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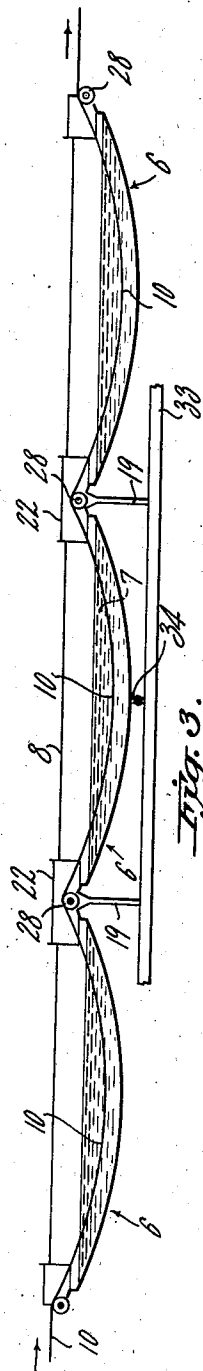
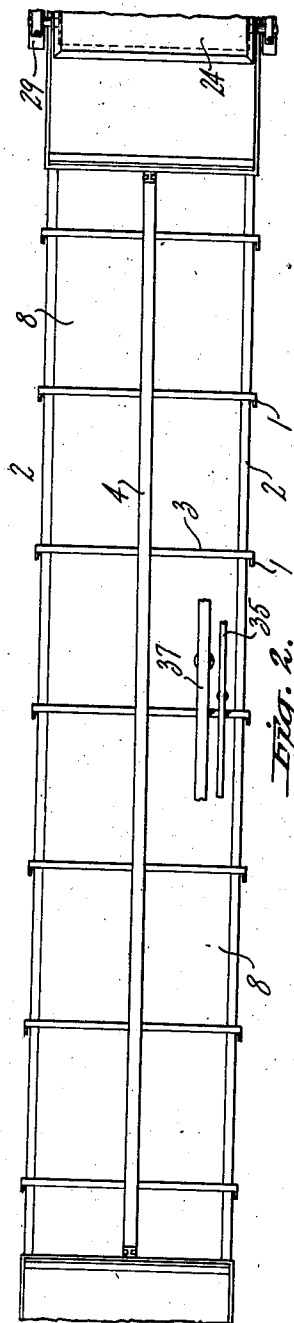
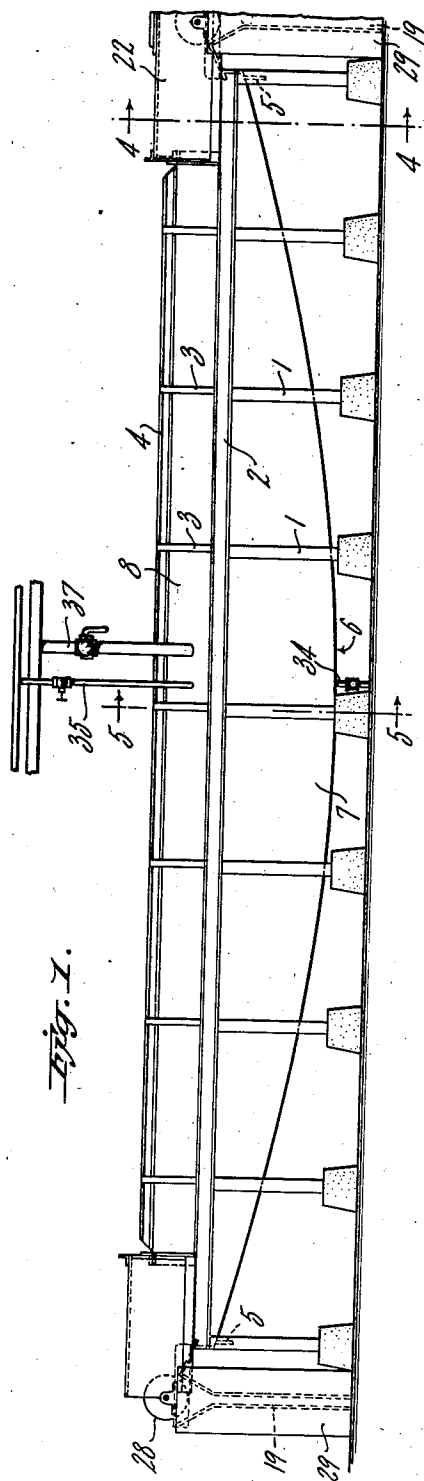
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2,216,544

PICKLING TANK

Filed June 27, 1939

3 Sheets-Sheet 1



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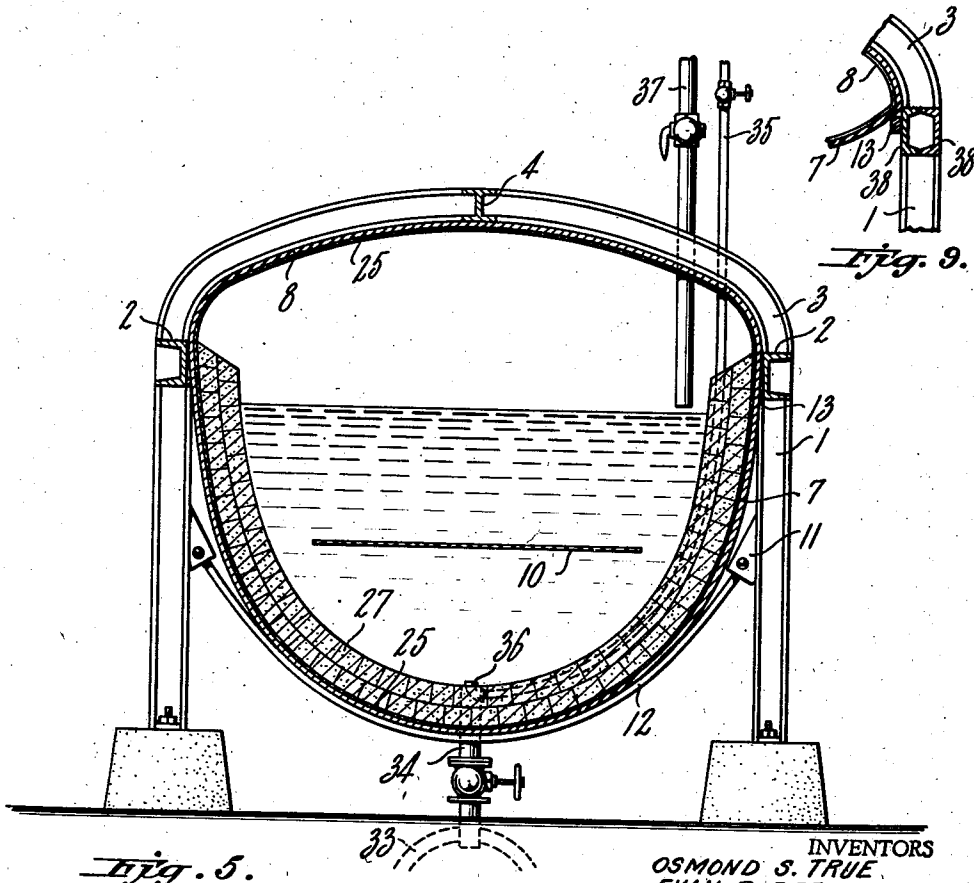
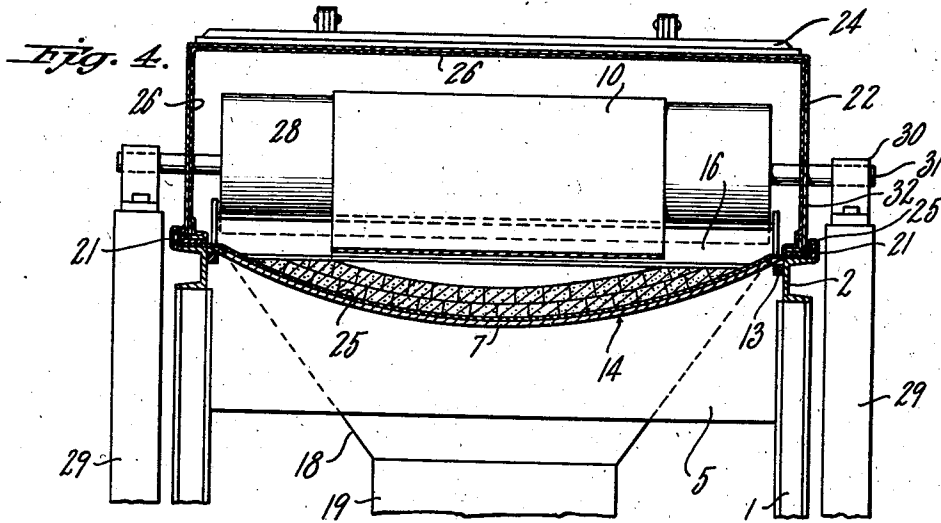
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3 Sheets-Sheet 2



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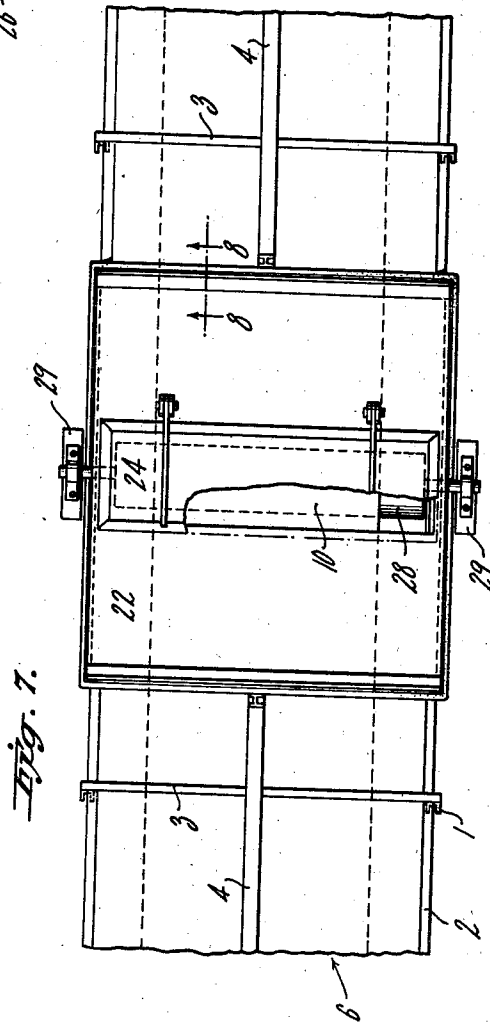
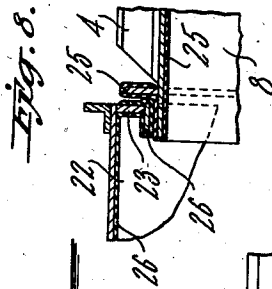
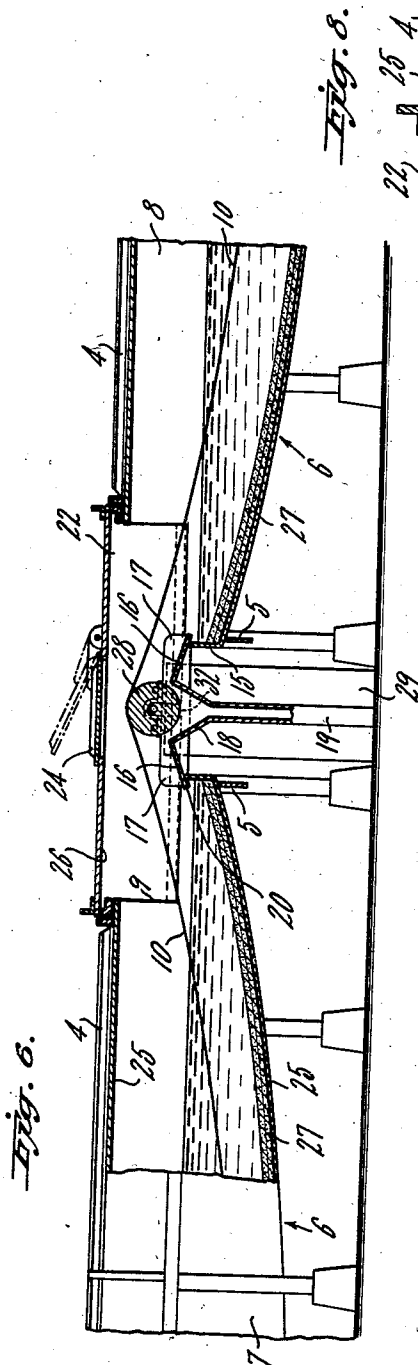
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3 Sheets-Sheet 3



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PICKLING TANK

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2 Claims. (Cl. 266—6)

This invention relates to steel rolling mill apparatus for forming and processing elongated strips of material in a continuous operation. More particularly it relates to improvements in acid pickling tanks for use in such a continuous system for removing iron oxide scale from the surfaces of the strip material, and the like, after passing from the hot calender rolls of the mill.

Heretofore acid pickling tanks in use in such continuous systems for producing strips of sheet material, and similar stock, have been constructed as elongated rectangular, box-like structures and placed end to end to receive progressively the strip material during the pickling steps of the continuous process. While these tanks have operated fairly successfully in the pickling operations, they have not been entirely satisfactory because of their expense and complexity of construction, of operation and of maintenance.

The apparatus of our invention, however, substantially eliminates these objectionable features and conditions of earlier apparatus by employing a series of pickling tanks of relatively light but exceedingly strong construction. Each of these tanks comprises a body of special shape and construction and a framework for supporting the body so as to form a very economical and efficient assembly. The bottom portion of the body of each tank is formed in substantially the shape of a suspended catenary in the longitudinal direction of movement of the strip material and also in the transverse direction thereof while the cover portion of the body, which is made integral with the bottom portion, is formed in an upwardly curved or semi-elliptical shape in the transverse direction thereof. This integral construction produces an elongated tubular or shell-like body having a substantially smooth, uninterrupted interior and at the same time stiffens and strengthens all parts of the body wall. It forms a complete enclosure and thereby prevents the escape of harmful acid or acid vapor to the exterior of the tank. In this manner the cover portion and bottom portion are combined to form a body of relatively small volume, for the pickling acid, and a substantially continuous inner surface which is of relatively small area and substantially free from corners and angles throughout the greater part thereof.

The entire interior of each tank and all other metallic parts of the apparatus which might otherwise be effected by the pickling acid are covered by protective linings of rubber composition, or similar acid resistant material, to isolate these parts from the corrosive acid or acid fumes

within the tanks. The lower portions of the protective linings of the tanks are in turn covered with sheaths of bricks, or like material, to prevent abrasion or injury to the protective linings by the strip material passing through the apparatus and to insulate the linings from the high temperatures maintained in the acid bath. The comparatively smooth continuous interior surfaces in these tanks greatly facilitates the placing of the protective linings and the insulating sheaths within the tanks, while the elimination of corners and angles from the inner surfaces of the tanks materially reduces the number of angles and corners necessary in the linings and accordingly materially reduces the possibility of failures at such points.

Suspending the bottom portion of the tank body also allows us to use a relatively light gauge material since all parts thereof are subjected only to tensional stresses. The curved or semi-elliptical shape of the cover portion allows the use of similarly shaped transverse frame members and provides a strong and compact construction. Tanks made in accordance with our invention require a minimum of material in their construction, are easy and economical to construct, require a relatively small amount of acid during operations, require less steam for heating the acid and thereby minimizes the acid dilution. It will be readily apparent that these tanks are easily maintained both inside and out because of their substantially smooth continuous inner surfaces and their fully exposed and readily accessible outer surfaces.

Referring to the drawings:

Fig. 1 shows a side elevational view of a pickling tank and associated structure of our preferred construction;

Fig. 2 is a plan view thereof;

Fig. 3 is a side elevational sectional view showing diagrammatically a plurality of tanks arranged in series for continuous processing operations;

Fig. 4 is a transverse sectional view taken substantially on section line 4—4 of Fig. 1;

Fig. 5 is a transverse sectional view taken substantially on section line 5—5 of Fig. 1;

Fig. 6 is an enlarged side elevational view, partly broken away, showing in detail the ends of adjacent tanks and associated structure;

Fig. 7 is a plan view, partly broken away, of the structure of Fig. 6;

Fig. 8 is a sectional view taken substantially on section line 8—8 of Fig. 7 and showing details of construction of parts of our invention; and

Fig. 9 is a sectional view of a modified form of frame construction which may be employed in the tanks of our invention.

Referring to the preferred embodiment of our invention and in particular to Figs. 1 and 2 a plurality of supporting columns 1 are suitably secured upon footings of any conventional construction and are arranged to support channel shaped side beams 2 upon the upper ends thereof. These side beams 2 are interconnected at a plurality of intermediate points by upwardly curved or semi-elliptical cross beams 3 having their ends attached to the top flanges of the side beams 2. Intermediate portions of the cross beams 3 are strengthened by a stiffening beam 4 extending therebetween. The ends of the side beams 2 are interconnected and braced by transverse gusset plates 5. The cross beams 3 and gusset plates 5 maintain the side beams 2 in a predetermined spaced relationship and form a strong and rigid framework. The frame members described above may be secured together in any conventional manner for forming a supporting frame for a tank 6. However, in our preferred embodiment we have shown these parts of the supporting frame secured together by welding so that a maximum of strength and rigidity is produced in this supporting frame.

The wall of the tank 6 is formed of sheet metal and comprises a suspended bottom portion 7, which is of substantially catenoidal shape both in the longitudinal and in the transverse directions of the tank, and a cover portion 8 which is of upwardly curved or semi-elliptical shape in the transverse direction. The bottom portion 7 is constructed so as to conform to the natural curve normally assumed by strip material while suspended in and passing through the tank during processing. The bottom portion is rigidly attached, preferably by welding, to the sides of the channel shaped side beams 2 and is suspended therefrom so as to hang in direct tension at all times and under all conditions. The cover portion 8 of the tank 6 is rigidly attached to the inner sides of the transverse beams 3 so as to form integrally with the bottom portion 7 a substantially smooth continuous enclosure of tubular or shell-like cross-section throughout the greater portion of the length and breadth of the tank body. The tank 6 is provided at its opposite ends with openings 9 which are formed by terminating the cover portion 8 inwardly of the ends of the tank 6, so that access may be had to the interior thereof for assembly and maintenance and to allow an elongated strip of material 10 to pass into or out of the tank during processing operations. Covered opening (not shown) may also be located in the cover portion 8, if desired, for the convenience of workmen and for inspection purposes.

Inwardly extending brackets 11 are mounted upon the columns 1 and are arranged to support transversely extending tie-bars 12. These tie-bars 12 extend beneath bottom portion 7 of the tank 6 and aid in supporting the weight of the tank and contents thereof. In welding the bottom portion 7 of our tank to the side beams 2, we have found it desirable to insert a spacing strip 13 between the wall and each beam and weld it securely to both throughout substantially the entire length of the tank.

Referring in particular to Figs. 4, 6 and 7 we have shown in detail end portions of adjacent pickling tanks and associated structure employed

in pickling operations. Each transverse gusset plate 5, as previously described, has its opposite ends attached to columns 1 and side beams 2 so as to rigidly maintain same in fixed spaced relation. The gusset plate 5 is cut away along its upper edge as indicated at 14 so as to accommodate the curved end portions of the bottom walls 7. An end wall 15 is arranged to fit against and close each curved end of the bottom portion 7 and has at its upper edge a flat surge plate 16 provided with side plates 17 at the sides thereof. The free edges of the surge plates 16 of adjacent tanks connect with a funnel or hopper shaped portion 18 of an overflow and draft pipe 19. An extension 20 is formed at the inner end of the surge plate 16 to act as a baffle for waves created in the acid by sudden starting of the strip material 10 suspended in the tank. Side beams 2 are provided with plates or flanges 21 along their outer lateral edges, from the cover portions 8 to the free ends of the side beams, so as to form supporting and centering ledges for a removable rectangular cover or hood 22.

The removable cover or hood 22 is of substantially inverted channel shape and is arranged to fit over the open ends 9 of adjacent tanks and upon the side beams 2 to form, with the surge plates 16, a substantially complete enclosure for adjacent tanks. Suitable means (not shown) may be added upon the inside of the side walls of the hood 22 to collect acid condensate which may form on and run down the side walls and direct it back into the tanks. This removable cover 22 is arranged with rectangular end walls 23 which are curved or cut away along their lower edges so as to fit closely over the curved ends of the semi-elliptical cover portions 8. An intermediate portion of this removable cover 22 is provided with a hinged door 24 so that access may be had to the interior thereof when desired without the necessity of removing the cover 22.

The interior surface of our pickling tank and all exposed edges around the openings 9 thereof are completely covered with a layer or lining 25 of rubber composition, or other suitable material, for protecting metallic parts of the tank body and frame from the corrosive effect of the pickling acid or acid fumes therefrom. This lining 25 is cemented or otherwise permanently secured in place upon all of said exposed surfaces of the metal. The free edges of this lining extend to points well beyond the area which would be affected by acid corrosion, if allowed to remain unprotected, so that a complete protection is afforded. The removable cover or hood 22 is also covered with a protective layer or lining 26, similar to the layer 25, which has its free edges extending around the edges of the cover and beyond the area of corrosion, as is clearly shown in Figs. 2 and 8.

In Figs. 4, 5 and 6 we show a sheath 27 of brick, or the like, placed within the tank and completely covering the bottom thereof so as to absorb any abrasive wear resulting from the strip material 10 passing through the tank and to protect the lower portion of the lining 25 of rubber composition from injury or rupture by the strip material. This sheath 27 also acts as a heat insulating layer between the hot acid and the lining 25 so that the lining 25 will be protected from the high temperatures of the acid bath.

We have found it desirable to place a plurality of tanks in longitudinal alignment with supporting rolls 28 at the remote ends of the tanks and

between adjacent tanks. Each supporting roll 28 is mounted upon pedestals 29 which are provided with bearings 30 for journalling the ends of an axle 31 of the roll 28 so as to locate the roll 28 directly above the overflow and draft pipe 19. The cover or hood 22 is cut away as indicated at 32 so as to form slots which fit about the axle 31 when the cover 22 is in place.

Each overflow and draft pipe 19 is connected to a drain 33 for carrying off excess acid from the tank and for removing acid fumes which accumulate in the tanks during the pickling process. The drain 33 is connected to a power driven fan or other suitable source of suction (not shown) so that fumes and objectionable gases may be drawn from the interior of the tanks. This prevents the accumulation of explosive mixtures within the tank and the escape of fumes from the tanks which might be injurious to workmen or material in the vicinity of the tanks.

A valve-controlled outlet 34 is shown at the center and bottom of each tank 6 so that acid may be easily and rapidly drained from the tank when it is necessary to clean or repair the tank interior or desired to replace deteriorated acid by a new supply. The numeral 35 indicates a heating pipe through which steam may be transmitted to the tank and injected into the acid bath there- of through an outlet 36 located near the bottom of the tank. A pipe line 37 is provided for conveniently supplying new acid of proper concentration to the tank when needed. If it is desired, however, to supply concentrated acid to the tank and dilute it within the tank and thereby save the heat generated during dilution another pipe (not shown) similar to pipe 37 may be employed for admitting water to the tank.

We show in Fig. 9 a slightly modified form of construction wherein two channel shaped side beams 38 may be used in place of each single beam 2 in our preferred construction. The beams 38 are placed with their flanges extending toward each other and are welded together along their abutting edges to form a box-girder construction. These beams are welded to the tops of the columns 1 and in turn support the bottom wall 7 which is welded to and suspended from one side thereof so that a rigid and strong connection is formed. The strips 13 serve to facilitate the welding of the portion 7 to the beams 38 and aid in producing this connection. The transverse beams 3 rest upon and are welded to the upper surfaces of these beams 38 and support the cover portion 8 which is firmly secured there- to by welding.

In operation we employ a series of tanks in alignment and arranged so that the elongated strip material 10, and similar stock, being processed may be supported upon the rolls 28 and hang freely as catenaries within the tanks and in the acid baths and in close proximity to the bottoms of the tanks. During pickling operations the material 10 is moved through these tanks by a pull placed upon the forward end thereof and progresses successively over the supporting rolls and into the acid baths at more or less uniform predetermined speeds depending upon the character of the stock and the particular results desired. As the strip material leaves the pickling tanks it is washed to remove all scale and acid from its surfaces and this may be accomplished by a spray of water, or if desired, by passing the strip through a tank or tanks of water. Such tanks may be made of the same general shape and construction as is employed in

our pickling tanks and may be aligned therewith to operate in the continuous system.

Should a sudden pull be exerted upon the material 10 in starting the strip material, a surge is liable to be created in the acid within the individual tank. Loss of acid from the tanks is materially lessened by the completely enclosed shell-like construction of our tanks and by the surge plates 16 and extensions 20 located at the ends thereon. The cover portions 8 of the tanks, the surge plates 16 and the removable hoods 22 between adjacent tanks form together a substantially continuous enclosed system which prevents loss of acid by splashing and surges and prevents the escape of acid fumes.

The tank wall 7 is suspended in the shape of a catenary both in the transverse direction and longitudinal direction of the tank so that substantially all parts thereof are subjected to tensional stresses only. With this construction the tank may be made of comparatively light gauge material and yet be of strong and sturdy construction. By having each tank of our apparatus suspended from a supporting framework the bottom thereof is maintained clear of the ground and all exterior portions thereof are exposed and easily and readily accessible for inspection and maintenance.

The shape of the tank materially reduces the amount of acid needed for the processing operations and this results in a substantial saving in quantity of acid and steam required. The smooth interiors of the tanks not only facilitate placing of the linings 25 and sheaths 27 more readily within the interiors thereof but also substantially eliminate all angles and corners which are objectionable in tanks of conventional construction. By using less acid within the tanks less steam is needed for maintaining the acid at proper temperatures during the pickling operations and accordingly the acid is not diluted as quickly when this smaller amount of steam is being employed.

As our series of tanks is open only at the remote ends thereof, except for the small openings 32 in the hoods 22 which may be covered if such is desired, a comparatively small evacuating fan or suction pump may be used for creating the suction necessary to draw the fumes and other gases into the overflow and draft pipe 19 and to the drain 33. Instead of drawing the acid fumes from the tanks by means of the pipes 19 and drain 33, it is obvious that suction pipes might be connected directly to the cover portions 8 of our tanks and arranged to operate independently of the drain means.

It is sometimes desirable during pickling operations, to initially use new acid in the last or final pickling tank and subsequently transfer it successively to the more forwardly positioned tanks and eventually discharge it as deteriorated acid from the first tank. Such a method of liquid transfer from tank to tank might readily be employed with the tanks of our invention. However, structural means for accomplishing this transfer of liquid has not been shown in the drawings since this method is not believed to form a material part of our invention.

It will be readily apparent to those skilled in the art that an automatic syphon drain of any common and well known type might be employed in place of the outlet 34 for drawing the tank without departing from the spirit and scope of our invention. And also it will be apparent that while we have shown in our preferred embod-

ment the use of tie-bars 12 beneath the wall portions 7 of the tank 6 these bars may be omitted or modified, if desired, without involving invention.

5 It will be seen from the foregoing description taken in conjunction with the accompanying drawings that we have produced, by our invention, a processing apparatus which is of economic construction, is efficient in operation and is easily maintained. While we have described preferred embodiments of our invention we do not desire to be limited thereby except insofar as is set forth in the appended claims.

15 Having thus described our invention, what we claim and desire to protect by Letters Patent is:

1. The combination of a rigid rectangular supporting frame comprising a pair of elongated side beams and a plurality of longitudinally spaced upwardly curved cross beams secured thereto and arranged to maintain said side beams in a predetermined spaced relation, an elongated hollow shell-like sheet metal body secured to and supported by said frame, said body comprising a lower wall portion of substantially catenoidal shape in longitudinal cross section and in transverse cross section suspended from said side beams, said body also comprising an upper wall portion of upwardly curved shape in transverse cross section secured to said cross beams and tangentially and integrally joining said lower wall portion at opposite sides of the body for forming an enclosure having a smooth continuous uninterrupted interior surface free from corners and angles throughout the greater portion of the length of the body, a layer of rubber composition secured to and completely covering the interior

surface of said shell-like body, and a layer of abrasion resisting material positioned within said lower wall portion of the body and adjacent said layer of rubber composition.

2. The combination of a rectangular supporting frame comprising a pair of elongated side beams and a plurality of longitudinally spaced upwardly curved cross beams secured thereto and arranged to maintain said side beams in a predetermined spaced relation, an elongated hollow tubular body of relatively thin sheet material secured to and supported by said frame, said body comprising a lower wall portion of substantially catenoidal shape in longitudinal cross section and in transverse cross section integrally attached along its opposite sides and throughout substantially the entire length thereof to said side beams so as to have each transverse section of the body suspended directly from said side beams, said body also comprising an upper wall portion positioned beneath and adjacent said cross beams and integrally secured thereto, said upper wall portion having laterally opposed marginal portions thereof downwardly curved so as to tangentially form with said opposite sides of the lower wall portion a smooth interior surface substantially free from corners and angles throughout the greater portion of the length of the body, a lining of rubber composition secured to and completely covering the interior surface of the body, and a wear resisting lining positioned within said lower wall portion and adjacent said lining of rubber composition.

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