 161, 162 mounted on the adjacent vertical frame 72.

The actuating mechanism previously described for the anode housings may be duplicated at all the stations. However, in order to reduce cost, a single housing actuating mechanism at a central station may be used to control movement of adjacent station housings. As shown in FIGURE 2, the spray housings 110, 112 at stations Nos. 2 and 4 may be rigidly connected to the anode housing 111 at station No. 3 by a frame 164 of welded plate steel so that movement of the anode housing 111 will cause similar movement of the adjacent spray housings 110, 112.

Referring now to FIGURE 13, the anode housing 114 further comprises an anode fixture which is mounted within the outer casing 128. The anode fixture comprises a casting 166 which has a lower inner peripheral surface 167 contoured and configured to match the configuration of a workpiece 168 to be plated and to provide a flow passage 169 along the outer surface of the workpiece.

The anode material varies according to the nature of the processing at a particular station For example, the alkali cleaning stations and the cyanide copper plating stations have cast iron anodes. The acid solution and nickel plating stations have cast iron anodes which are spray coated with a covering of .07 to 0.1 inch of lead. The chromium plating stations have cast aluminum anodes which are spray coated with a covering of .07 to 0.1 inch of lead. The thickness of the anodes are dependent on the amount of current applied, the amount of force which must be exerted thereon to obtain a satisfactory seal with the plating fixture, and other variables. A peripheral rim 170 surrounds the contoured surface 167 of the anode casting 166 and has a substantially flat botom surface 171 which is sealingly engageable with a portion of the palletized plating fixture 118 in the solution applying position. The upper portion of the anode casting is provided with spaced support posts 172, 173 which are rigidly secured to the anode casting 128 in any suitable manner. Slots 174, 175 are provided in the support posts to receive an electrical contact plate 176 which extends substantially the length of the anode casting and which is secured to a suitable connecting plate 177 at one end thereof. Insulating plates 178, 179 are provided between the contact plate 176 and the side surfaces of the slots to insulate the anode casing 128 from the anode casting 166. As seen from FIGURE 5, the connecting plate communicates with an electrical source via a flexible cable 180 and a bus bar 181.

Cell work carrier

Referring now to FIGURES 13–17, the palletized plating fixture 118 is shown to comprise a cathode fixture 185 formed about a hollow central casting 186 of any suitable

material. The casting has a base portion **187** and an upwardly extending rectangular shell portion **188** in which a central cavity **189** is formed. A fluid inlet passage **190** and a fluid outlet passage **191** are cast integral with the casting **186**. The inlet passage **190** terminates in an elongated channel **192** which is adapted to connect the inlet passage **190** to the flow passage **169** along the entire width of the workpiece **168**. The outlet passage **191** has an enlarged opening **193**, immediately adjacent the end of the workpiece **168**, which extends the entire width thereof. The inlet passage opens along the bottom surface of the base portion **187** and the outlet passage terminates at the bottom surface thereof. A plurality of cable ports **195, 196** are spaced around the periphery of the shell portion **188** and open into the central cavity **189** of the casting which provides a central cable passage. A clamp cavity **197** is cast integrally adjacent to the outlet passage **191** to accommodate clamping means for securing the workpiece **168** to the cathode fixture. As shown in FIGURES 13, 14, the clamping means comprise a control shaft **199** which extends through the casting **186** and is rotatably supported thereby. Suitable sealing means, such as neoprene seals, are provided about the periphery of the shaft **199** to prevent leakage from the clamp cavity **197**. The outer end of the control shaft **199** is connected to a drive coupling, such as a connecting nut **200**. A suitable tool **201** having a socket adapted for engagement with the nut **200** is provided to rotate the control shaft **199**. A bifurcated link **202** is operably fastened to the control shaft **199** and pivotally supports an intermediate link **203** which is pivotally secured to a latch plate **204**. A pin member **205** is mounted in the clamp cavity **197** in any suitable manner and rotatably supports the latch plate **204**. A neoprene clamp pad **206** is secured to the latch plate **204** and is adapted to retainingly engage a transverse portion **207** of the workpiece **168**. The latch mechanism is made from stainless steel to prevent corrosive deterioration thereof. It is to be understood that the latch mechanism may be varied to accommodate the design of a particular part being plated.

All exterior surfaces of the casting **186** are covered with a suitable protective coating **210**. A preferred material is the commercially available plastisols. A plastisol shell is formed on the upper portion of the casting shell portion **188** and is provided with a contoured upper surface **211** which duplicates a workpiece surface to be supported thereon. Electrode plate cavities **212, 213** are integrally formed in the plastisol shell **210** and are aligned with the cable ports **195, 196**, in the casting shell **188**. The plastisol shell **210** is formed integrally with a plastisol coating **214** of at least $\frac{3}{16}$ of an inch which is provided on all exterior surfaces of the casting **186**. The integral plastisol coating **214** is also provided in the inlet passage **190**, the outlet passage **191** and around the clamp cavity **197**. The contoured molded surface **211** of the shell of plastisol **210** surrounds the clamp cavity **197** and provides an upwardly extending opening through which the latch mechanism extends. A minimum coating **215** of at least $\frac{1}{16}$ of an inch of plastisol is provided on all interior surfaces of the casting **186** which are subject to contact with processing solution. A substantially flat rim surface **216** is provided around the entire periphery of the contoured upper surface **211** which receives the part to be plated. A neoprene seal **217** is mounted on the rim **216** by any suitable fastening means and extends continuously therearound. If desired, the seal **217** may be mounted on the surface **171** of the anode to promote drainage from the cathode fixture. Suitable metallic reinforcing members, such as the member **218** shown in FIGURE 15, are provided around the inner periphery of the plastisol shell **210** to provide additional support and to decrease the amount of plastisol needed to obtain the desired contoured upper surface **211**. A plurality of bolt holes **219** are provided in the base portion **187** to enable the cathode fixture to be secured to a pallet.

A cable holder **221** of copper or other suitable conducting material is mounted in the hollow interior **189** of the casting **186**. A plurality of flexible connecting cables **222** are connected to the cable holder **221** by suitable fastening means **223** and extend upwardly therefrom to and through the cable ports **195, 196** provided in the periphery of the shell portion **188**. Individual lead-in cable ports **225, 226, 227, 228, 229, 230** are integrally molded in the plastisol shell **210** and connect the electrode contact cavities **212, 213** with the central cavity **189** of the casting shell portion **188** through the cable ports **195, 196** provided therein. Since each of the lead-in cable ports is similarly formed, only the details of lead-in port **228** are described in detail.

As shown in FIGURES 13 and 16, the lead-in port **228** comprises stepped portions **231, 232, 233** of progressively wider dimensions to provide shoulders **234, 235** in the adjacent plastisol shell **210**. The flexible cable **222** is provided with a connecting head **236** to which a retaining plate **237** is secured. The retaining plate is supported in the stepped portion **232** on a neoprene seal **238** which is seated on the shoulder **234**. A pair of leaf spring electrical contact plates **239, 240** are secured to the connecting head **236** in any suitable manner and extend upwardly therefrom through a neoprene spacing and sealing member **241** seated on the shoulder **235**. The spring contacts **239, 240** normally extend upwardly to points slightly beyond the outer surface **211** of the plastisol shell **210**. The end surfaces **242, 243** of the spring contacts are contoured for full contacting engagement with the lower surface of the workpiece **168**. As a workpiece is clamped on the plastisol surface **211**, the flexible contacts are flexed downwardly and inwardly from the normal unflexed position to obtain suitable electrical contact with the workpiece. Any suitable number of cables and spring contacts may be provided. The location of the spring contacts may also be varied depending upon the characteristics of the part to be plated. As shown in FIGURE 13, retaining bars **244, 245** extend the length of the electrode cavities **212, 213** to secure the spring contacts and lead-in cables in place.

The particular workpiece shown for illustrative purposes in FIGURE 13 is a section of an automobile bumper having a configuration which provides a detent portion **248** adjacent the inlet orifice **192** in addition to a transverse flange **207** formed adjacent the other end thereof which is engageable by the clamp plate **206**. Rotation of the clamping plate **206** into engagement with the adjacent surface of the transverse flange **207** of the workpiece forces the workpiece downwardly into firm engagement with the outer surface of the plastisol shell **211** and with the flexible contacts **239, 240**. Any suitable latching mechanism may be provided to accommodate particular types of workpieces having different configurations. A detent or clamp arrangement could also be provided adjacent the inlet port **190** if the workpiece configuration were such as to require additional clamping means. Electromagnetic means might also be provided to clamp a workpiece through suitably located magnets in the plastisol shell. In order to insure proper flow of processing solution across the workpiece **168**, additional inlet ports may be provided along the length of the flow passage **169**. For example, as shown in FIGURE 14, a supplementary inlet orifice **250** may be formed in the anode housing **166** and connected to a source of plating solution through a flexible conduit **251**. As many additional inlet ports may be provided as are necessary to obtain sufficient application of plating solution at portions of the workpiece having complex contours and configurations. Suitable flow directing means, such as a Teflon guide tube **252** or the like, may be provided at the inlet orifice **253** to direct flow of processing solution upwardly along the side surfaces of the workpiece. Gates, troughs or other devices may be substituted for the Teflon tube and integrally formed in the plastisol shell adjacent to the

workpiece to direct flow at the beginning of the flow path to obtain uniform application of plating solution.

An alternative embodiment of the cathode fixture is shown in FIGURE 22 and comprises a shell **296** of Fiberglas made with a polyester resin instead of the aforedescribed casting. The workpiece **168** is clamped on a peripheral seating surface **297** against a seal element **298** integrally molded therein. The workpiece contacts the cathode fixture only along the relatively narrow seating surface **297** in which a seal is embedded. Electrical contacts **299** are sealed in the Fiberglas shell and engage the workpiece in the aforedescribed manner. The other peripheral portions of the cathode fixture are relieved at **300, 314, 315** relative to the workpiece to facilitate positioning and clamping of the workpiece thereon. The lower surfaces **316, 318** are downwardly sloped to facilitate drainage and the anode seal **319** is secured to the anode casting rather than to the cathode fixture. The other parts associated with the cathode fixture are identical to those previously described.

Referring now to FIGURES 5, 12, 13, 14 and 20, the pallet portion of the palletized plating fixture comprises a base plate **254** to which are welded or otherwise suitably fastened, upwardly extending rim plates **255, 256, 257, 258** which form a centrally located enclosure **259**. The top surface of the base plate **254** is provided with a central recess within the confines of the central enclosure. As shown in FIGURE 13, the anode housing rim **129** is adapted to be seated within the recess **260**. The peripheral seal **130** provided in the anode housing rim **129** is sealingly engaged with the top surface of the recess **260** when the anode housing **114** is seated thereon.

As shown in FIGURE 20, support plates **261, 262** are welded or otherwise suitably fastened to the outwardly extending side surfaces of the base plate **254**. Bracket assemblies **265, 266** are mounted on the support plates **261, 262** and include bushing members **267, 268** having guide pin holes **269, 270** which are adapted to receive and retain the guide pins **136, 137** carried by the anode housing **114**. Transfer blocks **271, 272, 273, 274** are bolted to the lower surface of the base plate **254** and extend downwardly therefrom. Each of the transfer blocks is provided with dog receiving slots **275, 276, 277, 278** for connecting the pallet to power transfer mechanism for movement of the pallet from station to station. Pallet support bars **279, 280**, for supporting the palletized plating fixture during movement from station to station, are spaced inwardly of the transfer blocks and extend transversely of the base plate **254**. As shown in FIGURE 13, the support bars **279, 280** are suitably fastened, as by welding, to the base plate **254**.

Referring now to FIGURE 13, guide rails **281, 282**, having downwardly and inwardly inclined side surfaces **283, 284** and **285, 286** which form a V cross section, are secured to the support bars **279, 280**. The base plate **254** is provided with an inlet port **287** and an outlet port **288** which are coaxially aligned with the fluid inlet passage **190** and the fluid outlet passage **191** in the cathode fixture. Annular bosses **289, 290** are secured to the lower surface of the base plate **254** and are concentrically mounted relative to the inlet port **287** and the outlet port **288**. As shown in FIGURE 12, a plurality of stop blocks **291, 292** are fastened to the lower surface of the base plate **254** for supporting engagement with corresponding stops provided at each of the anode stations. An electrical connecting port **293** is centrally located on the base plate **254** and a housing **294** is formed therearound. An electrical contact plate **295** is bolted or otherwise suitably fastened to the lower end of the housing **294** and is separated therefrom by an insulating gasket **296**. A portion of the cable holder **221** extends downwardly through the electrode connecting port **293** provided in the pallet base plate **254** and is fastened within the housing **294** to the electrical contact plate **295**. The electrode connecting arrangement may be insulated and sealed from the pallet by gaskets made of polypropylene or other suitable material. As shown in FIGURE 20, a plurality of drain slots **301, 302, 303, 304** are provided around the periphery of the recess **260** to permit drainage of processing solution through the pallet and a plurality of cathode fixture fastening holes **306** are also provided to secure the cathode fixture on the pallet. Any of the surfaces of the pallet which are subject to contact with processing solution may be provided with a plastic coating of any suitable material, such as the commercially available plastisols; and suitable material, such as the commercially available plastisols and suitable neoprene seals are provided at all the joints to prevent leakage of processing solution.

SOLUTION TANK—CELL COMMUNICATION

As shown in FIGURES 3, 5 and *5a*, a special roller conveyor frame **307** is provided at the anode stations to permit sealing engagement between the palletized plating fixtures **118** and processing equipment permanently located at each anode station. Referring now to FIGURES 3 and *5a*, the roller conveyor frame **307** is made by welded construction of plate metal and comprises parallel transverse side support plates **308, 309** which have a length greater than the corresponding dimension of the palletized plating fixture so that the ends thereof extend outwardly adjacent the lower column supports **67, 68, 71, 72** on each side of the conveyor line. Cross support plates **310, 311** and **312, 313** are welded to and extend between the parallel side plates **308, 309**. Each pair of cross support plates is divided into compartments for the conveyor rollers **95, 105** and each cross support plate rotatably supports three conveyor rollers. Each roller compartment comprises aligned shaft apertures in which a shaft member is fixably secured. As shown in FIGURE 13, conveyor rollers **95, 105** are rotatably mounted on the shafts in each compartment between thrust washers **320, 321, 322, 323**, which are suitably mounted on the shafts between the conveyor rollers **95, 105** and the adjacent side surfaces of the cross support plates. All of the rotatably mounted conveyor rollers **95, 105** are provided with V-shaped grooves **324, 325** to receive the guide bars **281, 282** fastened to the pallet.

Referring specifically to FIGURE 3, support blocks **326, 327, 328, 329** are mounted at each end of the transverse plates **309, 308** and bracket members **330, 331, 332, 333** are welded between the outer roller support plates **310, 313** and the side plates **308, 309** to provide additional support. The block members are provided with vertical apertures, each of which is adapted to receive vertically extending support rods **336, 337** as shown in FIGURE 5. It is to be understood that four support rods are provided, one at each corner of the roller frame **307**, as lost motion support means for the roller frame. The vertically extending support rods **336, 337** are threadably fastened to the support blocks **326, 328** for actuation of the conveyor frame **307** between a lower retracted position and an upper conveyor forming position whereat the conveyor rollers **95, 105** are rigidly supported in horizontal alignment with the similar conveyor rollers provided at the other work stations. Guide means are provided for guiding the conveyor frame between the retracted position and the conveyor position, and comprise guideway blocks which are secured to the machine conveyor platform **66**, and cooperating guide blocks, which are fastened to the side surfaces of the outer roller support plates **313, 310**. The support rods **336, 337**, which are fastened to each corner of the periphery of the roller frame, extend upwardly through guide sleeves provided in the bracket extensions **154, 155** of the anode housing **114**. The upper ends **344, 345** of the control rods **336, 337**, as shown in FIGURE 5, are provided with flanged stop members **346, 347**, which are securely fastened thereto by suitable means such as threaded nuts **348, 349** or the like. The stop members **346, 347** provided on the

control rods are adapted to be seated on the outer top surfaces 350, 351 of the anode housing brackets 140, 141 during movement of the anode housing 114 to the retracted position.

As the anode housing 114 is moved to the retracted position by the actuating cylinder 133, the upper surfaces 350, 351 of the support brackets engage the flanges 346, 347 of the control rods and raise the roller frame 307 to a position of roller engagement with the guide bars 281, 282 of the palletized plating fixtures 118 and to a position whereat the roller members are horizontally aligned with the other roller members of the machine to provide a continuous roller conveyor. Thus, as a palletized plating fixture is received at a particular anode work station, the roller frame is in the raised position and the rollers thereof receive the pallet for positioning at the particular work station. After the pallet is in position at the particular work station, the actuating cylinder moves the anode housing downwardly for engagement with the palletized plating fixture and the roller frame is simultaneously lowered during the initial portion of the stroke of the actuating cylinder to a position whereat the roller frame is seated on the support platform 66 and the roller members carried thereby are moved downwardly out of engagement with the guide bars provided on the pallet, as shown in FIGURE 13. In this manner, the palletized plating fixture may be lowered into processing position at each of the anode stations.

Referring again to FIGURES 3 and *5a*, an anode sink structure 355, as shown at station No. 3, is provided for all of the anode stations. As shown in detail in FIGURES 12 and 13, a lower sink support plate 356 extends across the machine frame and is fixed to the support platform 66. A fluid inlet port 357, a fluid outlet port 358 and an electrical connecting port 359 are provided in the lower support plate 356. Annular housings 360, 361 are welded or otherwise secured to the lower support plate 356 and are concentrically positioned around the inlet port 357 and outlet port 358. The anode sink further comprises a rim portion 362 which is welded to the lower support plate 356 and to the inlet and outlet housings 361, 360. A downwardly sloping floor plate 363 is welded or otherwise suitably secured to the inner side walls of the rim portion 362 at a point spaced above the top surface of the lower support plate 356. A rectangular housing 364 is formed around the electrical connecting port 359 and extends upwardly therefrom. The floor plate 363 slopes downwardly from the rim portion 362 and surrounds the housing members 360, 361 and 364. As shown in FIGURE 3, support plates 365, 366, 367 may be welded between each fluid housing 360, 361 and the electrical connecting housing 364 to provide additional support. A drain port 370, illustrated in FIGURE 13, extends through the outlet housing 360 from a point adjacent the lowermost surface of the sloping floor plate 363. Referring again to FIGURES 3 and 12, a plurality of stop posts 371, 372, 373, 374 are secured to the outer edges of the lower support plate 356 of the sink and extends upwardly through the sloping floor plate 363 to a point adjacent the top of the sink structure. The stop members 371, 372, 373, 374 are positioned to be engaged by coaxially aligned stop blocks 291, 292 which are mounted on the pallet plate 254 and extend downwardly therefrom to support the palletized plating fixture when the conveyor frame is in the retracted position. The sink may be connected to the platfrom 66 by bolts 375, 376 extending through bolt blocks 377, 378 formed integral with the stop blocks 373, 374 as shown in FIGURE 13 with a counterbore 380 on the top surface thereof which receives a threaded coupling member 381. A Saran-lined pipe 382 extends upwardly from a process solution pump through an inlet port 383 in the plate 66 into threaded engagement with the coupling member 381. A cover plate 384 is bolted or otherwise secured to the top surface of the annular housing 361 and extends radially inwardly beyond the threaded coupling member 381 for securement thereof in the counterbore 380. A gasket 385 is provided between the cover plate 384 and the threaded coupling member 381, and is fixely secured therebetween by engagement with the end of the Saran-lined pipe 382. The cover plate 384 has a central port 386 having a conically outwardly tapered surface 387 which terminates in substantial alignment with the inlet passage in the annular inlet housing 289 depending from the pallet. An O-ring 388 or other suitable sealing gasket of neoprene or the like is seated in a groove 389 surrounding the inlet opening of the cover plate 384 and is adapted for sealing engagement with the lower surface of the pallet inlet housing 289 when the conveyor roller frame 307 is in the retracted position as shown. A commercially available Saran-lined pipe 390 extends upwardly from the solution tank through an outlet port 391 provided in the conveyor platform 66. A threaded coupling ring 392 is welded or otherwise secured within the outlet opening 358 in the lower support plate 356 of the sink and a counterbore 393 in the lower portion of the outlet housing 360. A second counterbore 394 extends upwardly from the threaded coupling ring 392 and intersects the drain opening 370. A support plate 395 is bolted or otherwise secured to the top surface of the outlet housing 360 and is provided with a top surface adapted to abut the lower surface of the outlet housing 290 of the pallet. Suitable sealing means 396 are provided between the support plate 395 and the outlet housing 290 of the pallet to provide sealing contact therebetweeen when the conveyor roller frame 307 is in the retracted position as shown in FIGURE 13. In addition, all surfaces of the sink which are subject to contact with processing solution are provided with a plastisol coating to prevent corrosive action. Thus, the interior surfaces of the inlet housings of the pallet and the sink and the interior surfaces of the outlet housings of the pallet and the sink are coated with a suitable corrosive resistant plastic.

As shown in FIGURES 12 and 13, a contact support plate 401 is mounted on an insulating gasket 402 and plate 403, and secured to the electrical connecting housing 364 by suitable means, such as the bolts 404. A bus bar 405 extends upwardly through a port 406 provided in the support platform 66 and into the cavity 407 formed within the electrical connecting housing 364. A gasket 408 surrounds and seals the bus bar 405 within the cavity 407. Transversely extending portions 409, 410 are secured to the contact support plate 401 by a plurality of bolts 411 or the like. Flexible contacts 412 are supported in a curved seat 413 on the top surface of the contact support plate 401 and extend upwardly in a V-shaped pattern of sufficient distance to make electrical contact with the contact plate 295 of the pallet when the conveyor roller frame 307 is in the retracted position. The flexible contacts are secured to the seat 413 by a curved retaining bar 414. A plurality of spring members 415, 416 are secured to the contact support plate 401 beneath the flexible contacts 412 and serve to bias the flexible contacts upwardly above the normal contact position to insure good electrical contact when the pallet is in the lowermost position with the stop members 291, 292 and 373, 374 engaged. The electrical connector housing 364 is suitably sealed from the sink. It is to be noted that all surfaces of the pallet and sink which are subject to contact with the plating solution are also coated with protective plastic of any suitable composition, such as the commercially available plastisols; and suitable neoprene seals are provided at all the joints to prevent leakage of the plating solution.

Referring now to FIGURES 3 and 4, the sink structure provided at all non-electrical stations is shown in detail at station No. 3. It is not necessary to to effect a complete sealing engagement between the palletized plating fixture 118 and the sinks located at the rinse stations; and therefore the sinks at the rinse stations are of different

structure than those provided at the electrical stations. The sink **420** at station No. 4 is made of welded construction of sheet steel which has all exposed surfaces provided with a protective coating of plastisol. The sink **420** is a pan-like structure having upwardly extending side walls **421** and having a downwardly inclined bottom surface **422** which slopes to an outlet port **423**. The sink is directly supported on the platform plate **66** by a plurality of support blocks **424** which extend upwardly therefrom. A pipe coupling ring **425** is welded to the bottom surface of the sink circumjacent the outlet port **423** and is fixed to a support ring **426** that is welded to or otherwise secured to the platform plate **66**. A Saran-lined pipe **427** is threadedly inserted into the threaded coupling ring **425** and extends downwardly through an outlet port provided in the support plate **66** to suitable solution receiving means. As shown in FIGURE 2, at station No. 5, the Saran outlet pipe **428** depending from the sink **429** may be connected to the drain pipe **64** by means of suitable flange couplings **430**. A drain pipe is used at some of the non-electrical stations whereat the processing solution is rinse water or the like which may be conducted directly to a central drain system. As shown in FIGURE 4, the outlet pipe **427** extends from the sink **420** to an inlet port **432** in the tank **91** provided below the station. As shown in FIGURE 12, drain back troughs **434**, **435** extend between adjacent sinks to convey processing solution, which drips from the palletized plating fixtures **118** during transfer, into the sink at the previous station.

Solution tanks

Referring now to FIGURE 4, each of the process solution tanks, such as tank **91** at station No. 4, is conventionally constructed of steel plate. Each of the tanks of the machine is commonly provided with a suitable pump mechanism **94** comprising a motor **437** and an impeller section **438** which are supported on a support bracket **439** on the top of the tank. An inlet pipe **440** extends downwardly from the impeller section **438** and is normally immersed in processing solution within the tank. An outlet conduit **441** extends upwardly from the impeller section **438** and through the top of the tank for connection with the inlet piping **124** which connects the spray apparatus **116** in the shroud housings **115**. Suitable valve mechanism **442** and a flow meter **443** may be provided to control flow of processing solution to the spray unit. At the electrical stations, the outlet conduit **441** extends from the impeller housing **438** beneath the support platform **66** and is connected directly to the solution inlet pipe **382** shown in FIGURE 13. A heating element **444** is mounted within some of the tanks and some of the tanks are connected to remotely located regenerated tanks (not shown) by suitable piping **445**. The copper solution, which is depleted by deposition of copper on the parts, is replenished by a porous diaphragm regeneration system. In this system a steel cathode is placed inside a porous ceramic diaphragm which is filled with a suitable cyanide solution such as potassium cyanide or sodium cyanide. Other materials, such as potassium or sodium hydroxide, which will promote conductivity are also used. Copper on copper anodes is dissolved into the solution by passage of electrical current between the anode and cathode. Copper is prevented from reaching the steel cathode by the porous diaphragm and materials associated therewith. The nickel plating solutions are regenerated by the use of nickel salt, such as nickel carbonate, nickel oxide or nickel hydroxide in the solutions. The chromium plating solution is regenerated by the use of conventional chromium salts or chromic acid in the solution. A ventilation exhaust vent **446** may be positioned above the tanks and a second ventilation exhaust duct **447** may be positioned at each work station to provide adequate ventilation.

It is to be understood that conventional circuitry and control mechanism is provided to actuate the housings at each work station from the retracted position to the extended position and to control actuation of each of the pump mechanisms. Since the circuitry and control mechanisms are well known and may be readily applied to the subject machine by those skilled in the art, no detailed reference is made thereto. Referring now to FIGURES 5, 20 and 21, a locating detent means **450** is mounted on a longitudinally extending support plate **83** and centrally positioned at each station. A detent **451** is biased inwardly toward the palletized plating fixtures by a spring element **452** within a guide housing **453**. A locating plate **454** having a vertical groove **455** is fixed to one of the support brackets **265** of the pallet and is provided with cam approach and withdrawal surfaces **456**, **457** for locating the detent members within the groove **455** when the pallet is centrally positioned at the work station. When the detent **451** is suitably positioned within the groove **455**, a switch **458** is actuated by engagement of a cam block **459** with roller arm **459***a* on the plate **83** to permit further actuation of the control circuit. Thus, the control circuitry cannot be actuated to start the processing cycle until the pallet is exactly positioned at each station. After the palletized plating cells are properly located at each station, the control circuitry actuates the housing control cylinders to lower the housings into processing cell forming engagement with the palletized plating fixtures. As shown in FIGURE 5, the limit switches **161**, **162** are provided on an adjacent column support **72** of the machine frame at each work station and have actuating fingers which extend outwardly into the path of movement of the cam actuating blocks **159**, **160** which are fixed to one of the anode housing support brackets. The lower limit switch **161** is actuated when the anode housing is in its lowermost position in sealing engagement with the pallet and controls the pump motor so that the motor is energized and processing solution is pumped upwardly from the tank and through the inlet housing for flow over the workpiece between the anode fixture and the cathode fixture. In addition, actuation of the switch **161** starts an electric timer. When the timer times out, before the standard stop time elapses, conventional circuitry de-activates the pump and actuates the anode housing cylinder to retract the housings. In addition the switch **161** starts the D.C. current which energizes the workpiece at the electrical station. The electrical timer also stops the D.C. circuit. The upper limit switch **162** is actuated when the anode housing reaches the uppermost position to signal that the anode housing is in the retracted position and to permit the palletized plating fixture to be transferred to the next station.

Referring now to FIGURE 3, a control switch mechanism **460** is provided at the first and last stations of the machine to prevent initiation of a transfer cycle before a palletized plating fixture is positioned at station No. 1 and before the palletized plating fixture at station No. 32 has been removed. The mechanism comprises a cam roller **461** which is mounted on a pin **462** in a bifurcated control arm **463**. A switch actuating member **465** is connected to the control arm **463** in any suitable manner. The control arm **463** is rotatably supported in the conveyor roller frame **466**. The cam roller **461** extends upwardly into the path of the guide bars **281**, **282** on the pallet and is engaged thereby when a palletized plating fixture is in position on the conveyor rollers. Brake mechanism comprising shoe members **468**, **469** having V-shaped friction surfaced grooves **470**, **471** are mounted on the conveyor roller frames and extend upwardly for frictional engagement with the guide bar of each of the palletized plating cells. Each shoe is spring biased up-

wardly to produce a frictional retarding force on the pallet as it is moved into position at station No. 1.

THE TRANSFER MECHANISM AND OPERATION

Referring now to FIGURE 3, transfer mechanism for actuating the palletized plating fixtures from station to station along the conveyor line on the machine is shown mounted on the transfer mechanism support plate 86. The transfer mechanism comprises, in general, a carriage assembly 474 which is reciprocably mounted on a trackway 475 and actuably connected to a power cylinder 476. The carriage is adapted to move transfer rods 477, 478 and 479, 480 which are slidably and rotatably mounted on guide blocks 481 longitudinally of the machine.

Referring now to FIGURE 6, the carriage assembly 474 is formed about a carriage plate 484. The trackway 475 comprises a central guideway and spaced side guideways. The central guideway comprises a downwardly depending housing 485 secured to the carriage plate 484 by welding, or other suitable means, and including a lower guide plate 486 which is fastened to downwardly depending side plates 487, 488 by bolts or the like. The guide plate 486 is slidably supported between spaced guide rails 489, 490 that are mounted by bolt members onto support blocks 491, 492 which are welded or otherwise suitably fastened to the base plate 86. Support flanges 493, 494 may be additionally provided between the side support plates 487, 488 and the carriage plate 484. An axle rod 495 is rotatably mounted within the side support plates 487, 488 and extends substantially from end to end of the carriage plate 484.

Identical transfer rod actuating means are provided on both sides of the carriage and therefore only one of the actuating means is hereinafter described in detail. The axle rod 495 is rotatably supported at its outer end within a bearing sleeve 497 provided in an axle housing 498 which is welded or otherwise suitably fastened to the carriage assembly. Each of the spaced side guideways comprise a guide rail 499 which is suitably fastened to the bottom surface of the axle rod housing 498 and slidably supported on a slide block 501. An inwardly extending portion of the guide rail 499 is adapted to be received within a guide groove 502 provided by block members 503, 504 which are secured to the base plate 86. A gear member 505 is keyed or otherwise suitably fastened to a reduced end portion of the axle rod 495 and is engageable with a rack element 506 which extends transversely of the carriage plate and parallelly to the guideways. The rack element 506 is fixably secured to the base plate through a support plate 507 and is positioned between thrust blocks 508, 509. A connecting rod 510 is fastened to the carriage assembly by a suitable coupling formed of retaining blocks 511, 512 which are fixedly secured within the downwardly depending housing 485. A T-shaped groove (not shown) is provided by the connecting blocks 511, 512 and receives a T-shaped coupling 513 which is fastened to the end of the piston rod 510. The other end of the piston rod 510 is connected within the power cylinder 476 so that actuation thereof causes reciprocable movement of the carriage assembly within the guideways provided. As shown in FIGURES 3 and 6, suitable limit switches 516, 517 are provided in the path of movement of the carriage assembly. A limit switch actuating dog 518 may be suitably fastened to the carriage plate and extends downwardly therefrom for engagement with the limit switches 516, 517 at the extreme forward position of the carriage and at the extreme rearward position of the carriage. The limit switches 516, 517 control transfer bar apparatus in a manner to be hereinafter described in detail. A cushioned stop block 519 is provided at the forward end of the guideways.

Referring again to FIGURES 3 and 6, a power cylinder 520 is centrally located on the carriage plate 484 and is fastened thereto through a cylinder support plate 521 by bolt members or other suitable fastening devices. Cylinder rods 522, 523 extend outwardly from each end of the power cylinder 520 transversely of the path of movement of the carriage assembly 474 and are adapted to be connected through yoke members 524, 525 to actuating mechanism which controls the transfer rods 477, 478 and 479, 480.

Since the palletized fixture actuating mechanism is identical on both sides of the carriage, only the left-hand mechanism will be described in detail. Although a pair of transfer rods 477, 478 and 479, 480 are provided on each side of the carriage assembly 474, any number of transfer rods may be provided depending on the particular cycle of movement of the palletized plating fixtures desired to be obtained. In the illustrated preferred embodiment, the two transfer rods per side are adequate. Referring now to FIGURES 6–10, the outer transfer rod 479 is supported within a cylindrical housing 528 that is welded or otherwise suitably secured to a block housing 529 which is fastened to the carriage plate 484 and to the axle rod housing 498. The inner transfer rod 480 is supported within the block housing 529. A cylindrical transfer rod actuating mechanism housing 530 is rigidly fastened to the block housing 529 and to the outer transfer rod housing 528 by welding or other suitable means so that a compact and integrated housing arrangement is provided. A reduced end portion 531 of the outer transfer rod 479 is fixably mounted within a rack sleeve 532. The rack sleeve 532 is provided with rack teeth 533 along its lower surface and is adapted to engage the gear member 505 fixed on the end of the axle rod 495. The outer transfer rod housing 528 is provided with an opening 534 to receive the gear member 505 and permit meshing engagement thereof with the rack sleeve 532. A gear 535 is integrally formed on a hub member 536 which is connected by a longitudinal key element 537 to one end of the reduced end portion 531 of the outer transfer rod 479 through a longitudinal slot 538 in the rack sleeve 532. The gear hub member 536 is mounted circumjacent and slidably supports the rack sleeve 532. Suitable bearing sleeves 539, 540 rotatably support the reduced end portion 531 of the outer transfer rod 479 within the rack sleeve 532. The slot 538 has an arcuate width sufficient to permit approximately a ¼ turn of the transfer rod 479 relative to the rack sleeve 532. A bearing bushing 541 is secured in one end of the cylindrical housing 528 by a cover plate 542 and slidably supports the rack sleeve 532. The hub member 536 is rotatably supported within the cylindrical housing 528 by spaced bearing sleeves 545, 546 which are secured within the housing by a cover plate 547. Thus, the transfer rod 479 is slidable relative to the gear 535 and is also rotatably actuable thereby throughout all positions of the carriage assembly.

As shown in FIGURES 8 and 10, the inner transfer rod 480 is rotatably supported within spaced bearing sleeves 548, 549 in the housing 529 and has a drive gear 550 keyed to a reduced portion 551 thereof. The cover plate 547 also retains the bearing sleeve 548, 549 in the housing 529. The bearing sleeves 545, 546, for the outer transfer rod drive gear 535, and the bearing sleeves 548, 549, for the inner transfer rod drive gear 550, extend within an opening 552 between the housing 529 and the housing 528, and define a gear passage to permit meshing of the outer transfer rod drive gear and the inner transfer rod drive gear. The cover plate 547 is adapted to surround the gear components and be fastened to the end surfaces of the block housing 529 and the outer transfer rod housing 528. An actuating rod 555 is connected through the yoke 524 to the connecting rod 522 of the double acting cylinder 520 and is provided with rack teeth

556 on its lower surface. The actuating rod is reciprocably supported within the actuating mechanism housing 530 by sleeve bearings 557, 558. The rack teeth 556 are drivingly engaged with the inner transfer rod drive gear 550 through an opening 559 in the housing 530 and the drive gear 550 is drivingly engaged with the outer transfer rod drive gear 535. In this manner, the rack drives the gears 535, 550 in opposite directions. As shown in FIGURE 11, limit switches 560, 561, 562, 563 are secured to the carriage assembly in any suitable manner. The limit switches are controllably connected to the double acting cylinder 520 to control movement thereof between a central position and extended positions on both sides of the carriage assembly and to the cylinder 476. Switch actuating dogs 564, 565 and 566, 567 are mounted on the inner transfer rods 480 and 478, respectively.

As shown in FIGURES 5 and 19, a pair of pallet engaging dogs 568, 569 and 570, 571 are removably fixed to the inner transfer rods 480 and 478, respectively, at spaced intervals therealong and single pallet engaging transfer dogs 572 and 573 are fixed to the outer transfer rods 479 and 477, respectively, at spaced intervals therealong. The dogs are adapted to be received in the slots 275, 276, 277, 278 provided in the blocks 271, 272, 273, 274 on the pallet for driving engagement therewith. The dogs are removably secured to the transfer rod so that various transfer cycles may be provided by the various spacing arrangements of the dogs. In the preferred embodiment of the invention which is illustrated, the inner transfer rod is adapted to move each pallet two feet, which is the distance between centers of adjacent work stations, and the outer transfer rod is adapted to move pallets four feet so that under some circumstances stations may be by-passed for a purpose to be hereinafter described.

The operation of the transfer mechanism comprises movement of the carriage assembly 474 from a retracted position to an extended position. The carriage assembly, for purposes of illustration of the preferred embodiment, is adapted to move a distance of two feet. The power transfer cylinder 476 is conventionally actuated to drive the carriage assembly between the retracted position and the extended position at predetermined time intervals. The carriage assembly is moved from the retracted position to the extended position a distance of exactly two feet. Forward movement of the carriage assembly carries the inner transfer rods 478, 480 forward a corresponding distance of two feet. The outer transfer rods 477, 479 are simultaneously moved forwardly a distance of four feet when the carriage assembly is moved a distance of two feet due to the action of the gear members 505, mounted on each side of the axle rod 495, with the rack elements 506 fixed to the base plate and the rack sleeve 532 fixed to the outer transfer rods. Thus, the outer transfer rod moves twice the distance that the inner transfer rod moves during movement of the carriage assembly. In order to control movement of the palletized plating fixtures in a predetermined manner, the double acting cylinder 520 is connected to the actuating rods 555 which cause rotation of the transfer rods and thereby rotate the pallet engaging dogs between varying positions of engagement and disengagement with the palletized plating fixtures.

Referring now to FIGURE 19, the operating sequence of the double ended cylinder 520 and positioning of the pallet engaging dogs on the transfer rod is shown diagrammatically. As shown in the first schematic diagram which illustrates the normal central position of the connecting rods 522, 523 of the double ended cylinder 520, the pallet engaging dogs are positioned so that no contact is made with the pallets of the palletized plating fixtures. The first step of a transfer cycle comprises actuation of the double acting cylinder 520 to move the piston rods from the central position to one of two oppositely extended positions and cause contra-rotation of the inner transfer rods 478, 480 to engage the dogs 568, 571 of the inner transfer rods 478, 480 with the transfer blocks 272, 273 on the pallet. The outer transfer rods 477, 479 are simultaneously contra-rotated to a dog disengaged position. The next actuation of the double acting cylinder 520 returns the piston rods from the extended position to the central position, as shown in the third diagram, to place the dogs in disengaged position and to permit return movement of the carriage assembly after a transfer movement. The double acting cylinder may next be fully extended in the other direction to rotate both the inner and outer transfer rods into pallet engaging position. In this position, the pallet engaging dogs 569, 570 of the inner transfer rods 478, 480 and the pallet engaging dogs 572, 573 of the outer transfer rods 477, 479 are all placed in engaged position. Thus, in one of the extended positions, the dogs on the inner transfer rods are engaged with some of the palletized plating fixtures for two foot movement and in the other extended position, the dogs on both the inner and outer transfer rods are engaged with separate palletized plating fixtures to move some two feet and some four feet. It is to be understood that the transfer mechanism described may be used to actuate the palletized plating fixtures in several different sequences and to move certain of the palletized plating cells varying distances. For instance, it would be within the scope of this invention to add another transfer rod on each side of the transfer mechanism and to provide means similar to the actuating means disclosed to cause axial displacement of the additional transfer rod a greater or lesser distance than the axial displacement of the outer transfer rod. Variations in the rack and gear arrangement may be provided to obtain any length of axial displacement desired and any number of additional transfer rods may be parallelly supported with the inner transfer and outer transfer rods shown.

The special transfer sequence adapted for this invention is shown schematically in FIGURE 18. The palletized plating cells are shown individually along the conveyor line and the numerals 1–32 represent the various work stations provided along the path of travel of the palletized plating cells within the plating machine. The palletized plating fixtures are shown in varying positions on four schematic drawings of the machine. The first schematic drawing shows the transfer mechanism in the retracted position and illustrates palletized plating cells at all of the stations except idle station 17 and exit station 32. As may be seen, stations 18 and 19 represent nickel plating stations. It has been found that certain steps in the plating process require a longer time interval than other plating steps, and consequently, the nickel plating stations 18 and 19 are spaced by idle stations 17 and 20 for a purpose to be hereinafter described with reference to the outer transfer bars and the inner transfer bars. If a standard stop interval of 30 seconds is provided at each station, the plating cells at each of the stations may have the particular process applied for a period of approximately 30 seconds. Of course, this time interval can be varied and could be varied from station to station. However, to maximize plating rate and utilize production line methods, it is desirable to have equal stop intervals at each of the stations. After the palletized plating cells, shown in the first diagrammatic sketch, have been in the indicated positions for the predetermined time, the transfer mechanism is actuated, as previously described, to advance some of the palletized plating fixtures by use of the inner transfer rods which move those palletized plating fixtures engaged by the dogs thereon. Such palletized plating fixtures are moved two feet and thus each of the engaged palletized plating cells advances one station to the positions shown in the second diagrammatic drawing. It is to be noted that no transfer dogs are provided on the inner transfer rods at stations 18, 19 or 20. When the palletized plating cells are moved in the second step by the inner transfer rods, the palletized plating cells labeled

118*f* and 118*g* at stations 18 and 19 are not moved; but remain at their stations and the idle station 17 accomodates movement of the palletized plating cells at stations 1–16. In this manner, the workpieces carried by palletized plating fixtures **118***f* and **118***g* remain at the nickel stations for two stop intervals and the progressive step by step movement of the other palletized plating fixtures from station to station is not interrupted. The next step in the cycle is diagrammatically shown in the third drawing. In the third step, the transfer bars are retracted as previously described to prepare for another cycle and a palletized plating fixture **118***m* is removed from exit station No. 32. The finished workpiece is removed and another workpiece is loaded on the palletized plating fixture **118***m*. At the same time that one palletized plating fixture is removed from exit station No. 32, another one is positioned at entrance station No. 1. The fourth diagrammatic sketch illustrates an actuation of the transfer mechanism to cause forward movement of both the outer transfer rods and the inner transfer rods as hereinabove described. The outer transfer rods are provided with engaged dogs at stations Nos. 16, 17, 18, 19 so that when the transfer rods are advanced, the palletized plating fixtures **118***d*, **118***e*, **118***f*, **118***g* are moved from their positions at stations Nos. 16, 17, 18, 19 shown in the third schematic diagram, to the positions at stations Nos. 18, 19, 20, 21 shown in the fourth schematic diagram. Each of the palletized plating fixtures are thus moved a total of two work stations. Accordingly, the palletized plating fixtures **118***f* and **118***g* remain at stations Nos. 18 and 19 for a processing period twice the available processing period for the other palletized plating cells at the other stations. As the palletized plating fixtures **118***d*, **118***e*, **118***f*, **118***g* are moved from stations Nos. 16, 17, 18, 19, the inner transfer rods simultaneously move the other palletized plating fixtures two feet. The cycle of operation is completed by return of the transfer mechanism to the retracted position. It will thus be apparent that the applicants have provided transfer mechanism which may be utilized to provide a varied plating cycle without reducing the plating rate. Additional idle stations may be utilized and the idle stations described for purposes of illustration may be placed at other position in the plating cycle. The provision of additional transfer rods and idle stations in the manner disclosed will permit wide variations in the plating cycle depending on the particular type of workpiece being plated, and the particular plating solution being used, and other variables.

Automatic machine operation

In automatic continuous operation of the machine, the spray housings and anode housings at the individual stations are all located in the retracted up positions at the beginning of processing. Conventional manual controls are provided at each station to accommodate loading of the machine at the beginning of automatic continuous operation and unloading of the machine at the end of automatic continuous operation. Thus a palletized plating fixture is located at each station and the loading and unloading conveyor is also applied with palletized plating fixtures to maintain continuous operation.

A master control switch is turned to automatic continuous position and a cycle start button is pushed. Thereafter, the machine will continue to cycle, automatically load an unplated part and associated palletized plating fixture at station No. 1, and automatically unload a plated part and associated palletized plating fixture from station No. 32. The operation of the machine will be hereinafter described with reference only to the unplated part and associated palletized plating fixture located at station No. 1 at the beginning of the cycle. It is to be understood that the aforedescribed movements of the other palletized plating fixtures take place simultaneously and that the aforedescribed processing also is simultaneously initiated and completed at the other stations.

At the beginning of the cycle, the transfer bars are properly positioned with the dogs in engagement with the appropriate palletized plating fixtures on the machine. Actuation of the cycle start button energizes a solenoid control valve means associated with carriage cylinder **476** to actuate the cylinder and move the carriage to the extended position. The palletized plating fixture at station No. 1 is thereby moved to station No. 2. The carriage actuates limit switch **517** and the palletized plating fixture actuates the "on station" monitor switch (not shown). The limit switch **517** causes energization of a solenoid control valve means associated with transfer rod cylinder **520** to actuate the cylinder and rotate the transfer bars to the control, dog disengaged, position. Rotational movement of the transfer bars actuates limit switches **561** and **563**. The limit switch **561** causes de-energization of the solenoid control valve means associated with the transfer rod cylinder **520** to stop rotation of the transfer bars. The limit switch **563** causes actuation of the solenoid control valve means associated with the carriage cylinder **476** which actuates the cylinder to return the carriage to the retracted position. The carriage actuates limit switch **516** at the end of the return movement of the carriage. The limit switch **516** causes energization of the solenoid valve control means associated with transfer rod cylinder **520** and the cylinder is actuated to cause rotation of the transfer rods to dog engagement position whereat the palletized plating fixtures may be moved two feet.

The monitor switch at station No. 2 causes energization of a solenoid control valve means associated with housing cylinder **133** to cause actuation of the cylinder and extend the spray housing into engagement with the palletized plating fixture. Downward movement of the spray housing actuates limit switch **161** which controls an electric processing timer and a solenoid control valve means associated with the spray apparatus. The electric processing timer is energized and the valve means turns on the water spray. When the electric timer times out after the preselected processing interval, the solenoid control valve means associated with the spray apparatus is de-energized and the water spray stopped and the solenoid control valve means associated with the housing cylinder **133** is actuated to cause actuation of the cylinder and return the spray housing to the retracted position. Upward movement of the spray housing actuates limit switch **162** which signals that the next transfer can begin. A similar operational sequence takes place at all the non-electrical stations.

When the unplated part and palletized plating fixtures are transferred from station No. 2 to station No. 3, a similar operational sequence takes place. However, the operational sequence differs in that the solenoid control means associated with the transfer rod cylinder **520** is energized at the end of the previous cycle in a manner to cause the cylinder to be actuated in the opposite direction whereby both the two feet dogs and the four feet dogs are located in pallet engaging position. The limit switches **560**, **562** replace the limit switches **561**, **563** in the operational sequence; but perform exactly the same function. An additional difference is that the limit switch **161** at station No. 3, which is actuated by downward movement of the anode housing thereat, controls an electric process timer, a solution applying pump and electrical energization of the part. When the limit switch is actuated, the timer and pump are started, and D.C. current is applied to the part. When the timer times out after the preselected processing interval, the pump is deactivated, the current is shut off, and the anode housing cylinder is actuated as hereinbefore described. A similar operational sequence takes place at all the electric stations.

The aforedescribed illustrative embodiment of apparatus utilizing the principles of the present invention is not

intended to limit the scope of the invention. Accordingly, obvious changes in the details of construction or the arrangement of the component parts are intended to be included within the meaning of the appended claims. In particular, the concept of providing a plating cell, through which processing solution can be pumped at a plurality of processing stations, includes not only the illustrative palletized plating fixture and reciprocable housings at each station; but also, a combined housing and palletized plating fixture capable of being transferred to a processing station as a unit. Thus, the term "plating cell" is intended to include a complete plating cell unit embodying the principles of the present invention, except insofar as limited by the prior art.

We claim:

1. In plating apparatus for use with a palletized plating fixture, movable from station to station on a continuous conveyor, a movable conveyor frame section forming a part of the continuous conveyor, housing means reciprocably supported relative to said continuous conveyor to form a plating cell by association with said palletized plating fixture at one of said stations, power means to move said housing means from a retracted position above the continuous conveyor to an extended position in cell forming engagement with said palletized plating fixture, support means for said movable conveyor frame section, said support means being connected to said housing means and said movable conveyor frame section, movement of said housing from said retracted position to said extending position causing movement of said movable conveyor frame section through said connection from a first position supporting said palletized plating fixture for movement along said continuous conveyor to a position therebelow whereat said palletized plating fixture is connected to processing solution pumping means and electrical energization means.

2. In plating apparatus for use with a palletized plating fixture, horizontally movable from station to station on a continuous conveyor, a vertically movable conveyor frame section forming a part of the horizontal continuous conveyor, housing means reciprocably supported above said continuous conveyor to form a plating cell by association with said palletized plating fixture at one of said stations, power means to vertically lower said housing means from a retracted position above the continous conveyor to an extended position in cell forming engagement with said palletized plating fixture and lost motion means supporting said movable conveyor frame section, said lost motion support means including a sliding interconnection between said housing means and said movable conveyor frame section, movement of said housing from said retracted position to said extending position causing movement of said movable conveyor frame section from a first position supporting said palletized plating fixture for movement along said continuous conveyor to a position therebelow whereat said palletized plating fixture is connected to processing solution pumping means and electrical energization means.

3. In plating apparatus for use with a palletized plating fixture, movable from station to station on a continuous conveyor, a movable conveyor frame section forming a part of the continuous conveyor, housing means reciprocably supported relative to said continuous conveyor to form a plating cell by association with said palletized plating fixture at one of said stations, power means to move said housing means from a retracted position above the continuous conveyor to an extended position in cell forming engagement with said palletized plating fixture, lost motion means for supporting said movable conveyor frame section, said lost motion support means involving a sliding interconnection between said housing means and said movable conveyor frame section whereby movement of said housing from said retracted position to said extending position concurrently moves said movable conveyor frame section from a fixture supporting position to a nonsupporting position, whereby said palletized plating fixture is connected to processing solution pumping means and electrical energization means, and abutment means for supporting said conveyor frame section after a predetermined movement of said housing means, said sliding interconnection allowing further housing reciprocal movement without translational movement of said conveyor frame section.

4. An apparatus comprising a plurality of work stations, conveyor means for transferring workpieces to be treated from station to station, said conveyor including at least two spaced substantially parallel rows of rollers, work carrier means adapted to be carried on said conveyor means, transfer mechanism for moving said work carrier on said conveyor from station to station, said work carrier forming at least a part of a treatment cell, a processing solution inlet conduit at at least one of said stations between said spaced rows of rollers, a processing solution outlet conduit at said station between said spaced rows of rollers, a movable conveyor frame member supporting the section of said conveyor at said station, means for moving said conveyor frame section from a work carrier supporting position to a nonsupporting position whereby a work carrier at said station is associated with said inlet and outlet conduits for circulating processing solution through said treatment cell.

5. An apparatus comprising a plurality of work stations, conveyor means for transferring workpieces to be treated from station to station, work carrier means adapted to be carried on said conveyor means, transfer mechanism for moving said work carrier on said conveyor from station to station, a treatment cell formed with said work carrier at at least one of said stations, a processing solution inlet conduit at said station for association with said treatment cell, a processing solution outlet conduit at said station for association with said treatment cell, a movable frame member supporting the section of said conveyor at said station, means for moving said conveyor frame section from a work carrier supporting position to a nonsupporting position whereby a work carrier at said station becomes connected to said solution inlet and outlet for circulating processing solution through the treatment cell.

6. An apparatus comprising a plurality of work stations, conveyor means for transferring workpieces to be treated from station to station, work carrier means adapted to be carried on said conveyor means, transfer mechanism for moving said work carrier on said conveyor from station to station, said work carrier forming at least a part of a treatment cell, a processing solution inlet conduit at at least one of said stations for association with said treatment cell, a processing solution outlet conduit at said station for association with said treatment cell, housing means at said station for forming a treatment cell with said work carrier, a movable frame member supporting the section of said conveyor at said station, and means for concurrently associating said housing with said work carrier and for moving said conveyor frame section from a work carrier supporting position to a nonsupporting position, whereby a work carrier at said station becomes supported by said solution inlet and outlet and associated therewith for circulating processing solution through the treatment cell.

7. An apparatus comprising a plurality of work stations, conveyor means for transferring workpieces to be treated from station to station, work carrier means adapted to be carried on said conveyor means, transfer mechanism for moving said work carrier on said conveyor from station to station, housing means at at least one of said stations reciprocably supported relative to said conveyor to form a treatment cell by association with said work carrier, means for moving said housing from a retracted position to an extended position in cell forming engagement with a work carrier at said station, a processing solution inlet conduit at said station, a processing solution outlet con-

duit at said station, a movable frame member supporting the section of said conveyor at said station, lost motion means for supporting said conveyor frame section, said lost motion support means including a sliding interconnection between said housing means and said movable conveyor frame section whereby initial housing movement from retracted position translationally moves said movable conveyor frame section from a work carrier supporting position to a nonsupporting position, said initial movement simultaneously connecting a work carrier at said station to said inlet and outlet conduits for circulating processing solution through the treatment cell, and abutment means for supporting said conveyor frame section after a predetermined movement of said housing means, said sliding interconnection allowing further housing reciprocal movement without simultaneous translational movement of said conveyor frame section.

8. In plating apparatus, a plurality of work stations, conveyor means for transferring workpieces to be plated from station to station, said conveyor including at least two spaced substantially parallel support rows, work carrier means adapted to be carried on said conveyor means, transfer mechanism for moving said work carrier on said conveyor from station to station, housing means at at least one of said stations reciprocably supported relative to said conveyor to form a plating cell by association with said work carrier, means for moving said housing from a retracted position to an extended position in cell forming engagement with a work carrier at said station, a processing solution inlet conduit between said rows at said station, a processing solution outlet conduit between said rows at said station, a movable frame member supporting the section of said conveyor at said station, lost motion means for supporting said conveyor frame section, said lost motion support means including a sliding interconnection between said housing means and said movable conveyor frame section whereby initial housing movement from retracted position translationally moves said movable conveyor frame section from a work carrier supporting position to a nonsupporting position, said initial movement simultaneously supports a work carrier at said station on and connects it to said inlet and outlet conduits for circulating processing solution through the treatment cell, and abutment means for supporting said conveyor frame section after a predetermined movement of said housing means, said sliding interconnection allowing subsequent housing extending movement without translational movement of said conveyor frame section.

9. The method which comprises placing a part to be plated on a work carrier which forms part of a plating cell, moving said work carrier on a conveyor to a work station, registering inlet and outlet plating solution passages in said work carrier with inlet and outlet plating solution conduits at said station, moving a housing member into cell forming relationship with said work carrier, while moving said housing also moving a section of said conveyor at said station in translation with said housing from a work carrier supporting position to a nonsupporting position, while moving said section to a non-supporting position simultaneously transferring support of said work carrier to said conduits and connecting said passages to said conduits, and circulating plating solution from said inlet conduit over the part in the work carrier-housing cell to said outlet conduit.

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