March 27, 1951 J. E. ERHARDT, JR 2,546,538

APPARATUS FOR HANDLING AND BRIGHTENING METAL

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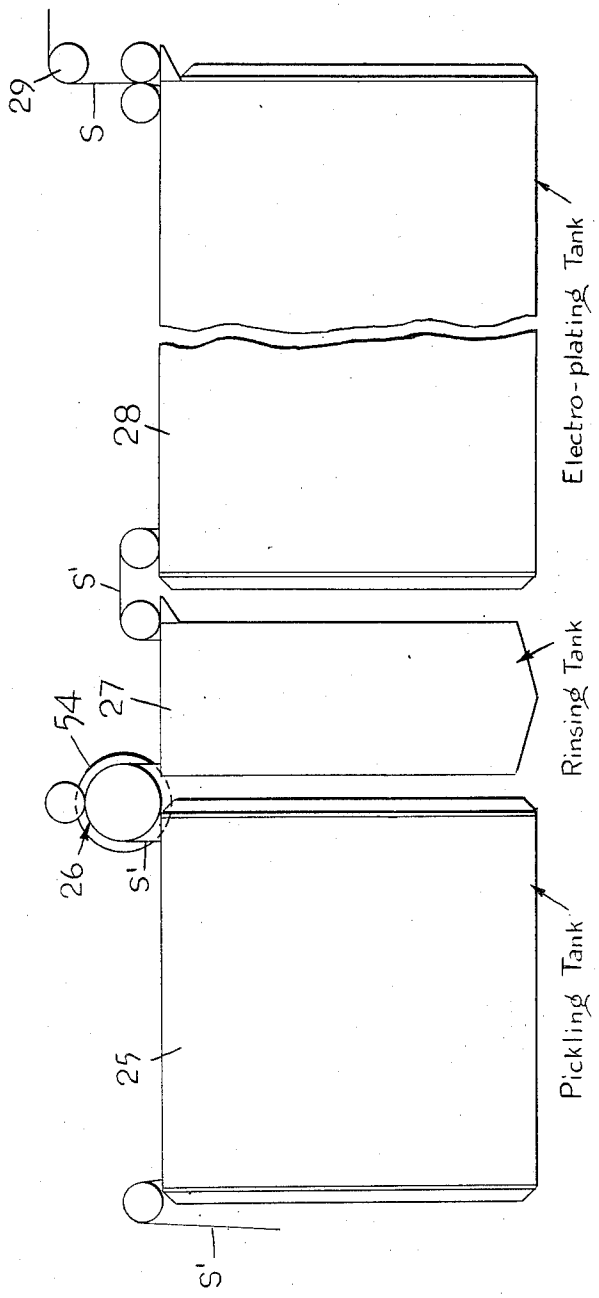


Fig. 1a

INVENTOR.
John E. Erhardt, Jr.
BY
Cushman, Darby & Cushman

March 27, 1951 J. E. ERHARDT, JR 2,546,538

APPARATUS FOR HANDLING AND BRIGHTENING METAL

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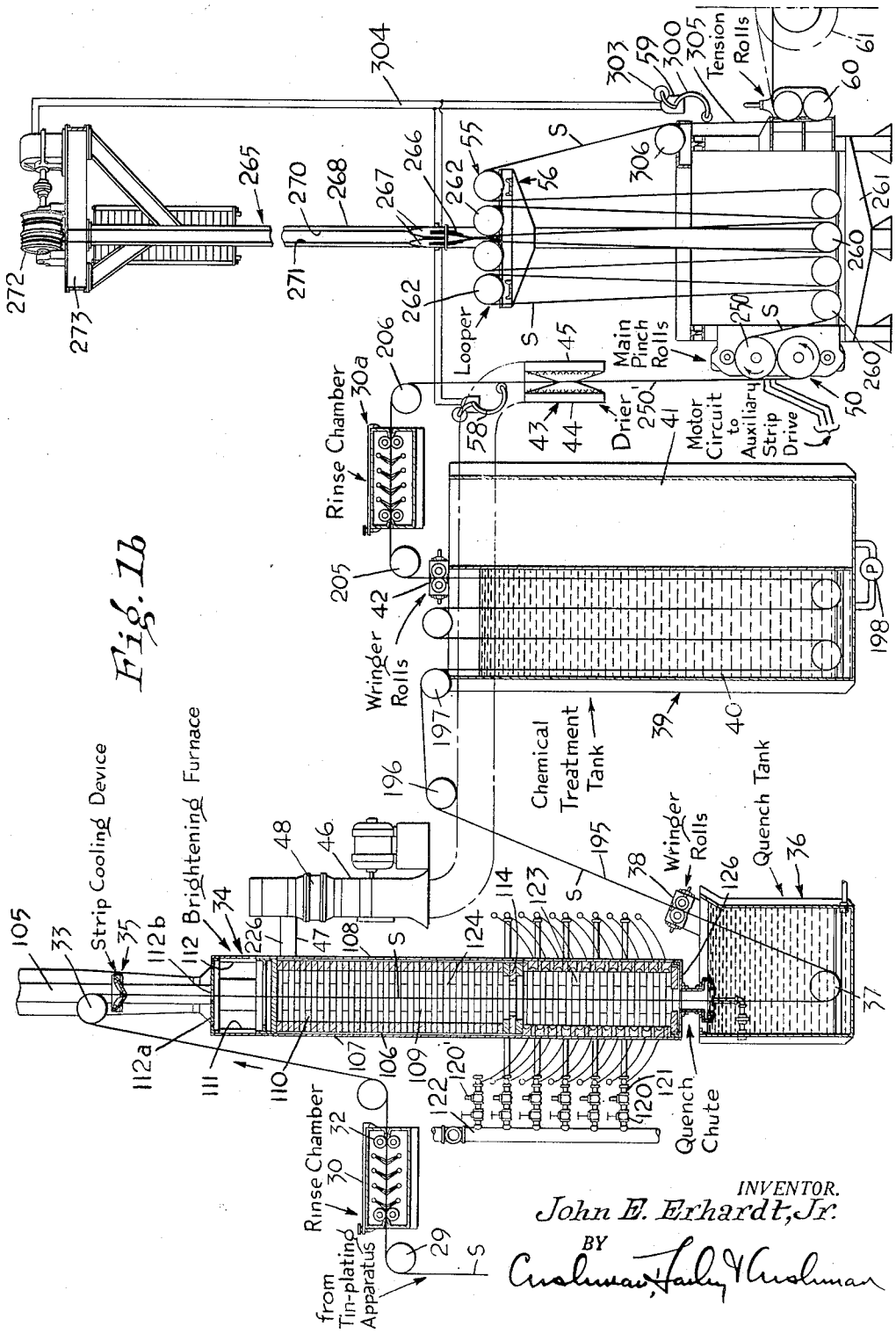


Fig. 1b

INVENTOR.
John E. Erhardt, Jr.
BY
Cushman, Darby & Cushman

March 27, 1951 J. E. ERHARDT, JR 2,546,538

APPARATUS FOR HANDLING AND BRIGHTENING METAL

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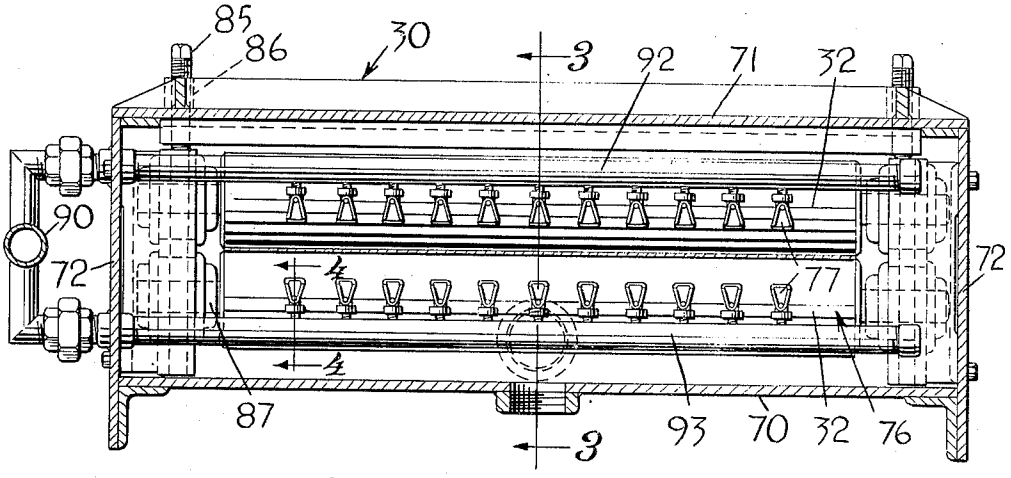
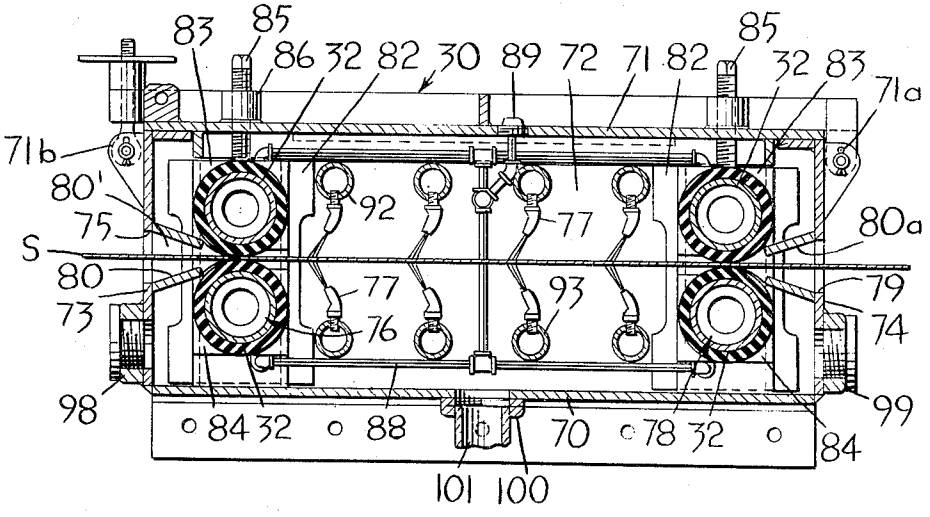


Fig. 2

Fig. 3



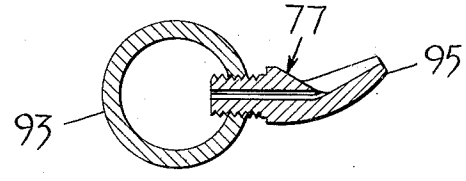


Fig. 4

INVENTOR.
John E. Erhardt, Jr.
BY
Cushman, Darby & Cushman

March 27, 1951 J. E. ERHARDT, JR 2,546,538

APPARATUS FOR HANDLING AND BRIGHTENING METAL

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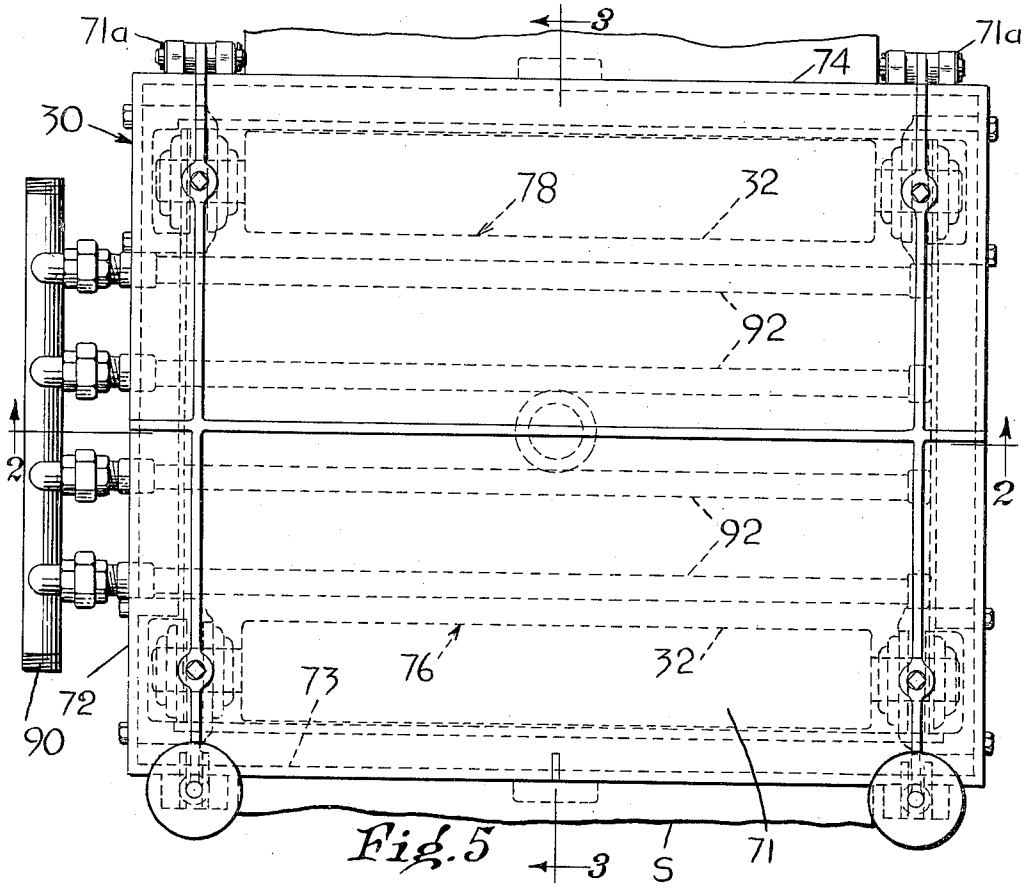


Fig. 5

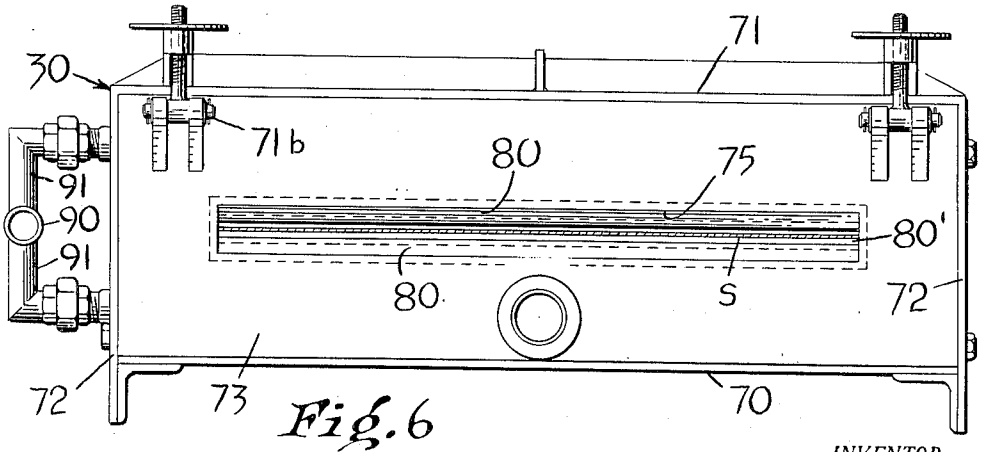


Fig. 6

INVENTOR.
John E. Erhardt, Jr.
BY
Cushman, Darby & Cushman

March 27, 1951 J. E. ERHARDT, JR 2,546,538

APPARATUS FOR HANDLING AND BRIGHTENING METAL

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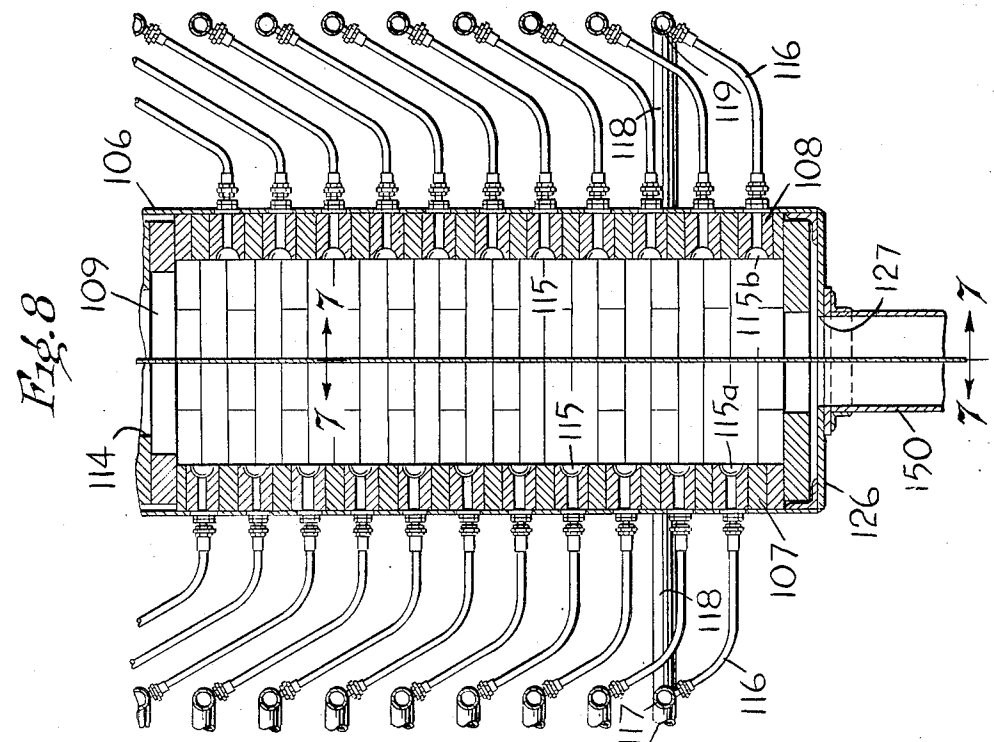


Fig. 8

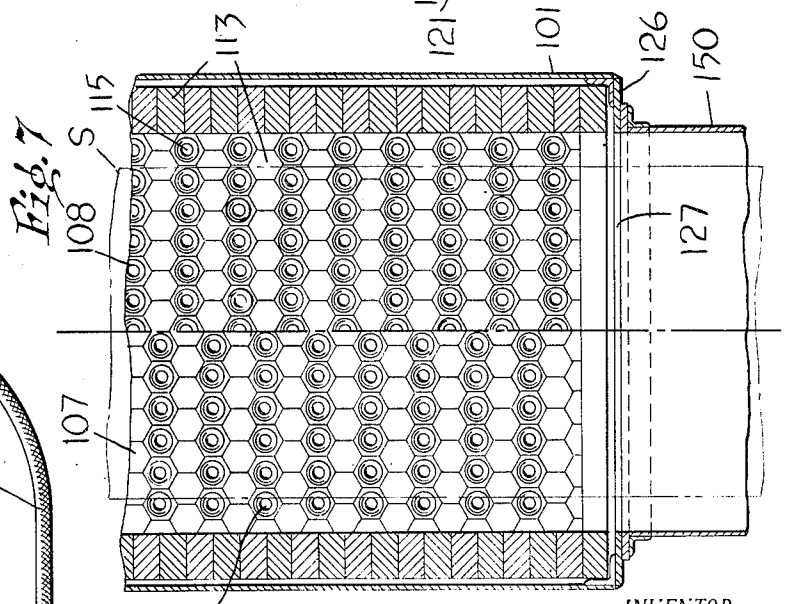


Fig. 7

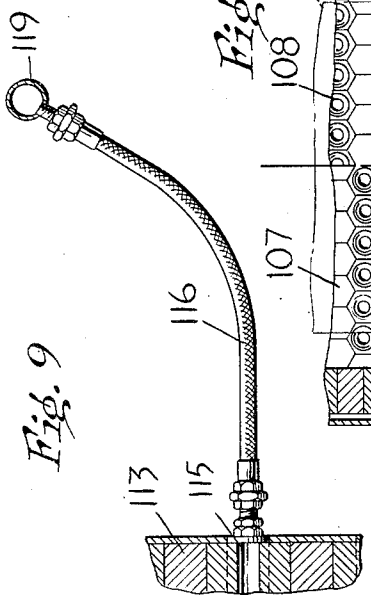


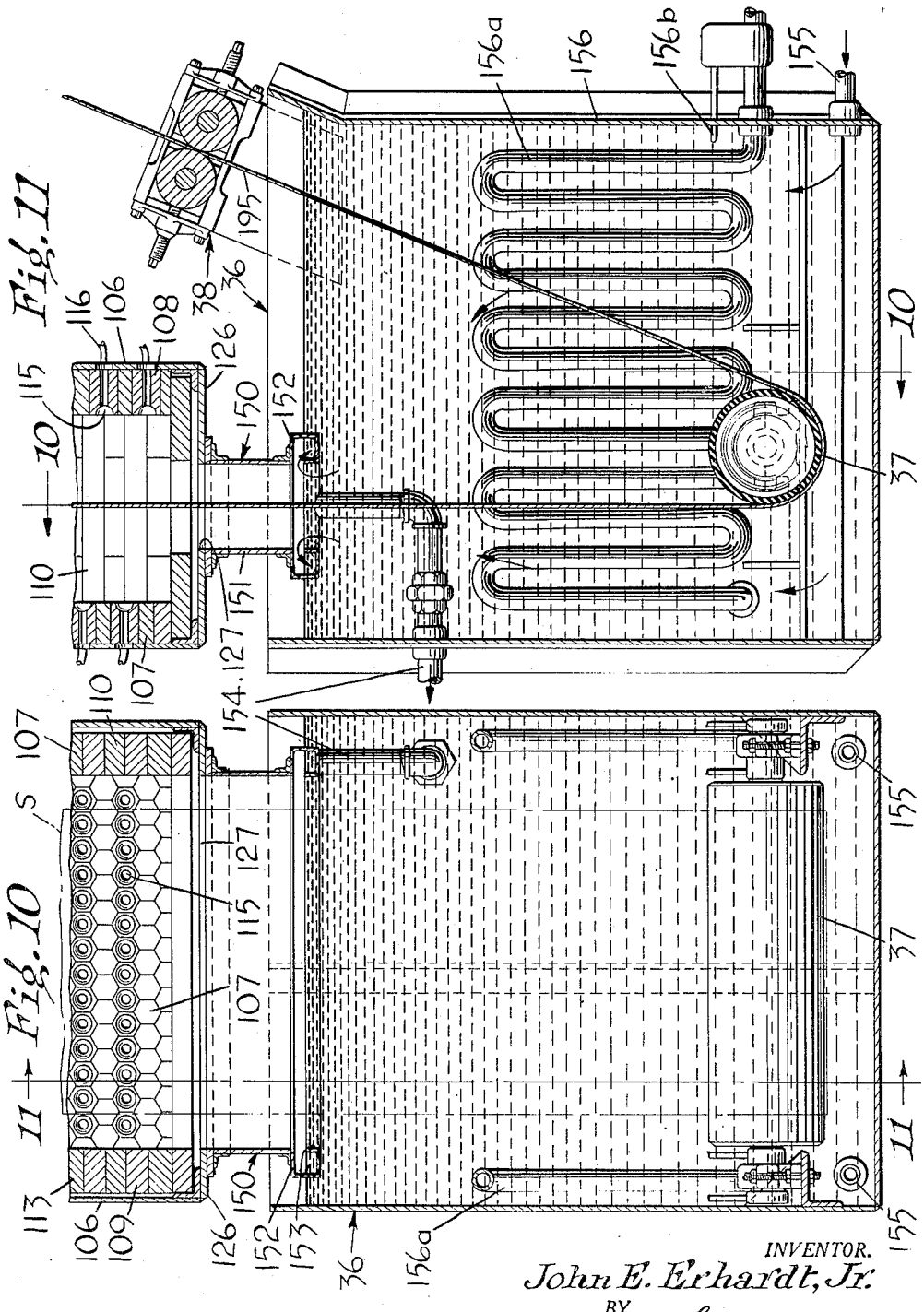
Fig. 9

INVENTOR.
John E. Erhardt, Jr.
BY
Cushman, Darby & Cushman

March 27, 1951 J. E. ERHARDT, JR 2,546,538

APPARATUS FOR HANDLING AND BRIGHTENING METAL

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APPARATUS FOR HANDLING AND BRIGHTENING METAL

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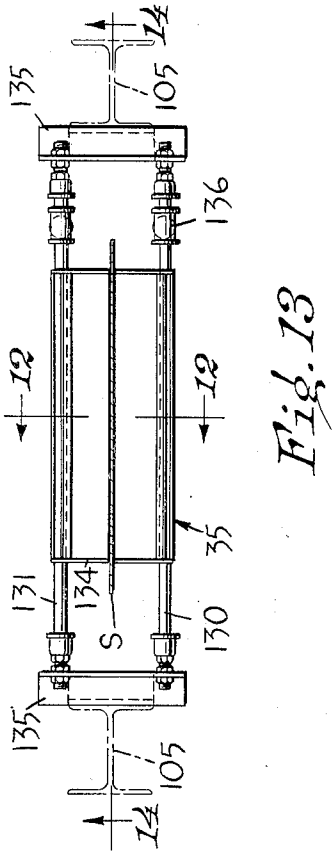


Fig. 13

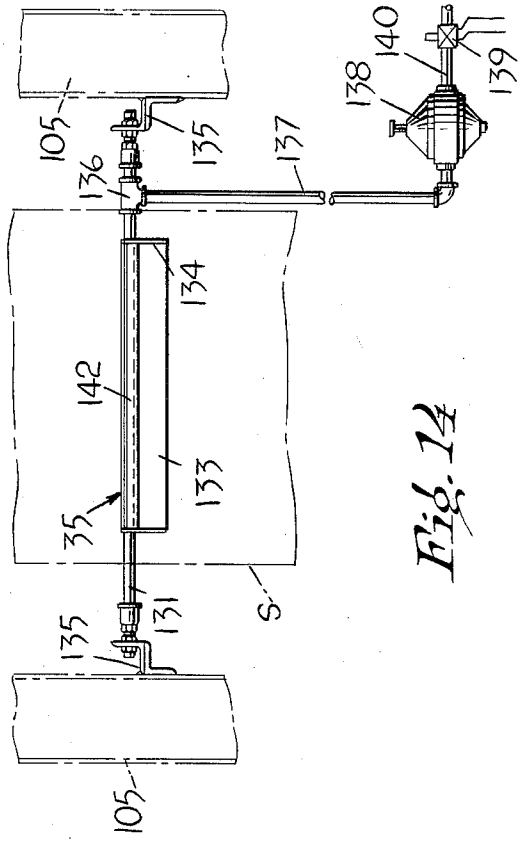


Fig. 14

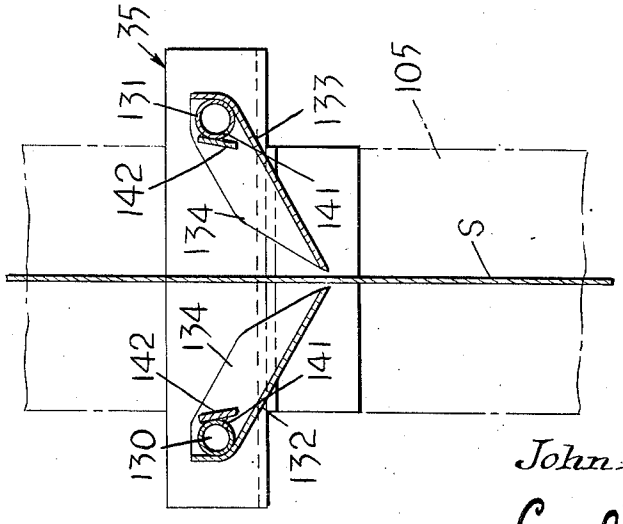


Fig. 12

INVENTOR.
John E. Erhardt, Jr.
BY
Cushman, Darby & Cushman

March 27, 1951 J. E. ERHARDT, JR 2,546,538

APPARATUS FOR HANDLING AND BRIGHTENING METAL

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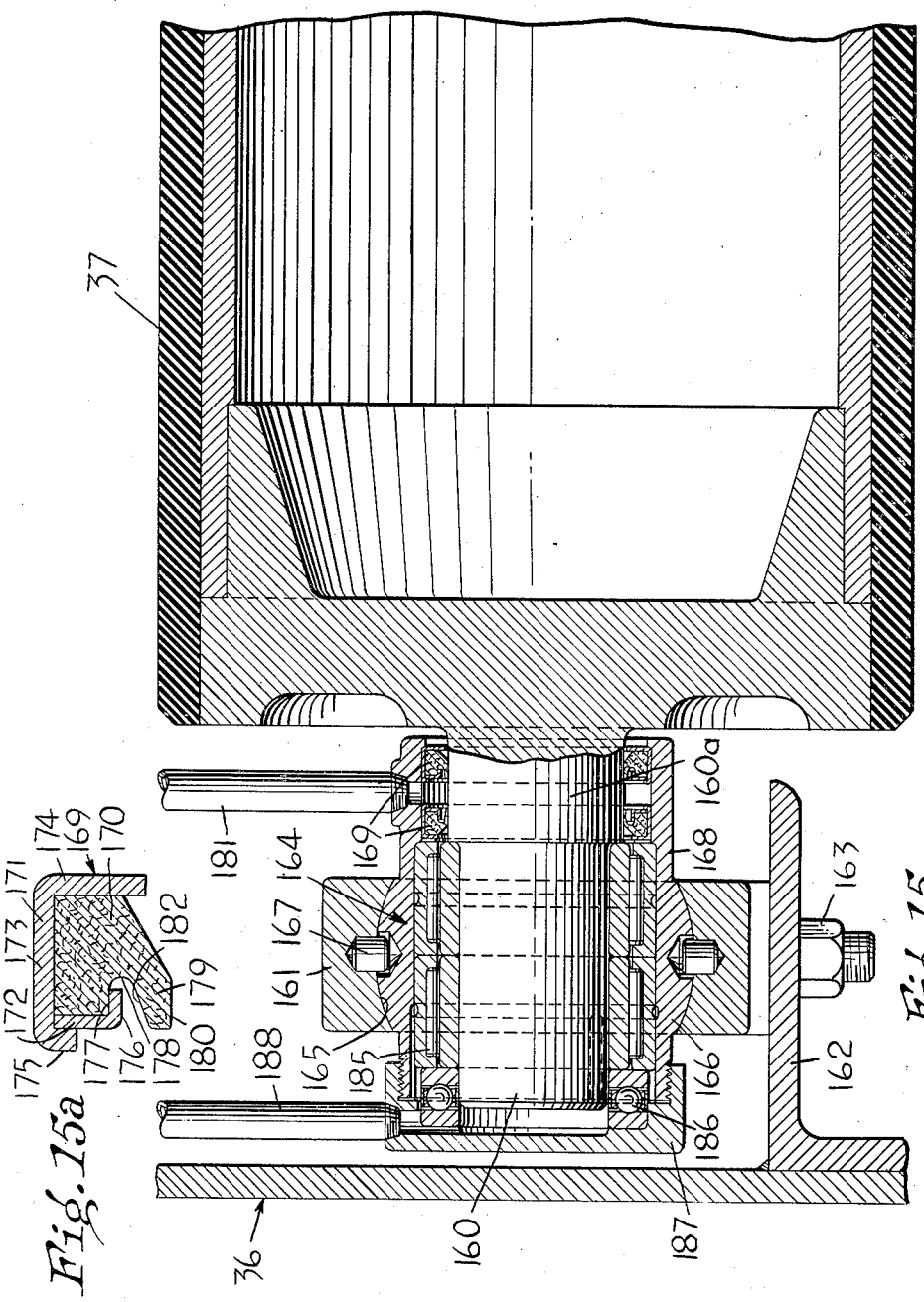


Fig. 15

Fig. 15a

INVENTOR.
John E. Erhardt, Jr.
BY
Cushman, Darby & Cushman

March 27, 1951 J. E. ERHARDT, JR 2,546,538

APPARATUS FOR HANDLING AND BRIGHTENING METAL

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Fig. 16

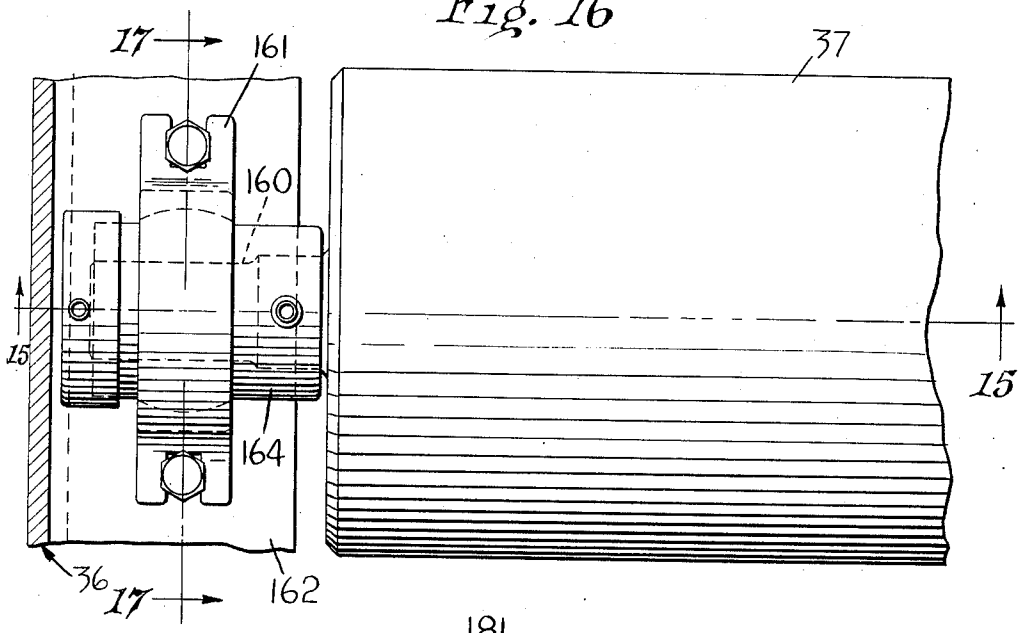
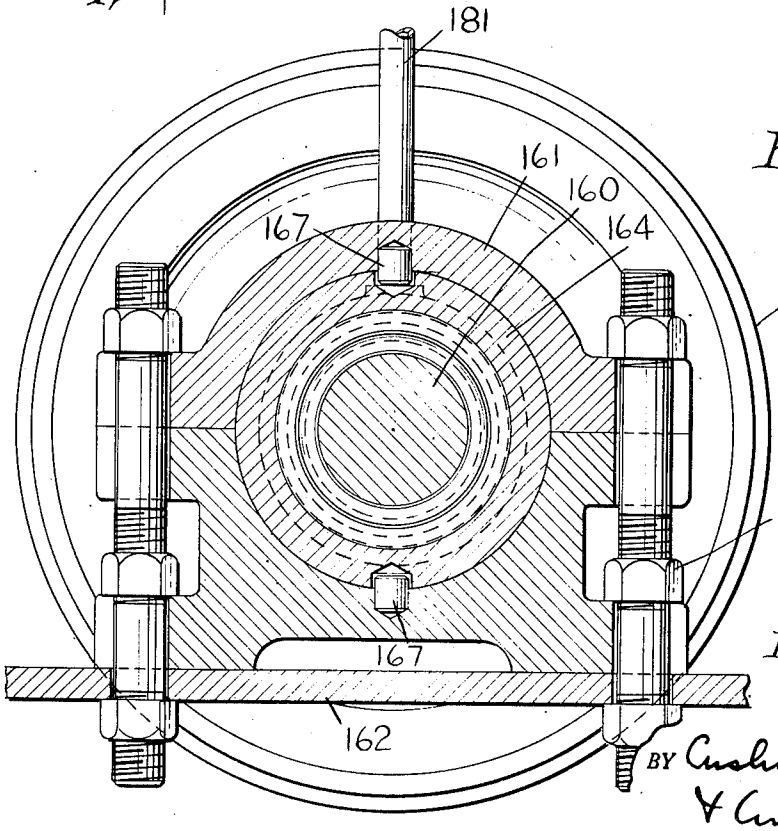


Fig. 17



John E. Erhardt, Jr.
INVENTOR.

BY Cushman, Darby & Cushman

March 27, 1951 J. E. ERHARDT, JR 2,546,538

APPARATUS FOR HANDLING AND BRIGHTENING METAL

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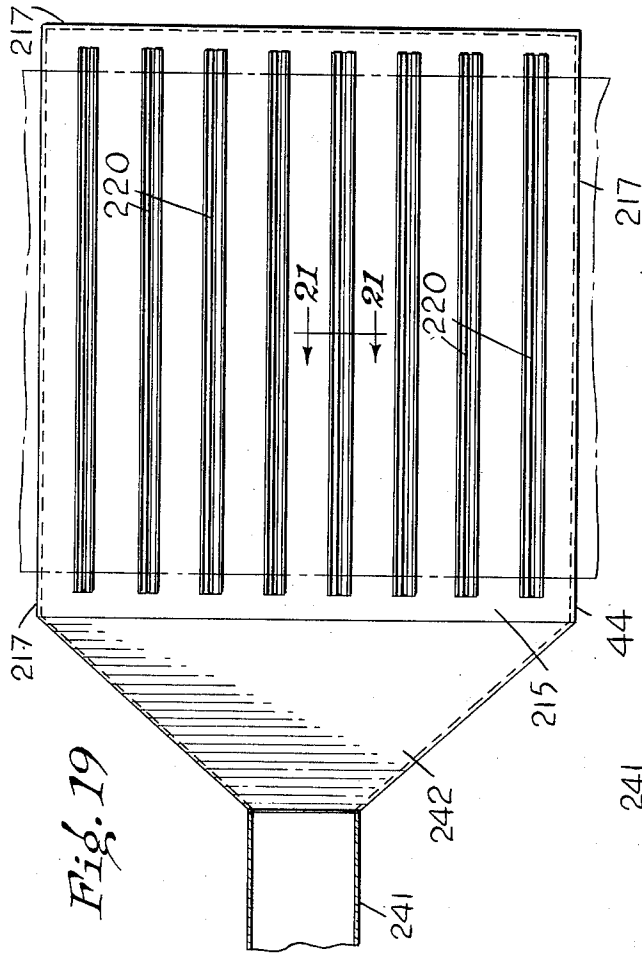
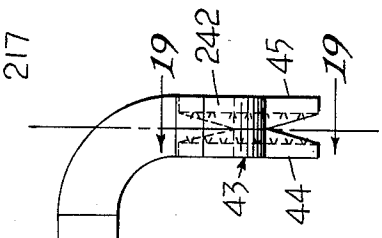


Fig. 19



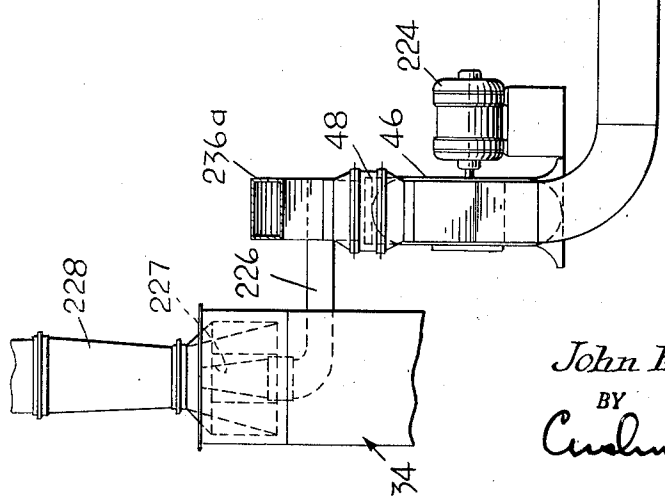


Fig. 18

INVENTOR.
John E. Erhardt, Jr.
BY
Cushman Darby & Cushman

March 27, 1951 J. E. ERHARDT, JR 2,546,538

APPARATUS FOR HANDLING AND BRIGHTENING METAL

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Fig. 21

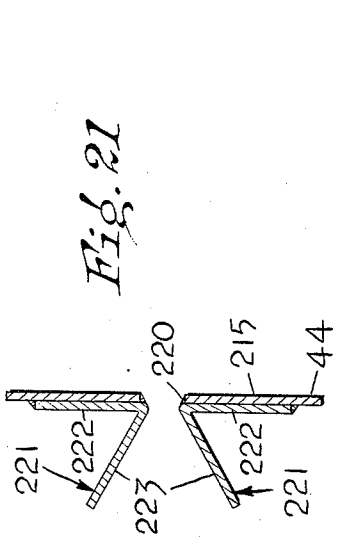


Fig. 20

INVENTOR.
John E. Erhardt, Jr.
BY
Cushman, Darby & Cushman

March 27, 1951 J. E. ERHARDT, JR 2,546,538

APPARATUS FOR HANDLING AND BRIGHTENING METAL

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Fig. 23

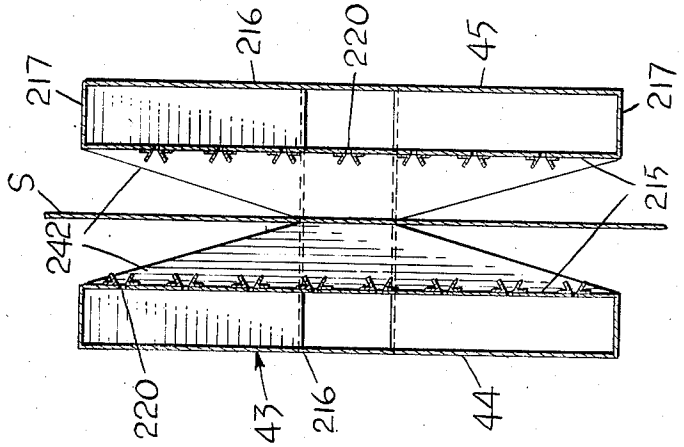
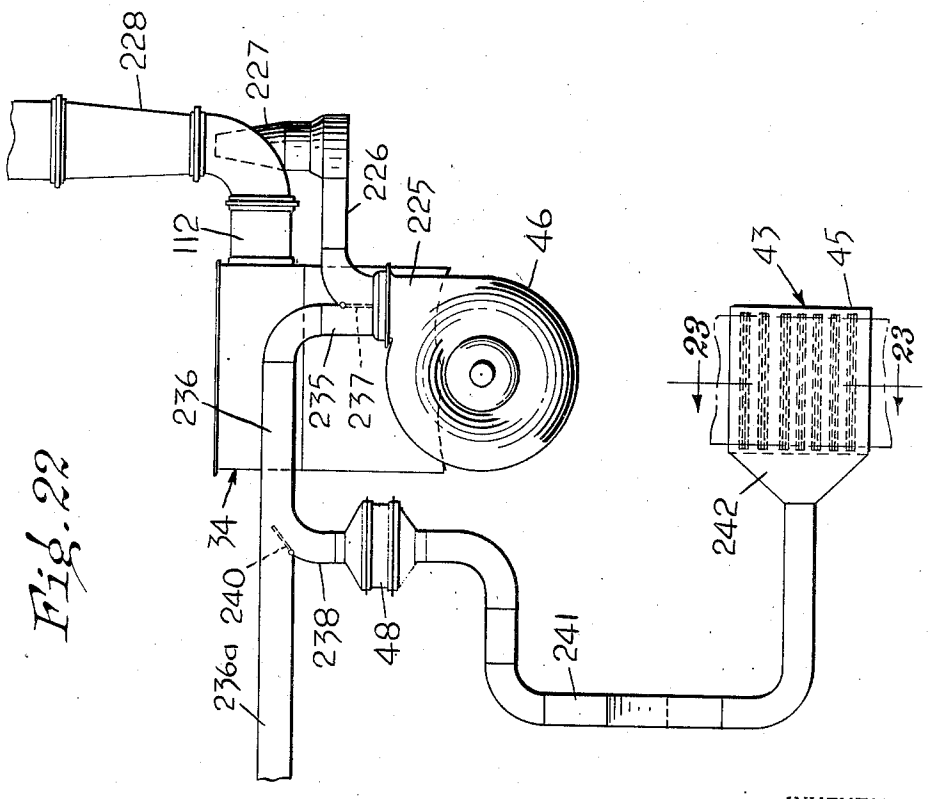


Fig. 22



INVENTOR.
John E. Erhardt, Jr.
BY
Cushman, Darby & Cushman

Patented Mar. 27, 1951

2,546,538

UNITED STATES PATENT OFFICE

2,546,538

APPARATUS FOR HANDLING AND BRIGHTENING METAL

John E. Erhardt, Jr., Baltimore, Md., assignor to Crown Cork & Seal Company, Inc., Baltimore, Md., a corporation of New York

Application October 30, 1945, Serial No. 625,505

6 Claims. (Cl. 266—3)

1

The present invention relates to apparatus for handling and brightening metal. Certain features of the invention relate to brightening fusibly coated metal, while other features involve handling metal strip, whether or not it bears a fusible coating.

Another object of the invention is to provide improved apparatus for use in brightening fusibly coated metal.

Previously developed methods and apparatus for brightening electroplated tin strip have involved heating the strip to a sufficient temperature to fuse the tin and then cooling the strip so that the tin coating would be left bright. However, by the previous systems, it was necessary to maintain the strip in a non-oxidizing or non-reducing atmosphere during the brightening and in order to prevent the strip from being pitted or burned. Maintenance of a non-oxidizing or non-reducing atmosphere required the use of special fuel and extremely close regulation of conditions within the furnace. In addition, the strip was moved through several vertical runs during the brightening, the reason for so moving the strip having been to enable it to be gradually brought to a temperature which would fuse the plating. Movement of the strip through a plurality of runs necessitated a structure including a great number of elevated heavy rolls to guide the strip in the various runs, as well as the provision of suitable walls in the furnace to separate or define the chambers through which each run passed. These two factors increased the initial and maintenance cost of the furnace.

An object of the present invention is to provide apparatus whereby a plated strip may be brightened in an atmosphere which includes oxygen but whereby pitting of the strip will be entirely avoided.

Another object of the invention is to provide an apparatus for brightening fusibly coated strip and whereby the brightening is accomplished during movement of the strip through a single vertical run.

Because fusing of the coating or plating and its cooling are accomplished by the present invention during a single vertical run, it is unnecessary to have the strip engaged by rollers or other guiding means while the coating is at a high temperature. Aside from eliminating the use of a large number of heavy rollers, marring of the tin-plate by contact with rollers and while the tin is soft is also avoided.

A further object of the invention is to provide an arrangement which will maintain the strip in

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the furnace at a low temperature if movement of the strip is stopped, and thereby protect it from being oxidized and burned through.

Another object of the invention is to provide a novel type of cooling or quenching bath for use in brightening plated metal strip, for example, tin-plate.

Still another object of the invention is to provide a rinsing chamber structure which is useful at numerous points in processes for handling metal strip.

Most rinsing operations performed upon moving metal strip have heretofore been carried out in tanks. The use of a tank necessitates the provision of rollers around which the strip moves in passing down into, through, and out of the tank. The rinsing chamber of the present invention is of such design that it can be positioned along a horizontal run of a strip. However, the chamber is so constructed that the washing or rinsing liquid will be confined to the chamber.

Another object of the invention is to provide a roll structure for use at submerged points in liquid containing tanks such as are provided at various points in strip handling processes.

Still another object of the invention is to provide a bearing for a submerged roller. the bearing being of such design that the liquid in which the bearing and roll are submerged cannot reach the bearing surfaces or elements.

A still further object of the invention is to provide an apparatus for drying the strip.

The drying apparatus included in the present invention is of such design that a flow of air at a controlled temperature can be directed against the strip.

Other objects and advantages of the invention will be apparent from the following specification and attached drawings wherein:

Figure 1*a* is a diagrammatic elevation showing certain apparatus through which a strip is passed before the brightening operation.

Figure 1*b* is a diagrammatic elevation of the brightening apparatus of the present invention, numerous portions of the apparatus being shown in vertical section.

Figure 2 is a transverse section of a rinsing chamber, the view being taken on the line 2—2 of Figure 5.

Figure 3 is a sectional view on the line 3—3 of Figure 2 as well as the line 3—3 of Figure 5.

Figure 4 is an enlarged sectional view of a nozzle arrangement included in the rinsing chamber structure.

Figure 5 is an elevation of the rinsing chamber, the view looking toward the top of the views shown in Figures 2 and 3.

Figure 6 is an end elevation of the rinsing chamber, the view being taken looking toward Figure 3 from the left.

Figure 7 is a diagrammatic view illustrating the arrangement of the heating burners in the brightening furnace. More particularly, the left-hand wall of Figure 7 shows the heating elements on the left-hand wall of Figure 8 while the right-hand portion of Figure 7 shows the heating elements on the right-hand portion of Figure 8.

Figure 8 is a vertical sectional view of the fusing chamber portion of the brightening furnace and showing the fuel supply connections to the burners.

Figure 9 is an enlarged sectional detail of a burner hose connection such as used in the assembly of Figure 8.

Figure 10 is a transverse vertical sectional view of a quenching tank, the section being taken on the line 10—10 of Figure 11.

Figure 11 is a vertical sectional view on the line 11—11 of Figure 10.

Figure 12 illustrates the strip cooling device, the view being a vertical section taken on the line 12—12 of Figure 13.

Figure 13 is a top plan view of the strip cooling mechanism.

Figure 14 is a vertical sectional view on the line 14—14 of Figure 13.

Figure 15 is a longitudinal sectional view showing a roll structure and a bearing therefor, the view being taken on the line 15—15 of Figure 16.

Figure 15a shows an enlarged detail of the Figure 15 structure.

Figure 16 is a top plan view of the roll structure of Figure 15.

Figure 17 is a transverse sectional view on the line 17—17 of Figure 16.

Figure 18 is a side elevation of the blower duct used with the furnace and connected to the strip drier.

Figure 19 is a sectional view on the line 19—19 of Figure 18, the view showing one drier element or box in elevation.

Figure 20 shows the structure of Figure 18 in top plan.

Figure 21 is a detail section taken on the line 21—21 of Figure 19.

Figure 22 is another showing of the duct, blower and drier assembly, this view being taken looking toward Figure 18 from the right of the latter figure, and

Figure 23 is a sectional view of the drier taken on the line 23—23 of Figure 22.

The principal elements of the present apparatus and their general operation are as follows: Referring to Figure 1a a strip of metal S', ordinarily a steel strip of a width of approximately thirty inches, is passed through a picking tank 25, then between pinch rolls 26, into a rinse tank 27, and then through the apparatus 28 which will electro-plate a tin coating upon strip S' to produce the plated strip S. The pickling, rinsing and electro-plating operations just referred to are described in the application of William B. Cooper and Charles E. Glock for Apparatus and Method of Coating, filed December 24, 1941, Serial No. 424,402 now abandoned. The plated strip S then moves over a roll 29 and through a rinse chamber 30 illustrated in detail in Figures 2 to 6. In the rinse chamber the strip is subjected to a spray of water or other suitable wash liquid, the chamber 30 being of such construction that no liquid can be jetted therefrom. In addition, the rinse chamber 30 includes rubber-covered rolls 32 which remove all surplus water or rinsing liquid from the strip before the latter leaves the rinse chamber.

The strip S then moves upwardly (Figure 1b) to a roll 33 positioned above the brightening furnace 34 and passes down about roll 33 for movement in a vertical run through the furnace. A strip cooling device 35 shown in detail in Figures 12 to 14 is positioned immediately below roll 33. The purpose of device 35 is to enable water to be jetted upon the strip in the event that movement of the strip should be stopped. The water thus jetted upon the strip will flow downwardly along the vertical run to prevent the portion of the strip within the furnace 34 from being burned and thereby disintegrated by the oxidizing action which will occur when the strip is stopped while the furnace is at normal operating temperature.

The brightening furnace 34 is illustrated in detail in Figures 7 to 9, with an additional showing of its lower end structure appearing in Figures 10 and 11. Generally speaking, the brightening furnace 34 comprises a tower open to atmosphere only at its upper end and with burners positioned adjacent its lower end so that rising products of combustion will pre-heat the strip S as it moves downwardly through the upper portion of the furnace. The lower end of the furnace 34 has a water-sealed connection with a quench tank 36 illustrated in detail in Figures 10 and 11. During its movement past the burners of the brightening furnace 34, the tin coating on the steel strip will be fused so that it will flow. While the coating is in this condition, the strip moves into the quench tank 36 and the coating is thereby instantly hardened so that the strip will be brightened, i. e., all small protuberances upon or other roughness of the surface of the strip will be smoothed out and a bright mirror-like finish will be imparted to the strip.

A roller 37 of the detailed structure best shown in Figures 15 to 17 is journalled at the bottom of the quench tank 36, the roller 37 being rubber-covered and provided with a bearing structure which includes means to prevent the quenching liquid reaching the bearing surfaces. After movement about roller 37, the strip moves upwardly and between rolls included in a wringer roll assembly 38 which removes surplus quenching liquid from the strip. After movement through a short horizontal run, the strip moves in vertical runs through a chemical treatment tank 39. During movement through the tank 39, the strip will be subjected to known treatments whereby its surface will be given an adequate affinity for lacquer or other coatings. Tank 39 preferably comprises two compartments 40 and 41. The strip moves through the compartment 40 in vertical loops, this compartment being filled with the treating solution. Compartment 41 is ordinarily empty and is used to store the treating solution when the treating solution compartment 40 is being cleaned. A pump, as shown, may be included in the tank structure to enable the treating solution to be moved from one compartment to the other.

After the strip S leaves the chemical treatment tank 39, it will be passed through wringer rolls 42 which will remove excess treating liquid from the strip. Then, in a horizontal run, the strip passes through rinse chamber 30a which is identical in structure with the previously de-

scribed rinse chamber 30. Beyond rinse chamber 30*a* the strip moves in a vertical run through a drier 43 designed to remove all moisture from the strip.

The drier 43 and the duct and blower system associated therewith are illustrated in detail in Figures 19 to 23. Generally speaking, the drier 43 comprises two outlet boxes 44 and 45, one positioned on each side of the strip as shown in Figures 1*b* and 23. Each outlet box is provided with outlet openings through which air of the proper temperature is directed against the strip as it moves through the drier. The outlet boxes are supplied with air of the desired temperature by a blower and duct system shown in Figures 18, 20 and 22. The air is forced through the ducts by the blower 46 which also serves to create a forced draft in the upper portion of the brightening furnace 34 through a duct 47. The temperature of the air directed against the strip S by the drier 43 may be controlled by a heater 48 mounted in the duct system between blower 46 and drier 43.

After the strip S has been dried, it moves through a series of main pinch rolls 50. As is shown in my divisional application S. N. 180,683, filed August 21, 1950, for Apparatus for Handling Metal Strips, the lower pinch roll 51 of the series 50 is driven by a motor. The pinch roll structure 50 imparts the necessary drive and tension to move the strip through the elements shown in Figures 1*a* and 1*b* and which are in advance of the rolls 50 and to the rear of the auxiliary pinch rolls 26 of Figure 1*a*. The auxiliary pinch rolls 26 diagrammatically illustrated in Figure 1*a* exert tension upon the strip to move it through the pickling tank 25 and the usual elements in advance of tank 25. In short, the strip is driven by the auxiliary pinch rolls 26 while it is moving through the infeed portion of the electrolytic coating apparatus and the portion of the strip moving through the remainder of the electrolytic apparatus and through the apparatus of Figure 1 is driven by the main pinch rolls 50. The motor 54 for the auxiliary pinch rolls is electrically connected with the motor 52 of the main pinch rolls 50 as schematically shown in Figure 1*b* so that both sets of pinch rolls will be driven in synchronism. The provision of main pinch rolls at a point in the brightening apparatus which is beyond all of the strip treating elements is highly advantageous because it insures that the strip will be under uniform tension during its movement through all of these elements.

As is shown in Figure 1*b*, the strip S moves from the main pinch rolls 50 directly to the outlet looper 55. Looper 55 includes an upper vertically movable sheave carrying platform 56. As best shown in Figure 1*b*, the platform 56 is connected by suitable cables passing through a main sheave and auxiliary sheaves to counterweights 57. In order to control the anti-crash braking system, strip breakage detectors 58 and 59 (Figure 1*b*) are provided immediately in advance of the drier 43 and immediately beyond the looper 55, respectively. These detectors are electrically connected with the brake. Location of these detectors at the points specified, i. e., the points of greatest tension, insures that the anti-crash devices will be highly responsive to any breakage.

Immediately beyond the second detector 59 the strip S moves through a pair of rolls designated by the numeral 60 and by means of which the strip may be gripped. From the roll 60 the strip is directed to coiling drum 61 upon which the strip may be wound into a coil. Shearing means, not shown, will be positioned between the tension rolls 60 and the coiling drum 61. In accordance with usual practice, when a full coil has built up on the coiling drum 61, the tension rolls 60 will be held against movement so that the strip will be clamped between these rolls. The strip will then be sheared between the tension rolls and the coiling drum and the full coil removed from the coiling drum. During this interval of time, the looper 55 will take up the supply of strip which is moving through the apparatus. The sheared end of the strip will then be connected to the coiling apparatus and the tension rolls 60 released for normal operation and during which operation the looper will gradually feed out the strip which has accumulated thereon during the stoppage.

The detailed construction and operation of each element of the apparatus is hereinafter disclosed.

Rinsing chamber

The rinsing chambers 30 and 30*a* are identical in construction, and therefore, only the detail construction of the chamber 30 will be described. Figures 2 to 6, inclusive, illustrate the rinsing chamber 30, which is of rectangular box-like shape including a bottom wall 70, a top wall 71, side walls 72 and end walls 73 and 74, respectively. It is to be understood that the designation of these walls as top, side or end walls is for the purpose of the present description because, as is hereinafter explained, the rinsing chamber 30 need not be positioned in a horizontal plane and with the various walls in the positions shown in Figure 1*b*.

The various walls of the rinsing chamber 30 are rigidly secured together except that the top wall 71 is pivoted as indicated at 71*a* to the end wall 74, thereby making the interior of the chamber accessible. The free end of the top wall 71 is secured in closed position by means of the fastening devices 71*b*.

The strip S moves into the chamber through a slot 75 provided in the end wall 73 as best shown in Figure 3. The strip then passes between rolls 32 of a pair 76, then between spray nozzles 77 positioned inwardly of the roll pair 76, and then moves between a roll pair 78. Immediately beyond the last mentioned pair of rolls the strip moves out of the chamber through a slot 79 formed in the end wall 74.

As best shown in Figure 6, the slot 75 in the end wall 73 is of slight width but is of a length which closely approximates the width of the strip S. As best shown in Fig. 3, flanges 80 inwardly from wall 73 along both of the long edges of the slot. These flanges converge to a point adjacent the roll pair 76 and so that their free ends will be close to the strip. The ends of the flanges are closed by walls 80'. The slot 79 in the opposite end wall 74 of the chamber is provided with flanges 80*a* which converge toward the interior of the chamber and near the roll pair 78 in a manner identical to that described in connection with the flanges 80.

As best shown in Figure 3, the side walls 72 are provided with slide-ways 82, one slide-way being provided at each end of each wall 72 so that the chamber includes a pair of opposed slideways at each end thereof. A plate 83 and a plate 84 are mounted in each slide-way, the plates 84

being the lowermost plates in Figure 3. The plates 84 are secured against movement in the slide-ways but the plates 83 are slidable longitudinally of the slide-ways, being held in the adjusted position by means of adjusting bolts 85 which extend to the exterior of the wall 71 and are threaded in bosses 86 on that wall. Each plate 83 and 84 has a bearing 87 mounted therein for one of the rolls 32 of the pairs 76 or 77. It will be observed that by this construction the position of each uppermost roll 32 with respect to its opposed lower roll may be adjusted so that rolls will closely contact with the strip. Suitable piping such as generally indicated by the numeral 88 may be provided to enable the various bearings 87 to be supplied with lubricant from a lubricant fitting 89 mounted in the top wall 71 of the chamber.

Water or other rinsing liquid may be supplied to the rinsing chamber through a manifold 90 (Figures 5 and 6) connected to a suitable source of supply. Manifold 90 has branches 91 secured to it which extend toward the lower and upper walls 70 and 71 and, as best shown in Figures 2 and 3, these pipes extend to upper and lower headers 92 and 93, respectively, which extend parallel to the rolls. It will be observed from Figure 3 that a number of headers are provided on each side of the strip. Each header is fitted with a number of nozzles 77, the nozzles including deflectors 95 which serve to spread the water moving from the nozzles as shown in Figure 2 and also direct the jet toward the sheet along a line which is at an obtuse angle with respect to the sheet as best shown in Figure 3. Figure 3 indicates how the sheet moves through the chamber 30 from the left to the right of that figure and it will be observed that the jets face toward the approaching sheet.

The end walls 73 and 74 and the bottom wall 70 are provided with threaded outlets 98, 99 and 100, respectively. When the chamber is used in connection with the strip moving in a horizontal run, the outlet 100 will be fitted with a water outlet line 101 because the outlet 100 will then be the lowermost outlet. At such time the outlets 98 and 99 will be closed with suitable plugs. However, if the casing is mounted adjacent a vertical run, either of the outlets 98 or 99 may have an outlet line connected thereto, depending on which outlet is lowermost. In such case the other end wall outlet and the outlet 100 will be plugged.

The rinsing chamber 30 described above insures that a rapidly moving strip may be thoroughly rinsed and without the necessity of any large tank structure. The rolls 32 positioned adjacent the inlet slot 75 cooperate with the converging flange structure of that slot to prevent water from moving outwardly through the slot. The rolls 32 positioned adjacent the outlet slot 79 have a similar cooperation with the flanges of that slot. In addition, by having the rolls 32 in close engagement with the strip, excess water is removed from the strip by the rolls.

The rinse chamber structure included in the present invention is highly advantageous in a strip line because it enables a strip to be rinsed or washed at any point in the line and without the necessity of providing a tank or the rolls necessary to guide a strip downwardly into a tank, and then upwardly, and then over the edge of the tank.

As has been indicated above, the chamber 30 can be positioned in any plane. In any position, the rolls and converging flanges will prevent liquid from reaching the exterior of the chamber. It will also be understood that if the strip is to move in a direction opposite to that shown in Figure 3, the nozzles 95 may be turned 180° to cause water to impinge upon the advancing sheet.

Brightening furnace

As best shown in Figure 1*b*, the brightening furnace 34 is in the form of an enclosed tower with vertical beams 105 extending above it to support the journals for the roll 33. The furnace includes an outer casing formed of metal plates and designated by the numeral 106. Two opposite walls 107 and 108 are somewhat wider than the width of the strip to be passed through the furnace. The remaining walls 109 and 110 lie opposite the edges of the strip and therefore are of less width than the walls 107 and 108. At the extreme upper end of the enclosed portion, a pair of spaced ducts 111 and 112 communicate with the furnace to withdraw the products of combustion therefrom as hereinafter explained. Above these ducts, the furnace is closed by plates 112*a* adjustable with respect to each other to define a slot 112*b* (Figure 20) through which the strip enters the furnace.

From a point downwardly of the ducts 111 and 112, the furnace is lined with firebrick 113. At a point approximately three-fifths of the distance from the ducts to the lower end of the furnace, the firebrick lining extends inwardly to form a ledge as indicated at 114, and thereby reduce the furnace bore at this point. Below this ledge, the wider walls 107 and 108 have burner nozzles 115 extending therethrough and fitted between firebrick elements as best shown in Figures 8 and 10. As best shown in Figure 10 the burner nozzles 115 are arranged in horizontal rows in the walls 107 and 108. However, as indicated in Figure 11 and also in Figure 7, the horizontal rows of nozzles of the respective walls are vertically staggered with respect to each other. Each nozzle 115 has a flexible tube or line 116 extending therefrom to a manifold, a manifold being provided for each row of nozzles. As shown in Figure 8, a manifold 117 for a horizontal row 115*a* of burners in the wall 107 is connected by a line 118 to the manifold 119 for the substantially opposite row 115*b* of burners in the other wall 108 and a valve 120 (Figure 1) may be provided to control the connected pair of manifolds. The valve 120 is mounted in a branch line 121 which connects the pairs of manifolds to the main fuel supply line 122.

It will be observed that by connecting the opposed manifolds in pairs and providing a valve 120 for each pair, the burners in the furnace can be separately controlled in horizontally extending banks.

The valves 120 are hand-operated valves for emergency shut-off and flow of fuel ordinarily will be controlled by a solenoid operated valve 120′ (Figure 1*b*) positioned adjacent each valve 120. For the purpose of clarity, Figure 1 shows valves only for every other pair of manifolds.

The fuel supplied to the burner nozzles is a "premixed" gaseous fuel. However, for the reasons hereinafter set forth, the fuel need not be non-oxidizing.

The operation of the brightening furnace in connection with the movement of a strip therethrough is as follows: The strip S moves downwardly over the roll 33 at a speed ranging from 200 to 550 feet per minute, depending upon

the width and thickness of the strip and the thickness of its coating, a narrower and thinner strip, with a thin coating, moving at the higher range. With a thirty inch wide strip, having a thickness of .009 of an inch, and with a one-half pound per base-box coating, the strip would move at approximately 380 feet per minute. With the burners in operation, the temperature in the lower or fusing portion 123 of the furnace, i. e., the portion below ledge 114, will range from 2300° F. to 2500° F. However, the rapid movement of the strip will cause the latter to be heated to from 450° to 500° F. The above temperature figures are given for the case of tin coated steel plate, tin having a fusing temperature of 449.5° F. It will be observed that the tin coating will be fused by passage of the strip through the burner equipped lower zone or portion 123 of the furnace. The downwardly moving strip and inwardly extending ledge or baffle 114 slightly retard upward movement of the gases of combustion from the burners and so that an area of high temperature will be provided in the portion 123 beneath ledge 114. However, the gases of combustion will rise past the ledge 114 and into the upper portion or zone 124 to maintain a temperature there which will be somewhat lower than that in the fusing zone 123 so that the tin may not become molten while moving through zone 124. Nevertheless, the tin will be pre-heated in the zone 124 to a sufficient extent that the tin coating will be only slightly below fusing temperature by the time that it enters the fusing zone 123. The major portion of the products of combustion will be drawn off through the ducts 111 and 112 as hereinafter explained.

As is illustrated in Figures 10 and 11, the extreme lower end of the furnace is closed by a horizontally extending wall 126 including an opening 127 therein through which the strip may move from the furnace. However, as is subsequently described, this end of the furnace is sealed against the entrance of atmospheric air by the quench tank 36.

It will be noted that the brightening furnace 34 is of such design that no roll contacts with the strip during its descent through the furnace. Also, no rolls are mounted in the hot atmosphere of the furnace, roll 33 being well above the furnace. Therefore, when any area of the strip is moving over the upper roll 33, that strip area is at normal temperature so that its coating of tin or other fusible material is still hard. During the remainder of its downward travel, the strip has no contact with any guiding means. Therefore, when the tin becomes heated to a fusing temperature, it will fuse to a smoothly flowing coating without any possibility of being marred or scratched in any way before it is again hardened by quenching as subsequently explained.

In a furnace designed for movement of a strip therethrough at a speed of the range stated above, the fusing zone 123 would be approximately six feet long, pre-heating zone 124, including the ducts 111 and 112, would be eleven feet long, and roll 33 would have its axis about twelve feet about the wall 112*a*. The ducts would be approximately three feet high.

Strip cooling device

The strip cooling device 35 is best illustrated in Figures 12 to 14 although Figure 1*b* shows its relationship to the upper end of the furnace 34 and the roll 33. As best shown in Figure 12, the strip cooling device 35 comprises apertured pipes 130 and 131 which extend horizontally and parallel with the opposite faces of the strip S. Each of the pipes 130 and 131 has a tray or plate 132 and 133, respectively, secured thereto with the plates inclined downwardly and toward the strip S. The lateral ends of the plates have walls 134 extending upwardly therefrom. The pipes 130 and 131 are supported on brackets 135 secured to the vertical beams 105 and each pipe is connected at one end by a fitting 136 to a line 137 which leads to a pressure regulator 138. A solenoid actuated valve 139 is connected in the supply line 140 which delivers water to the pressure regulator 138 from which it flows to the horizontal pipes 130 and 131. The pipes 130 and 131 have ports 141 spaced along the same, the ports preferably being drilled on axes which extend substantially parallel with the plates or trays 132 and 133, respectively, and facing the free ends of the trays. A deflector plate 142 is secured to each of the ported pipes 130 and 131 as illustrated in Figure 12, i. e., to deflect the jets from the pipes downwardly for flow upon the trays 132 and 133 and then upon the strip S.

The operation of the strip cooling device is as follows: If it becomes necessary to stop the movement of the strip S for any reason and while the furnace is at normal operating temperature, the solenoid valves 120' of the burner fuel supply lines will immediately be operated to extinguish the burners 115. However, the temperature of approximately 2300° F. and the oxidizing atmosphere in the fusing zone 123 would almost immediately burn and destroy the length of strip S which is in that zone. Operation of solenoid controlled valve 139 in the water supply line 140 will result in a flow of water from the apertured pipes 130 and 131 which will cause both sides of the strip to be completely covered and thereby protected by a sheet of water from a point just below the strip cooling device 35 to the surface of the liquid in the quench tank 36. When water first reaches the portion of the strip in the fusing zone 123, it will be converted to steam by the high temperature, but the steam will protect the strip and its protection eventually will be augmented by the continuously descending sheet of water. When the temperature of the furnace drops to a point below oxidizing temperature, the flow of water may be cut off.

The provision of the strip cooling device 35 eliminates the necessity of maintaining non-oxidizing atmosphere in the furnace. It is found that with a furnace supplied with a gas which results in oxidizing products of combustion, a tin-coated strip will completely burn and disintegrate within a few seconds if its movement through the furnace is stopped while the furnace is at the operating temperature indicated above. However, provision of the strip cooling device prevents this burning and disintegration because even though the water flowing down the strip may be converted to steam, it adequately blankets the strip at such a point against the surrounding temperature. For that reason, the provision of the strip cooling device 35 eliminates one of the principal reasons for maintaining a non-oxidizing atmosphere in a brightening furnace. Because the cooling water moves down along the strip into the quench tank from which it can overflow through an overflow arrangement hereinafter de-

scribed, no water will come into contact with the furnace structure.

Quench tank

The quench tank **36** is best illustrated in Figures 10 and 11 and is of open-topped formation including a bottom wall and four side walls. Tank **36** is positioned directly beneath the lower end of the furnace **34** and a substantially rectangular duct **150** extends downwardly from the bottom wall **126** of the furnace to a point below the upper edge of tank **36**. The duct **150** includes two long walls **151** which extend parallel to the long walls **107** and **108** of the furnace **34** and are somewhat longer than the width of the strip. The two remaining walls of the duct are sufficiently far apart to permit the strip to readily move through the duct. The lower end of the duct **150** has a trough **152** secured thereto, the trough preferably being rectangular in radial cross section but being open on its upper and inner quarter so that water or other quenching liquid in the tank **36** may flow over the inner edge **153** of the trough. An outlet pipe **154** extends downwardly from the trough **152** at one point in the length of the latter.

The roll **37** journaled in the lower portion of the quench tank is so positioned that the strip S may move in a straight vertical run from the roller **33** down to the roller **37** as best shown in Figure 1*b*, the strip passing about roll **37** and moving up out of the quench tank along a run which may be at an angle to the vertical. Quenching liquid, preferably water, is supplied to the quench tank through two delivery pipes **155** which open to the tank through the side wall **156** which is furthest from the trough **152** as shown in Figure 11. The diagrammatic showing of these pipes **155** included in Figure 10 illustrates their position with respect to the strip roll **37**; that is, the inlets are below the strip roll **37** and are beyond the edges of the strip moving about that roll.

The temperature of the quenching liquid in the quench tank **36** is controlled as follows: In handling tin-plate it is desirable that the quenching liquid have a temperature slightly below 200° F. at the point at which the molten tin coating first contacts with the liquid, i. e., in the portion of the liquid bounded by the trough **152**. If the temperature of the liquid in this area rises above 200° F., the water will become agitated and splash upon the descending strip so that quench marks will appear on the strip. Such marks detract from the desired bright finish.

When the quench tank **36** is to be placed in operation, the water in the tank may be brought to such a temperature that the heated strip will not raise its temperature above 200° F. This heating is obtained by means of a steam coil **156***a* immersed in the tank, the flow of steam being controlled by a valve controlled by a thermocouple 156*b* responsive to the temperature of the quenching liquid. When the movement of heated tin-plate into the tank begins, the incoming water will be supplied at a rate determined by the thermocouple, the latter being so adjusted that the water within the area bounded by trough **152** will not have a temperature in excess of 200° F. In the area immediately bounded by the trough **152**, the descending strip at a temperature of between 450° F. and 500° F. will raise the water in that area to 200° F. but this water will immediately flow into the trough **152** and leave the tank so that the temperature there will never exceed 200° F.

The construction of the outlet trough **152** is highly desirable because it withdraws water at the point at which the water reaches its highest temperature. In addition, because the trough **152** is located at the lower end of the duct **150**, the trough forms a seal about the lower end of the furnace **34** and prevents any upward drafts from entering the furnace. Air entering the furnace at this point would reduce the furnace temperature.

Submerged roll bearing structure

The detailed construction of the bearing for the submerged roll **37** is illustrated in Figures 15 to 17. Referring to Figure 15, roll **37** includes a stub shaft **160** at each end thereof. The purpose of the present bearing structure is to prevent the liquid surrounding the bearing from reaching the interior of the bearing.

The support **161** for each bearing is secured to a bracket **162** secured to a side wall of the tank **36**, the support being held to the brackets by threaded studs and spaced nuts as indicated at **163** in Figure 17. The support **161** is of two-piece form so that it readily can be disassembled. A housing **164** of sleeve-like form is positioned within the support and the inner surface **165** of the support **161** is spherically concave to receive a central enlargement **166** on the housing, the enlargement being spherically convex. This arrangement eliminates the necessity of having the supports **161** at each end of the roll **37** exactly in alignment. However, a pair of diametrically opposite pins **167** may be provided in the support **161** to loosely engage sockets in the housing **164** and thereby limit movement of the housing in the support.

The inner end **168** of the housing **164** extends to a point closely adjacent the end of the roll **37** and a pair of sealing members **169** are positioned within this end of the housing to bear upon the surface of the stub shaft **160** which is preferably enlarged at this point as indicated at **160***a*.

As shown in Figure 15*a*, each sealing member **169** includes a ring **170** of compressible and resilient material, the ring being enclosed in an outer metal collar **171** and an inner metal collar **172**, the outer collar **171** including an outer wall **173** and a side wall **174**. The other edge of wall **173** is turned inwardly as indicated at **175** and the inner collar **172** is positioned within the short flange thus provided. Inner collar **172** carries a short flange **176** at its inner edge and this flange lies against the outer wall **177** of a groove **178** in one side of ring **170** to thereby fix the position of the body of the ring **170** with respect to the periphery of the stub shaft or supported element **160**. The portion of the ring **170** inwardly of the groove wall **177** is in the form of a tongue **179** including a surface **180** adapted to bear on the periphery of the shaft **160** and the groove **178** provides an annular space which lies outwardly of this tongue.

As best shown in Figure 15, the two sealing members **169** are so positioned that they will be spaced apart and their grooves **178** will face each other. An air pressure line **181** is threaded in the housing **168** between the two sealing members so that air pressure flowing through the pipe **181** from a suitable source will move into the grooves **178** and thereby act upon the outer surfaces **182** of the tongues **179** to hold the inner surface **180** of those tongues in close engagement with the periphery of stub shaft **160**.

A roller bearing assembly designated by the numeral 186 and including inner and outer raceways is positioned in the housing 164 outwardly of the sealing members 169 and a thrust bearing 186 is positioned in the housing between the bearing 186 and a cap 187 threaded upon the outer end of the housing. A lubricant line 188 opens to the cap and the housing and the bearings are suitably grooved so that the lubricant may move to the same. The bearing assemblies 185 and 186 support the stub shaft or supported element 160.

The action of the sealing members 169 is as follows: Air is supplied through the tube 181 under a pressure greater than the head of the liquid in the quench tank 36, this pressure holding the inner surfaces 180 of the tongues 179 in sealed contact with the periphery of each stub shaft 160. As a result, the liquid in the tank 36 cannot move past the sealing members 169 to reach the bearing assemblies. The fact that the outer end of the housing assembly 160 is sealed by the screw cap will prevent liquid from entering the housing at that point.

Strip drier

The strip S moves from the quench tank 36 along an inclined run 195 as best shown in Figures 1*b* and 11. In order to remove the maximum amount of water or other quenching liquid from the strip at this point, a wringer roll assembly 38 is secured to the upper edge of the quench tank as best shown in Figure 11. Referring to Figure 1*b*, the run 195 extends to a roller 196 about which the strip moves to pass in a horizontal run and over a roller 197 beyond which the strip moves downwardly into liquid contained in a compartment 40 of a tank 39. The strip moves about a number of vertically spaced rolls associated with the tank compartment 40 so that it will pass through the liquid in the compartment in vertical runs. The submerged rolls provided in the compartment 40 may be mounted in the same manner as the submerged roller 37 illustrated in Figures 15 to 17 so that the liquid in compartment 40 will be excluded from the bearings.

The liquid in the compartment 40 is of such nature that it will give the strip a proper affinity for lacquer or other coating or decoration.

Tank 39 preferably includes a second and storage compartment 41 which is normally empty. When it is necessary to clean the treating compartment 40, the treating liquid may be moved from compartment 40 to the storage compartment 41 by operation of a pump 198.

On leaving the compartment 40, the strip S moves through wringer rolls 42 which remove surplus treating liquid from the strip. The strip then moves about a roller 205 to pass, in a horizontal run, through a rinse chamber 30*a* which is identical in construction with the rinse chamber 30. The rinse chamber 30*a* will remove all treating liquid from the strip and also all surplus water or whatever other liquid is used to wash the strip in chamber 30*a*. However, it is necessary at this point that the strip be thoroughly dried and, for that purpose, the strip moves from rinse chamber 30*a* about a roller 206 and between outlet boxes 44 and 45 included in a drier 43.

As best shown in Figures 19, 21 and 23, each of the outlet boxes 44 and 45 includes a body portion which is of rectangular and box-like form to include an inner wall 215, an outer wall 216, and three edge walls 217 which join the inner and outer walls. Each inner wall 215 is provided

with vertically spaced slots 220 (Figure 19) of a length approximating the width of the strip and angled members 221 best shown in Figure 21 are positioned on the outer face of the inner wall 215 immediately adjacent the edges of the slots 220. Each angled member 221 includes a portion 222 which lies upon the wall 215, the walls 223 of the two members 221 associated with each slot diverging toward their outer ends so as to direct air in a V-shaped stream against the opposite surface of the strip S.

The boxes are supplied with air under pressure by the following system: A blower 46 driven by a suitable motor 224 is positioned adjacent the brightening furnace 34 and has its outlet 225 (Figure 22) communicating with a duct 226 leading to a nozzle 227 positioned at the lower end of the furnace stack 228 so that air blown through the nozzle will move upwardly in the stack 228 to create a strong draft therein. The outlet ducts 111 and 112 at the upper end of the furnace 34 open to the stack 228 so that products of combustion will be withdrawn from the furnace by the action of the blower 46. The outlet ducts 111 and 112 may be provided with dampers 230 to regulate the volume of combustion gases moving therethrough so that the gases will not be drawn too rapidly from the furnace.

A duct 235 (Figure 22) also leads from the outlet 225 of the blower 46 and opens to a duct 236 including an outlet or waste 236*a* leading to the exterior of the plant. A damper 237 is positioned in the outlet 225 between the ducts 235 and 226. By swinging this damper to the right or left as viewed in Figure 22, the volume of air delivered from blower 46 may be divided between the stack nozzle 227 and the duct 236 as conditions require.

Duct 236 also communicates with a duct 238 leading to a steam-operated heater 48 and a damper 240 at the junction of the ducts 236 and 238 enables some or all of the air directed through duct 236 to move into the duct 238 and then to heater 48. A duct 241 leads from the outlet of heater 48, the duct 241 diverging into two branches 242 which respectively open to the outlet boxes 44 and 45 of drier 43 as shown in Figures 19 and 20.

In operation, referring to Figure 22, the blower will supply air to both of the ducts 226 and 235, the proportion delivered to each being determined by the damper 237. If conditions are such that drier 43 does not require all of the air blown through duct 235, damper 240 may be positioned to divert the excess through waste duct 236*a*. The remainder will pass through heater 48 and thence through duct 241 to the drier. If movement of the strip S is stopped and if blower 46 is still being operated at such time, damper 240 may be operated to direct all air supplied to duct 235 to waste duct 236*a*.

It will be observed that the duct system just described and the action of drier 43 will enable the strip to be thoroughly dried without the necessity of a blower other than the stack blower 46. Also, the construction of the slotted port outlet boxes 44 and 45 enables the strip to be dried without movement through a closed chamber or about any rolls.

The terminology used in the specification is for the purpose of description and not of limitation, the scope of the invention being indicated in the claims.

I claim:

1. In a strip handling apparatus, a vertically

extending furnace structure, means to move a strip downwardly in a vertical run through said structure, means adjacent the lower portion of the structure to heat the strip, and means adjacent the upper portion of the structure to flow a cooling liquid upon the run within the structure.

2. In a strip handling apparatus, means to move a strip of metal in a substantially vertical run, means to apply heat to the strip at a point on said run, and means above said last-named means to direct cooling liquid upon the strip so that the liquid will flow downwardly and substantially cover the strip.

3. In combination, a liquid-containing tank, means above the tank to heat a metal strip, means to guide the strip in a run through said heating means, downwardly into the liquid in the tank and upwardly out of the liquid, a horizontally disposed endless trough surrounding the downward run of the strip at a point adjacent the top of the tank, a liquid overflow line communicating with said trough, and liquid inlet means adjacent the bottom of the tank, said inlet means being positioned on the opposite side of said upward and outward run from said downward run.

4. In a strip brightening apparatus, a furnace including heating elements, means to move the strip through said furnace, means to apply cooling liquid to the portion of the strip in the furnace, and means responsive to strip breakage to render said strip moving means and the furnace heating elements inoperative and cause said liquid applying means to apply liquid to the strip.

5. A strip handling apparatus of the character defined in claim 1 wherein the means to flow a cooling liquid upon the strip includes a tray inclined downwardly toward the run.

6. A strip handling apparatus of the character defined in claim 2 wherein the means to direct cooling liquid upon the strip includes a tray inclined downwardly toward the run.

JOHN E. ERHARDT, JR.

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