

Dec. 2, 1941.

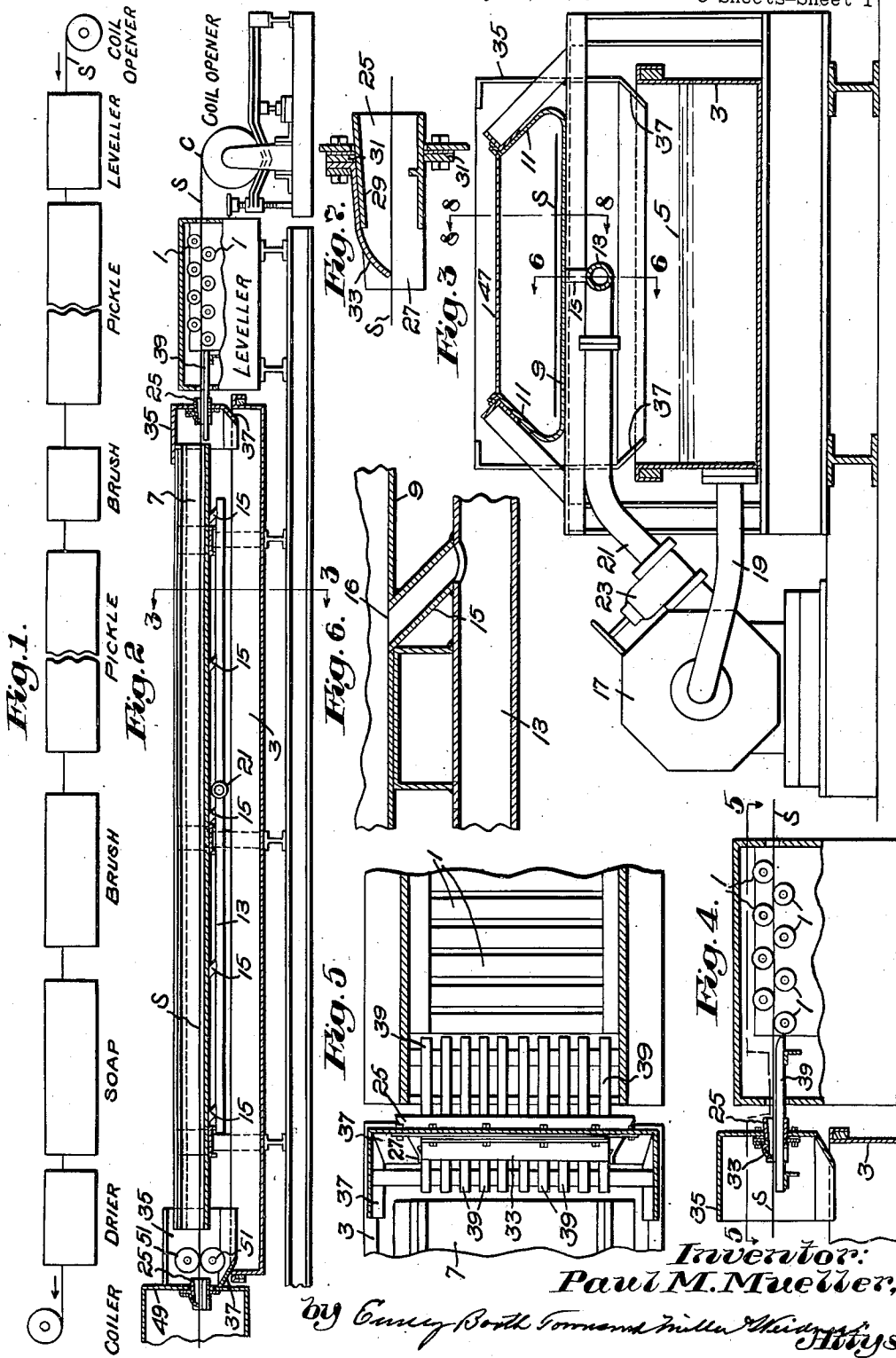
P. M. MUELLER

2,264,885

STRIP TREATING APPARATUS

Filed July 28, 1938

6 Sheets-Sheet 1



Dec. 2, 1941.

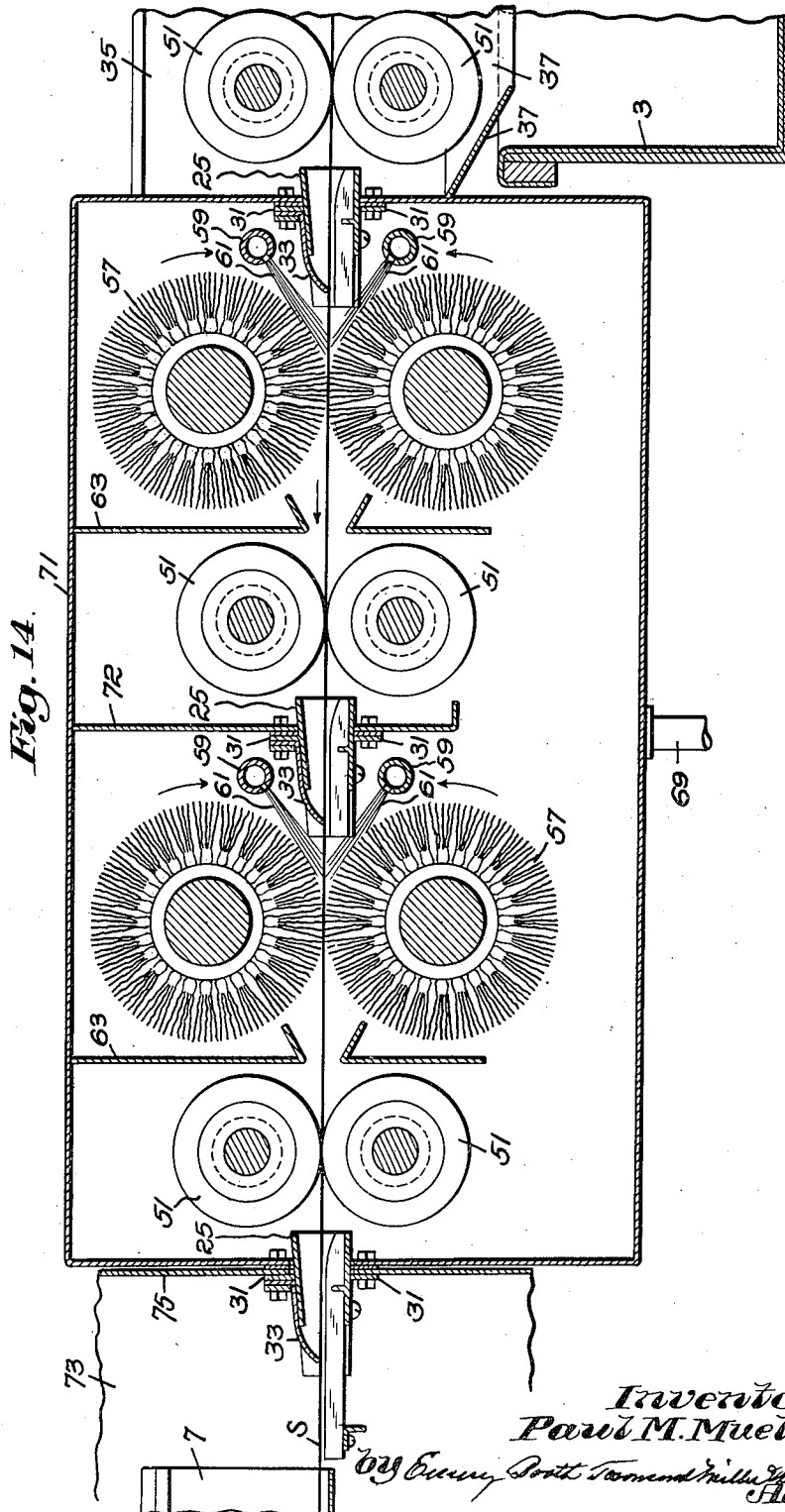
P. M. MUELLER

2,264,885

STRIP TREATING APPARATUS

Filed July 28, 1938

6 Sheets-Sheet 3



Inventor:
Paul M. Mueller,
South Townsend Mills, N.Y.
Albany.

Dec. 2, 1941.

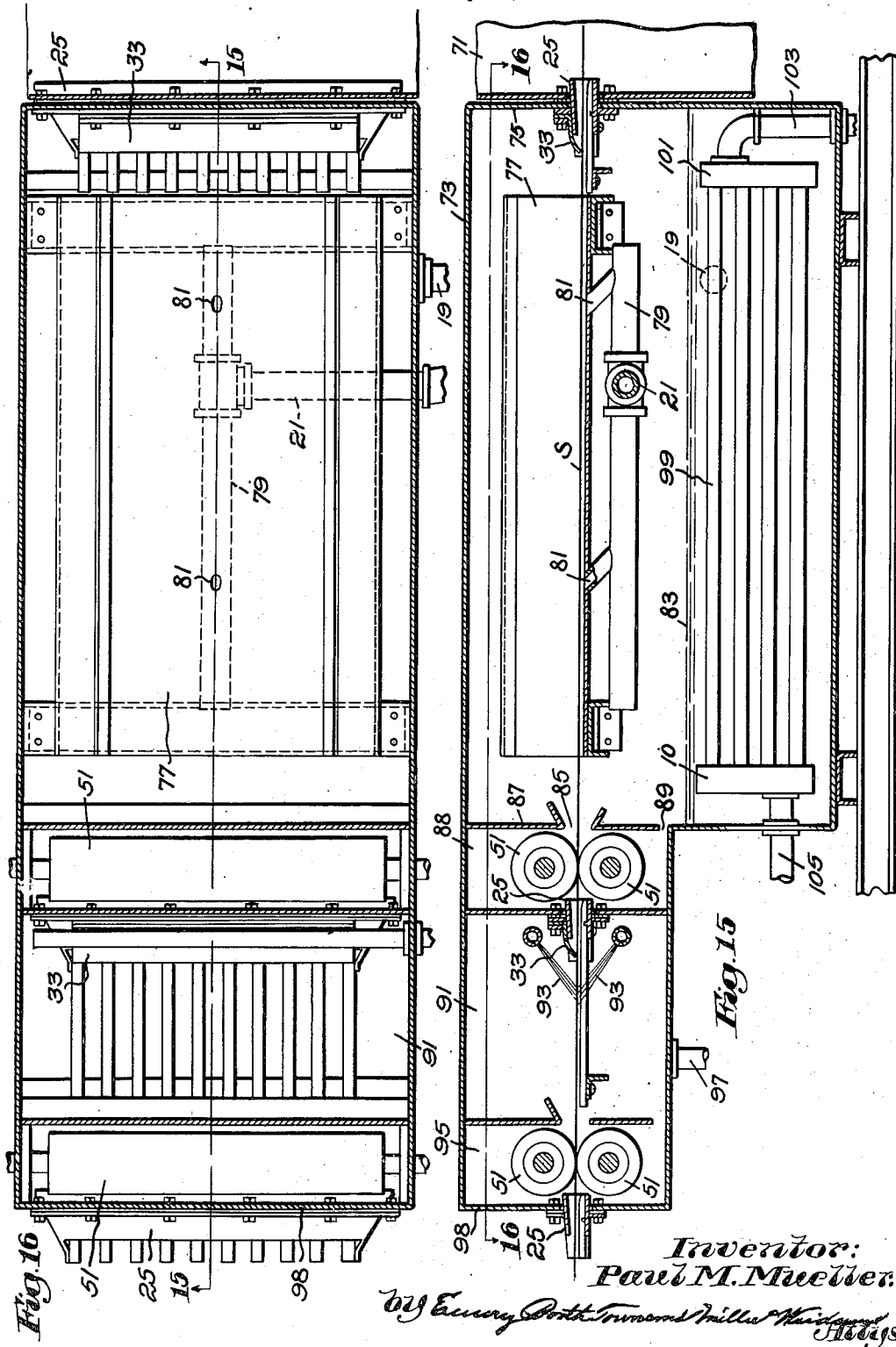
P. M. MUELLER

2,264,885

STRIP TREATING APPARATUS

Filed July 28, 1938

6 Sheets-Sheet 4



Inventor:
Paul M. Mueller

by Emory Roth Townsend Miller Hand
Attys

Dec. 2, 1941.

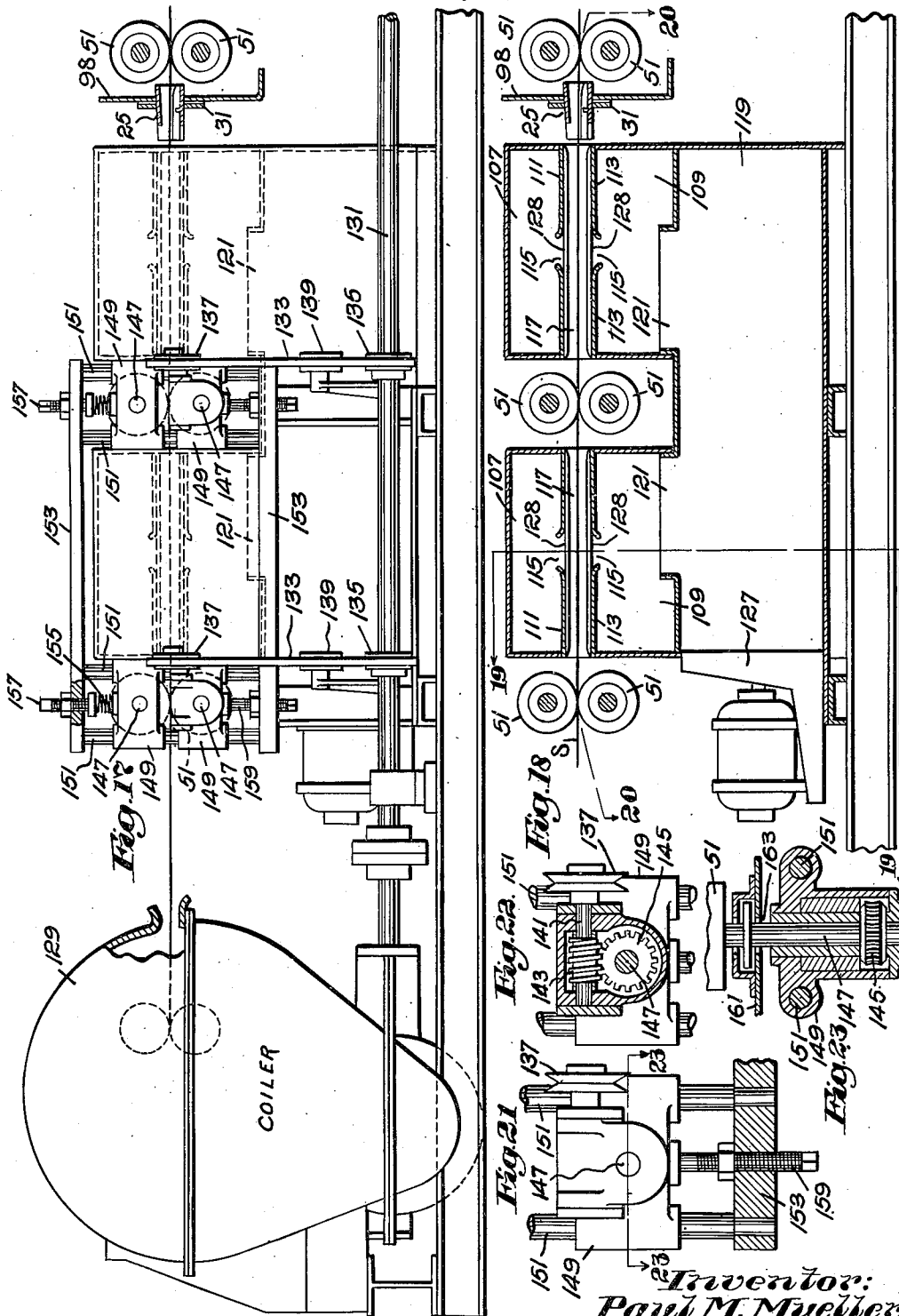
P. M. MUELLER

2,264,885

STRIP TREATING APPARATUS

Filed July 28, 1938

6 Sheets-Sheet 5



Inventor:
Paul M. Mueller.

by *Curry & Thompson* Attys

Dec. 2, 1941.

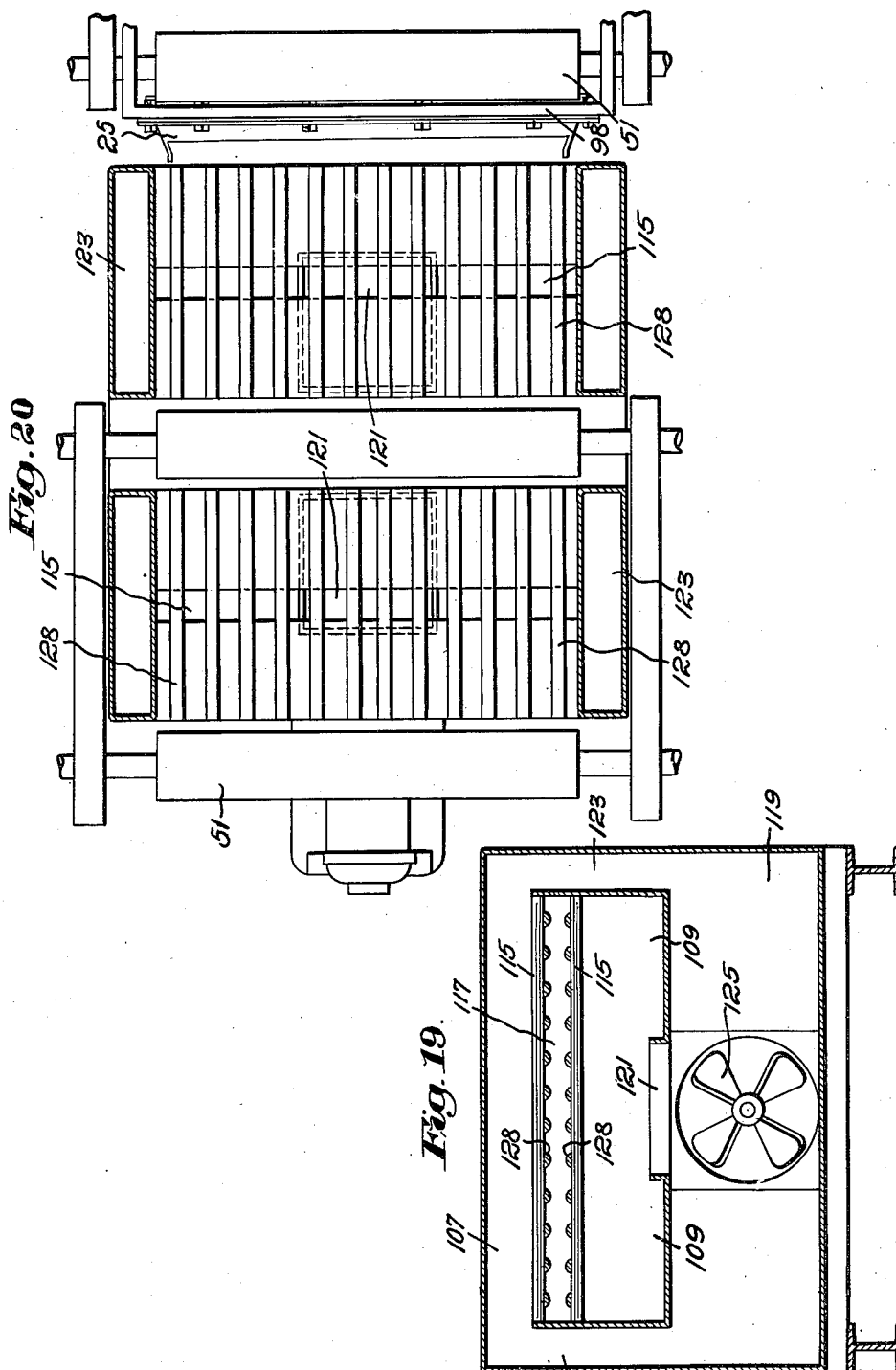
P. M. MUELLER

2,264,885

STRIP TREATING APPARATUS

Filed July 28, 1938

6 Sheets-Sheet 6



Inventor:
Paul M. Mueller,
by *Ernest South Foreman Miller & Co. Attys.*

UNITED STATES PATENT OFFICE

2,264,885

STRIP TREATING APPARATUS

Paul M. Mueller, Rome, N. Y., assignor to Revere Copper and Brass Incorporated, Rome, N. Y., a corporation of Maryland

Application July 28, 1938, Serial No. 221,775

20 Claims. (Cl. 266—3)

My invention relates to apparatus for treating strip material, as, for example, metal strips, the invention, without being limited thereto, being particularly applicable to apparatus for pickling and cleaning hot rolled brass strips of comparatively heavy gauges, say those over 0.025 inch in thickness.

The invention will be best understood from the following description when read in the light of the accompanying drawings of an embodiment of the invention selected for illustrative purposes, the scope of the invention being more particularly pointed out in the appended claims.

In the drawings:

Figure 1 is a schematic arrangement of the different units of an apparatus according to the invention;

Fig. 2 is a more or less diagrammatic, longitudinal section, with parts in elevation and parts broken away, of the coil opening unit, the leveller, and the first pickling unit;

Fig. 3 is a section, on an enlarged scale, on the line 3—3 of Fig. 2;

Fig. 4 is a side elevation, with parts omitted and parts broken away, of the leveller unit and associated end of the first pickling unit, according to Fig. 2, on a larger scale;

Fig. 5 is a section on the line 5—5 of Fig. 4;

Fig. 6 is a section, on an enlarged scale, on the line 6—6 of Fig. 3;

Fig. 7 is a longitudinal section of one of the transfer funnels and associated wiper, according to Fig. 2, on an enlarged scale;

Fig. 8 is a section on the line 8—8 of Fig. 3;

Figs. 9 and 10, respectively, show different modifications of the pickling trough;

Fig. 11 is a plan of the transfer funnel according to Figs. 2 and 7, on an enlarged scale;

Fig. 12 is a section on the line 12—12 of Fig. 11;

Fig. 13 is a more or less diagrammatic, longitudinal section of the first brush unit according to Fig. 1;

Fig. 14 is a more or less diagrammatic, longitudinal section of the second brush unit according to Fig. 1;

Fig. 15 is a more or less diagrammatic, longitudinal section of the unit marked "Soap" of Fig. 1, and corresponds to a section on the line 15—15 of Fig. 16;

Fig. 16 is a section on the line 16—16 of Fig. 15;

Fig. 17 is a side elevation of the units marked "Drier" and "Coiler" in Fig. 1;

Fig. 18 is a longitudinal section of the drier

unit according to Fig. 17, with parts in elevation and parts omitted;

Figs. 19 and 20 are, respectively, sections on the lines 19—19 and 20—20 of Fig. 18, with parts in elevation and parts omitted;

Fig. 21 is an end elevation, on an enlarged scale, of the bearing supports for the lower wringer rollers, according to Fig. 17;

Fig. 22 is a view corresponding to Fig. 21, with parts broken away and parts omitted; and

Fig. 23 is a section on the line 23—23 of Fig. 21.

Referring to the drawings, in the apparatus illustrated successive coils of strip are placed in the so-called "coil opener" which supports them while being unwound. The unwound length of strip first passes through the so-called "leveller" which acts to straighten it. It then passes through the first pickling unit where it is treated with a pickling solution, as, for example, dilute sulphuric acid. It then passes through the first unit marked "Brush" where it is washed and brushed to remove loosened scale, dirt and the like. After leaving the first brush unit, the unwound strip passes successively through a second unit marked "Pickle" and the second unit marked "Brush," and then passes through the unit marked "Soap" where it is treated with a neutralizing substance, as, for example, an alkaline solution of whale oil soap. After being heated and washed in the last mentioned unit, the strip passes through the unit marked "Drier" where it is dried. After leaving the "drier" it enters the unit marked "Coiler" where it is rewound into a coil.

Brass strips, particularly those of the heavier gauges, produced by a rolling mill are of relatively short length, commonly from 25 to 250 feet long. The present apparatus has provision for passing such strips through the apparatus in succession, without the necessity of first threading them through the apparatus or attaching the end of one strip to the other.

The coil opening and levelling units are well known to those skilled in the art and may be of any convenient construction. As shown, the leveller comprises a series of staggered rolls which operate to draw the strip S from the coil C thereof rotatably supported by the coil opener, and, as the strip passes through the leveller it in effect is bent back and forth by these rolls so as to straighten it. The coil opener, it will be understood, has provision for the operator readily inserting a new coil therein

as a coil becomes exhausted. In operation, when the coil is placed in the coil opener, the operator unwinds a slight length of coil and presents the end thereof to the rolls of the leveller, which thereupon draws the strip from the coil, straightens the strip, and pushes it into the adjacent pickling unit.

Referring particularly to Figs. 2 to 12, the first pickling unit, as illustrated, comprises an elongated tank or other receptacle 3 adapted to contain a body 5 of the pickling liquid. Above the tank is a suitably supported, elongated, open-ended trough 7 having a bottom wall 9 (Fig. 3) and re-entrant side walls 11.

As illustrated, beneath the trough 7 and extending lengthwise thereof is a suitably supported pipe 13. Establishing communication between that pipe and the bottom of the trough are short lengths of pipe 15 which preferably are upwardly inclined in the direction of the travel of the strip and communicate with orifices 16 in the bottom of the trough distributed along its medial line. At the side of the pickling unit is shown a pump 17, Fig. 3, which preferably is motor driven. Conduit connections comprising a pump suction pipe 19 and a pump discharge pipe 21, the latter communicating with the pipe 13, act to draw the strip treating liquid from the tank 3 and discharge it through the short lengths of pipe or nozzles 15 in the form of fountains beneath the bottom of the strip S as it travels through the trough. In this way sufficient pressure is created beneath the bottom of the strip to support it out of contact with the bottom wall of the trough as it travels through the latter, and that avoids scratching the strip. For regulating the amount of liquid thus discharged into the trough, the pipe 21 is shown as provided with a manually adjustable valve 23. By manipulating that valve, the pressure exerted on the bottom of the strip may be controlled with nicety to compensate that pressure for different gauges, widths and weights of strip.

The liquid entered into the trough in the manner just described flows transversely the strip in opposite directions and over its edges, so that the strip is submerged in the liquid to cause both sides to be treated. The liquid which overflows from the open ends of the trough falls into the tank 3, and thus the liquid is circulated between that tank and the trough.

As illustrated, at each end of the pickling unit is a so-called transfer funnel, indicated in its entirety by the reference character 25, which acts to receive the advancing end of the strip and guide it into that unit and from that unit into the next successive unit. As illustrated (see Figs. 7, 11 and 12), the transfer funnel comprises the relatively flaring side walls 27 and relatively flaring upper and lower walls 29, which latter have welded thereto flanges 31 for securing the funnel to its support.

As shown (see Figs. 4, 5 and 7), the transfer funnel at the right-hand end of the pickling unit has associated therewith a wiper for preventing the flow of liquid along the upper surface of the strip into the leveller. This wiper is preferably in the form of a sheet or flap 33 of flexible rubber fixedly secured in any suitable way to overlie the upper wall 29 of the transfer funnel, and is of such width as to fit between the side walls 27 of the latter, as shown in Fig. 5. The free edge portion of the sheet 33 wipes on the top surface of the strip, and, when the strip is removed, falls so as partially to block the opening of the transfer funnel, and thus acts to prevent splashing

of liquid through the latter. When the advancing end of the strip strikes the flap it raises it into the position shown by Fig. 7. It will be understood that the wipers of the transfer funnels hereinafter referred to in a like fashion act to prevent flow of liquid along the strip into the, preceding unit or any other piece of apparatus.

The transfer funnel at the entrance end of the pickling unit, shown by Fig. 2, is carried by the vertical end wall of a suitably supported hood 35. The lower portions of the side walls of this hood are shown as flared at 37 so as to direct the liquid wiped off the upper surface of the strip into the tank 3.

As illustrated, extending through the transfer funnel 25 at the entrance end of the pickling unit illustrated by Fig. 2, are suitably supported, spaced bars 39, best illustrated in Figs. 4 and 5. These bars preferably are formed of a smooth substance, such as Bakelite, inert with respect to the treating liquid. As shown, the right-hand ends of the bars are adjacent the last roll 1 of the leveller, while the left-hand ends thereof are adjacent the right-hand end of the trough 7. These bars thus act to guide the advancing end of the strip from the leveller into the transfer funnel and then into the trough 7. As soon as the advancing end of the strip is acted upon by the liquid in the trough, it is raised out of contact with the bars, as will be clear from Fig. 4.

As indicated by Figs. 3, 9 and 10, the trough 7 of the pickling unit may have various shapes. As illustrated by Fig. 10, the side walls, instead of being inclined as illustrated at 11 in Fig. 3, may have the horizontal reentrant portions 41. As shown by Fig. 10, the trough may have vertical side walls 43 carrying angle irons or brackets 45 which provide re-entrant portions projecting over edges of the strip. The purpose of these re-entrant portions is to prevent any possibility of the strip being raised from the trough in case the pressure exerted on the under side of the strip inadvertently is too great, which particularly is liable to happen in connection with the advancing front and rear end portions of the strip.

Conveniently the troughs, no matter how formed, are provided with removable covers 47 which preferably are made in short sections and laid over each other in overlapping relation, as shown by Fig. 8. These covers are preferably employed so as to prevent the escape of liquid from the top of the trough, which may occur if the liquid is entered into the trough under too great a pressure, and especially if no strip is in the trough.

As shown, at the exit end of the pickling unit illustrated by Fig. 2, is a hood 35 similar to that at the entrance end of the unit, the hood at the exit end being carried by the end wall 49 of the first brush unit, as illustrated in Figs. 2 and 13. In this hood is a pair of cooperating rollers 51, which preferably are rubber faced so that they act as squeeze or wringer rolls to wring excess liquid off the strip, such liquid so wrung off being guided by the flaring lower wall portions 37 of the hood into the tank 3. The rolls 51 also act to receive the advancing end of the strip and push it into the brush unit at the left-hand end of the pickling unit.

The brush unit just referred to, as shown by Fig. 13, comprises a casing 53, the end wall 54 of which carries a transfer funnel 25 and wiper 33, similar to those hereinbefore described. The guide bars 55 carried by this particular transfer

funnel are exactly like the guide bars 39 carried by the transfer funnel at the right-hand end of the pickling unit, except that they are relatively short. This brush unit further comprises a pair of rotary brushes 57 which rotate in such direction as to brush the strip in the direction of its travel. Associated with the brushes are spray pipes 59 which act to spray jets 61 of water on the strip and brushes. The brushes, which are long enough to take care of the maximum width of strip accommodated by the trough 7, act to clean opposite sides of the strip of scale and dirt loosened when the strip is pickled.

The brush unit further comprises a second pair of wringer rolls 51 which act to wring residual water off the strip and to feed it and to push its advancing end into the next unit. Preferably the wringer rolls just referred to are protected from the water thrown off by the brushes by a partition 63 having an opening 65 with adjacent flaring flanges 67 for guiding the strip into that opening. The liquid used in the brushing unit collects at the bottom of the casing 53 and discharges through a drain 69 to any suitable place of disposal.

In the apparatus illustrated, the strip as it leaves the wringer rolls of the brush unit, shown by Fig. 13, passes through a further transfer funnel 25 into a second pickling unit. This second pickling unit may be exactly like the one just described, its right-hand end being illustrated in Fig. 13 and its left-hand end in Fig. 14. The wringer rolls 51 at the left-hand end of the second pickling unit, as shown by Fig. 14, are so positioned as to push the advancing end of the strip into the transfer funnel 25 at the left-hand end of the second brush unit.

The brush unit shown by Fig. 14 is substantially like that shown by Fig. 13, except that it is provided with two sets of brushes and spray nozzles within a casing 71 so as to insure satisfactory cleaning of the strip and the removal therefrom of all of the pickling solution before the strip is passed into the unit containing the neutralizing solution. The second brush unit preferably is provided with an intermediate pair of wringer rolls 51 and transfer funnel 25 for guiding the advancing end of the strip into proper relation with the second pair of brushes, this pair of wringer rolls acting to support the strip properly as it passes through the pairs of brushes. As shown, this last mentioned transfer funnel is carried by a partition 72 which separates the intermediate wringer rolls from the last set of brushes and protects them from the water thrown off by those brushes.

The unit marked "Soap" in Fig. 1 is illustrated by Figs. 15 and 16. As shown, it comprises a casing 73, the end wall 75 of which carries a transfer funnel 25 for guiding the strip into a trough 77, which latter is similar to the trough 7 except that, as illustrated, it is of shorter length. Beneath the trough 77 is a suitably supported pipe 79, similar to the pipe 13 described in connection with the pickling unit, while short lengths of pipe 81, similar to the lengths 15 of Fig. 6, place the bottom of the trough 77 in communication with the pipe 79. In the lower portion of the casing 73 is maintained a body of the neutralizing liquid, the upper level of which body is indicated at 83. By means of a pump and valve and pipe connections like those shown in Fig. 3, liquid is pumped from this body into the pipe 79, whence it discharges into the trough and there acts to support and treat both sides of the

strip, and, overflowing from the end of the trough, returns to the body of liquid in the bottom of the casing.

The strip, after leaving the trough 77, passes through an opening 85 in a partition 87 adjacent the exit end of the trough into a compartment 88 containing a further pair of wringer rolls 51, the liquid wrung off the strip falling to the bottom of this compartment and discharging through an opening 89 in the partition 87 so as to return to the body of liquid in the casing 73. After passing through the wringer rolls 51 just mentioned, the strip passes through a further transfer funnel 25 into a compartment 91 where it is sprayed with jets 93 of water for cleansing it of the neutralizing liquid, after which it passes into a still further compartment 95 in which it is operated upon by a still further pair of wringer rolls 51 to free it of all excess liquid. The water forming the sprays 93 and the water which is wrung off the strip in the compartment 95 drain from that compartment and the compartment 91 through a suitable pipe 97. The strip is guided from the compartment 95 into the drier, hereinafter described, by a transfer funnel 25 carried by the end wall 98 of the compartment 95.

The neutralizing liquid which acts on the strip and the water sprays 93 are preferably hot, say at a temperature of about 150° F., so as to more effectively treat the strip and to heat it for co-operation with the drying operation. To this end, submerged in the body of neutralizing liquid in the casing 73 is shown a heater, preferably in the form of steam pipes 99 extending between headers 101, the steam supply pipes for the heater being indicated at 103 and the condensation discharge pipe at 105.

As shown by Figs. 17 to 20, the drier comprises compartments 107 and 109, respectively, at opposite sides of the strip. The bottom walls 111 of the compartments 107 and the upper walls 113 of the compartments 109 are each interrupted at their center points to form an opening 115. The hot strip passes between the walls 111 and 113 which in effect form conduits 117 having upper and lower central openings 115. Air supplied to compartments 107 and 109 flows through the openings 115 and along the conduits 117 in contact with the upper and lower surfaces of the strip to dry it and discharges from the opposite ends of the conduits. The strip being hot effectively causes evaporation of all moisture thereon in the presence of this draft of air.

As shown, the drier comprises a lower chamber 119, the upper wall of which has openings 121 leading into the compartments 109. At each of opposite sides of the chamber 119 are vertical ducts 123 which act to conduct air to the upper compartments 107. A motor driven fan 125 (Fig. 19), the casing of which is indicated at 127 in Fig. 18, serves to force air into the chamber 119, whence it flows through the openings 121 and ducts 123 into the lower chamber 109 and upper chamber 107, respectively. It then passes through the openings 115 in the conduits 117 in each of opposite directions and discharges through the open ends of those conduits as above explained.

As illustrated, extending through each conduit 117 at the upper and lower sides thereof are spaced bars 128 of smooth material, such as Bakelite. These bars serve to guide the advancing end of the strip past the openings 115 and to prevent that end from contacting the walls of the

conduit. As will be clear from Fig. 18, normally the strip does not contact these bars.

As shown, wringer rolls 51 are positioned between the two conduits 117, which there act merely to support and guide the strip.

A pair of wringer rolls 51 at the left-hand end of the drier serves to guide the strip into the coiler 129 (Fig. 17). The coiler may be of any of the convenient constructions commonly employed in mill practice. It acts to wind the strip into a coil and has provision for quick removal of the completed coil.

Conveniently, the several pairs of wringer rolls of the units of the apparatus may be driven from a common shaft extending lengthwise of the apparatus, a fragment of which shaft is shown at 131, Fig. 17. This shaft is preferably geared to the mechanism which drives the rolls 1 of the leveller and is arranged to drive the coiler. Preferably each group of pairs of wringer rolls is driven at a slightly greater speed, say 1% greater, than the immediately preceding group so as to prevent any possibility of the strip buckling on account of variations in effective diameters of the wringer rolls, which diameters are difficult to control if the wringer rolls are faced with compressible rubber, which is the preferable construction. The coiler for the same reasons is preferably driven at a slightly greater speed than the wringer rolls which immediately precede it, or it may be of a type in which the coiling mechanism is driven by a slip clutch so as to maintain the strip being coiled under a slight tension.

All the wringer rolls are conveniently driven by belts 133, which for convenience of illustration are shown only in Fig. 17, these belts being passed about pulleys 135 fixed to the shaft 131 and about driven pulleys 137, idler pulleys indicated at 139 in Fig. 17 acting to maintain the requisite tension on the belts, as will be clearly understood by those skilled in the art.

As clearly shown by Fig. 22, the driven pulleys 137 are carried at the ends of shafts 141, which also carry worms 143 for driving worm wheels 145 on the ends of the shafts 147 supporting the lower roll of each pair of wringer rolls. The opposite ends of the shafts 147 of the wringer rolls in the present embodiment of the invention are carried by bearing blocks 149 (Figs. 17, 21, 22 and 23) which are slidably mounted on fixed vertical bars 151, the opposite ends of these bars being carried by fixed, suitably supported frame members 153. As illustrated, the upper bearing blocks 149 are pressed downwardly by springs 155, the tensions of which springs may be adjusted by upper spring abutments 157 screw-threadedly supported by the upper bars 153. The shafts 141 which drive the lower roll of each pair of wringer rolls are supported by studs 159 screw-threaded into the lower bars 153. By this construction not only may the pressure between the wringer rolls of each pair be varied, but the wringer rolls may be adjusted to different levels by means of the studs 159. As will be obvious, where the shafts 147 of the wringer rolls pass into a compartment containing the rolls, such as the compartments formed by the casings of the several units, the wall 161, Fig. 23, of such compartment has an opening 163 of larger diameter than the shaft to permit these adjustments.

It will be understood that within the scope of the appended claims wide deviations may be made from the forms of the invention described, without departing from the spirit of the invention.

I claim:

1. Apparatus for removing scale and the like from elongated copper-base alloy strip comprising means for continuously moving the strip lengthwise, an elongated container of pickling solution through which the moving strip is passed for partially pickling it, means associated with said container for so supporting the moving strip therein as to cause the entire area of each side of the strip to be subjected to the action of the pickling solution in its passage through said container, water applying and brush means for scrubbing from the moving strip loosened scale and reaction products after treatment of the strip by the pickling solution in said container, and one or more further containers of pickling solution through which the moving strip is passed for loosening the remaining scale.

2. Apparatus for removing scale and the like from elongated copper-base alloy strip comprising means for continuously moving the strip lengthwise, an elongated container of pickling solution through which the moving strip is passed for partially pickling it, water applying and brush means for scrubbing from the moving strip loosened scale and reaction products after treatment of the strip by the pickling solution in said container, and one or more further containers of pickling solution through which the moving strip is passed for loosening the remaining scale, the containers each being provided with means for entering the pickling solution therein beneath the strip in the form of jets distributed along the container for supporting the strip by the pickling solution while submerged therein whereby the entire area of each side of the strip is acted upon by the pickling solution in its passage through said containers.

3. Apparatus for removing scale and the like from elongated copper-base alloy strip comprising means for continuously moving the strip lengthwise, an elongated container of pickling solution through which the moving strip is passed for partially pickling it, water applying and brush means for scrubbing from the moving strip loosened scale and reaction products after treatment of the strip by the pickling solution in said container, and one or more further containers of pickling solution through which the moving strip is passed for loosening the remaining scale, the containers each being provided with means for entering the pickling solution therein beneath the strip in the form of jets distributed along the container for supporting the strip solely by the pickling solution while submerged therein whereby the entire area of each side of the strip is acted upon by the pickling solution in its passage through said containers, the means for moving the strip through said containers comprising mechanism for pushing it endwise.

4. Apparatus of the character described having, in combination, means for progressively subjecting an elongated lengthwise traveling strip of tarnishable metal such as brass to a hot liquid for treating and heating it, means for subjecting the heated portion of the strip to a draft of unheated air for drying and cooling it, and means for substantially immediately coiling the strip upon it being so dried.

5. Apparatus of the character described having, in combination, means for progressively subjecting an elongated lengthwise traveling strip of tarnishable metal such as brass to a liquid for chemically treating it, means for progressively subjecting the treated strip to a hot liquid for

eliminating the first mentioned liquid and heating the strip, means for subjecting the heated portion of the strip to a draft of unheated air for drying and cooling it, and means for substantially immediately coiling the strip upon it being so dried.

6. Apparatus of the character described having, in combination, means for progressively subjecting an elongated lengthwise traveling strip of tarnishable metal such as brass to a hot liquid for treating and heating it, a drier, means for passing the strip into said drier having provision for subjecting the strip to a second hot liquid for maintaining the strip in heated condition, said drier having provision for subjecting the strip to a draft of unheated air for drying and cooling it, and means for substantially immediately coiling the strip upon it being so dried.

7. Apparatus for treating tarnishable metal strip such as brass having, in combination, means for progressively subjecting an elongated lengthwise travelling strip to a liquid for treating it, a drier, means for passing the strip from the first mentioned means into said drier having provision for subjecting the strip to hot liquid for heating it, said drier having means for subjecting the heated strip to a draft of unheated air for drying and cooling it, and means for substantially immediately coiling the strip upon it being so dried.

8. Apparatus for treating strip with a liquid having, in combination, an elongated trough, means for passing strip lengthwise through said trough with the opposite side edges of the strip in spaced relation to the lateral walls of the trough, means beneath the plane of the pass line of at least the major portion of the length of strip in the trough for discharging liquid from said trough, and means for entering the treating liquid into the trough beneath the strip at spaced points along its length in the form of jets directed toward the strip under such force as to support the strip and in such amount as to maintain a liquid level in the trough sufficiently above the discharge means therefrom to submerge said length of strip.

9. Apparatus according to claim 8 in which the jets are directed upwardly at such angle as will insure against the liquid from the jets spurting from the trough in absence of a strip.

10. Apparatus according to claim 8 in which means are provided for regulating the force of the jets for compensating for strips of different weight.

11. Apparatus according to claim 8, in which the means for passing the strip through the trough pushes it through the same with its advancing end unsupported except by the jets and there is provided means positioned above the line of travel of the strip, adapted to be engaged by the strip upon excess upward movement thereof, to insure against buckling of the strip and its being raised from the trough under the influence of said jets.

12. Apparatus according to claim 8 in which the trough has a substantially straight, horizontally disposed bottom surface and provision for continuous discharge of liquid from an end portion of the trough in the plane of said surface, whereby to prevent trapping of solid particles on said surface and to wash them therefrom.

13. Apparatus according to claim 8 in which the trough has a substantially straight, horizontally disposed bottom surface and open ends, whereby the liquid may discharge from each end

of the trough in the plane of said surface and wash solid particles from said surface.

14. Apparatus according to claim 8, in which there is provided means for entering the strip substantially horizontally into the trough, and there is provided, adjacent that end of the trough which the advancing strip enters, means for preventing flow of liquid along the surface of the strip in the direction opposite that in which the strip advances.

15. Apparatus according to claim 8, in which there is provided means for entering the strip substantially horizontally into the trough with its advancing end unsupported except by the jets, and there is provided, adjacent that end of the trough which the advancing strip enters, a yieldable wiper adapted to operate on the strip for preventing flow of liquid along the surface of the strip in the direction opposite that in which the strip advances, which wiper is adapted to be raised by the advancing end of the strip and to accommodate itself to the surface of the strip as its level changes.

16. Apparatus for treating elongated strip with a liquid having, in combination, an elongated trough for the liquid, through which trough the strip is passed lengthwise in spaced relation to the bottom and lateral walls of the trough, means for discharging liquid from the trough, means beyond each end of the trough for feeding the strip therethrough comprising squeeze rolls adjacent the exit end of the trough, container means for receiving the liquid discharged from the trough and that removed from the strip by said squeeze rolls, and means for removing liquid from said container means and entering it into said trough beneath the strip at spaced points along its length in the form of jets directed toward the strip under such force as to support the strip.

17. Apparatus for treating elongated strip with a liquid having, in combination, an elongated trough for the liquid, through which trough the strip is passed lengthwise in spaced relation to the bottom and lateral walls of the trough, means for discharging liquid from the end portions of the trough beneath the pass line of the strip, means beyond each end of the trough for feeding the strip therethrough comprising squeeze rolls adjacent the exit end of the trough, container means for receiving the liquid discharged from the trough and that removed from the strip by said squeeze rolls, and means for removing liquid from said container means and entering it into said trough beneath the strip at spaced points along its length in the form of jets directed toward the strip under such force as to support the strip and in such amount as to maintain a liquid level in the trough sufficient to submerge the strip.

18. Apparatus for treating elongated strip with a liquid having, in combination, an elongated horizontal open ended trough for the liquid, through which trough the strip is passed lengthwise in spaced relation to the bottom and lateral walls of the trough, means adjacent the ends of the trough for removing the treating liquid from the strip, container means for receiving liquid discharged from the ends of the trough and that removed from the strip, and means for removing liquid from said container means and entering it into the trough beneath the strip at spaced points along its length in the form of jets directed toward the strip under such force as to support the strip.

19. Apparatus for treating elongated strip with

a liquid having, in combination, an elongated horizontal open ended trough for the liquid, through which trough the strip is passed lengthwise in spaced relation to the bottom and lateral walls of the trough, means adjacent the ends of the trough for removing the treating liquid from the strip, container means for receiving liquid discharged from the ends of the trough and that removed from the strip, and means for removing liquid from said container means and entering it into the trough beneath the strip at spaced points along its length in the form of jets directed toward the strip under such force as to support the strip and in such amount as to maintain a liquid level in the trough sufficient to submerge the strip.

20. Apparatus for treating moving strip having, in combination, an elongated trough having provision for discharge of liquid from opposite end portions thereof, through which trough the strip

is adapted to be advanced endwise, means for discharging liquid into said trough at points along its length in an upward direction beneath the strip for supporting the latter, means for entering said strip into and removing said strip from the trough while in substantially horizontal position, means adjacent each of the opposite ends of the trough for removing liquid from those portions of the strip which are at opposite sides of the liquid in the trough, receptacle means for receiving the liquid so removed and the liquid discharged from the end portions of the trough, a pump and conduit connections for delivering liquid from said receptacle means to said means for discharging liquid into the trough, and means for regulating the amount of liquid so delivered for regulating the upward pressure on the strip to compensate for strips of different weight.

PAUL M. MUELLER.