Jan. 23, 1934. E. N. MILLAN ET AL 1,944,607

PICKLING DEVICE EMPLOYING VIBRATION

Filed Oct. 22, 1932 3 Sheets-Sheet 1

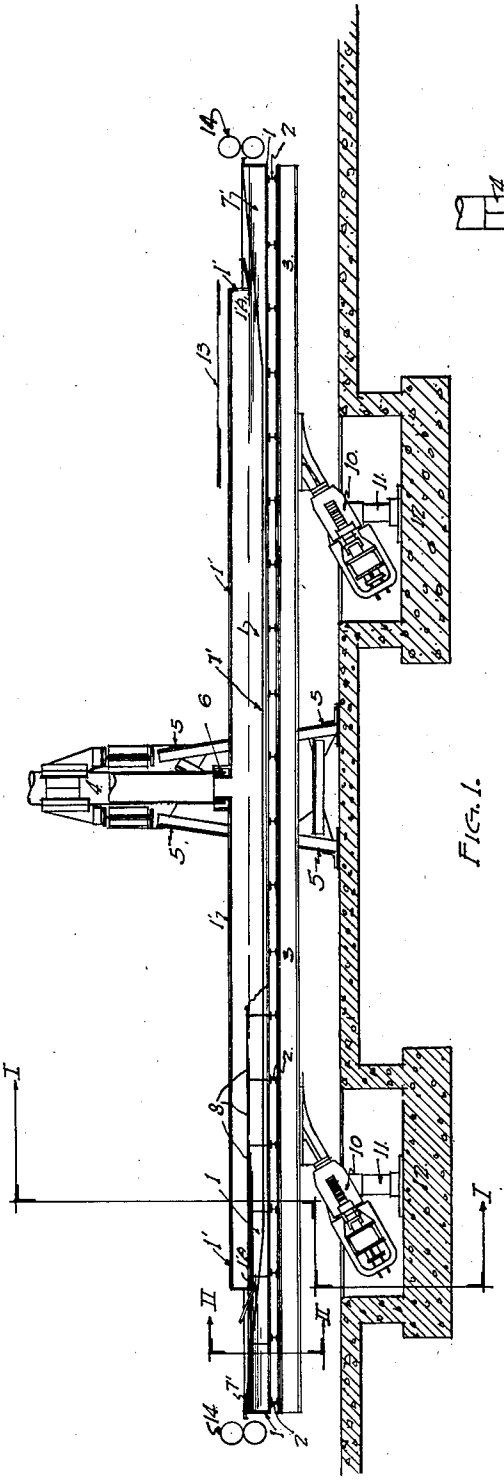

FIG. 1.

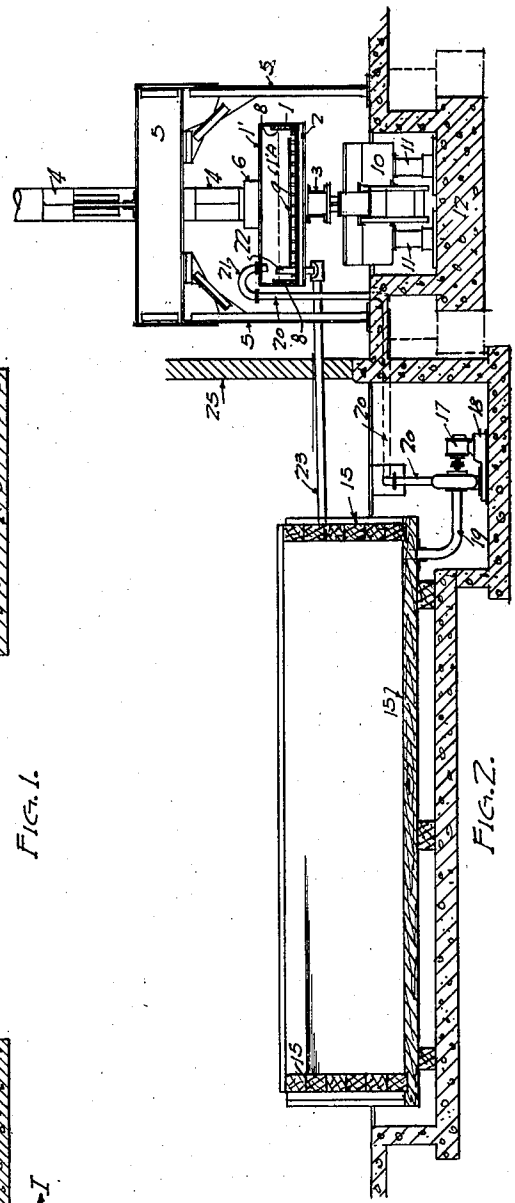

FIG. 2.

INVENTORS,
Edward N. Millan
Edwin B. Hudson
BY
Allen & Allen
ATTORNEYS

Jan. 23, 1934. E. N. MILLAN ET AL 1,944,607

PICKLING DEVICE EMPLOYING VIBRATION

Filed Oct. 22, 1932 3 Sheets-Sheet 2

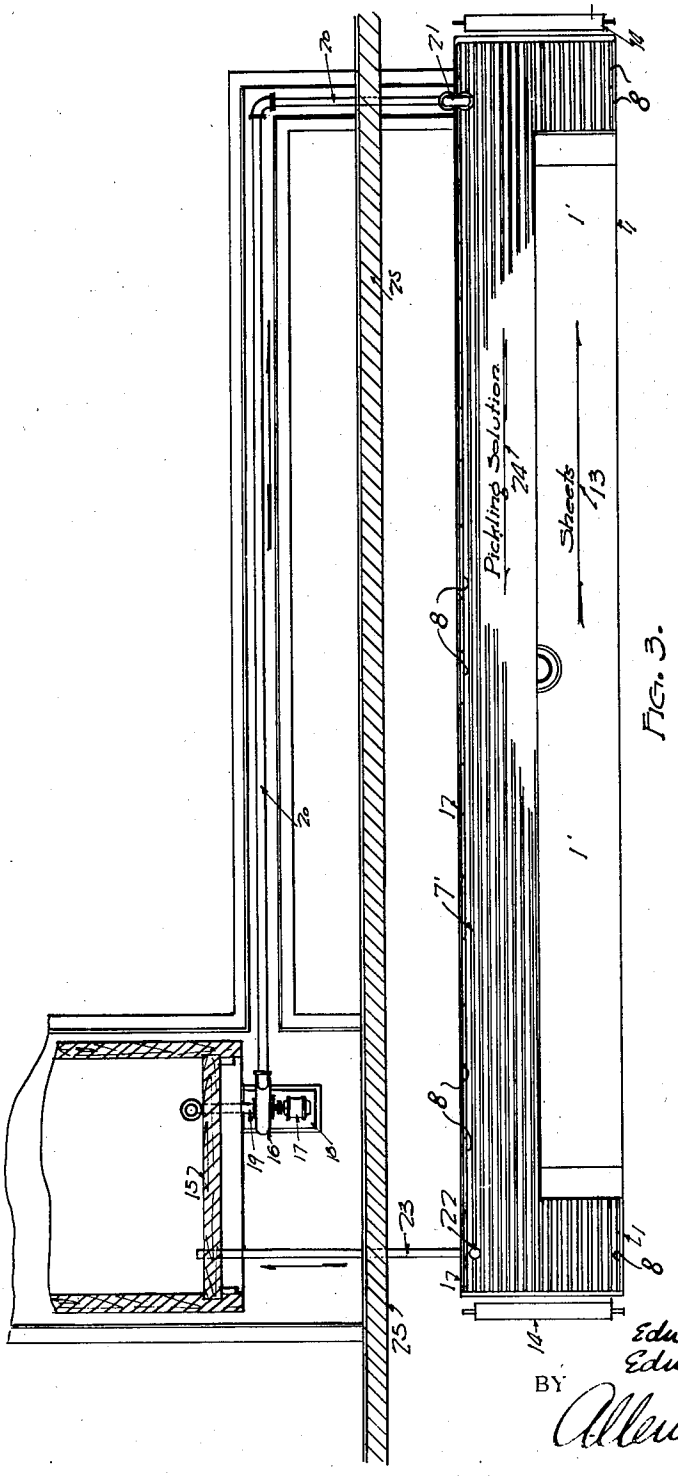

FIG. 3.

INVENTORS,
Edward N. Millan
Edwin B. Hudson
BY
Allen & Allen
ATTORNEYS.

Jan. 23, 1934. E. N. MILLAN ET AL 1,944,607

PICKLING DEVICE EMPLOYING VIBRATION

Filed Oct. 22, 1932 3 Sheets-Sheet 3

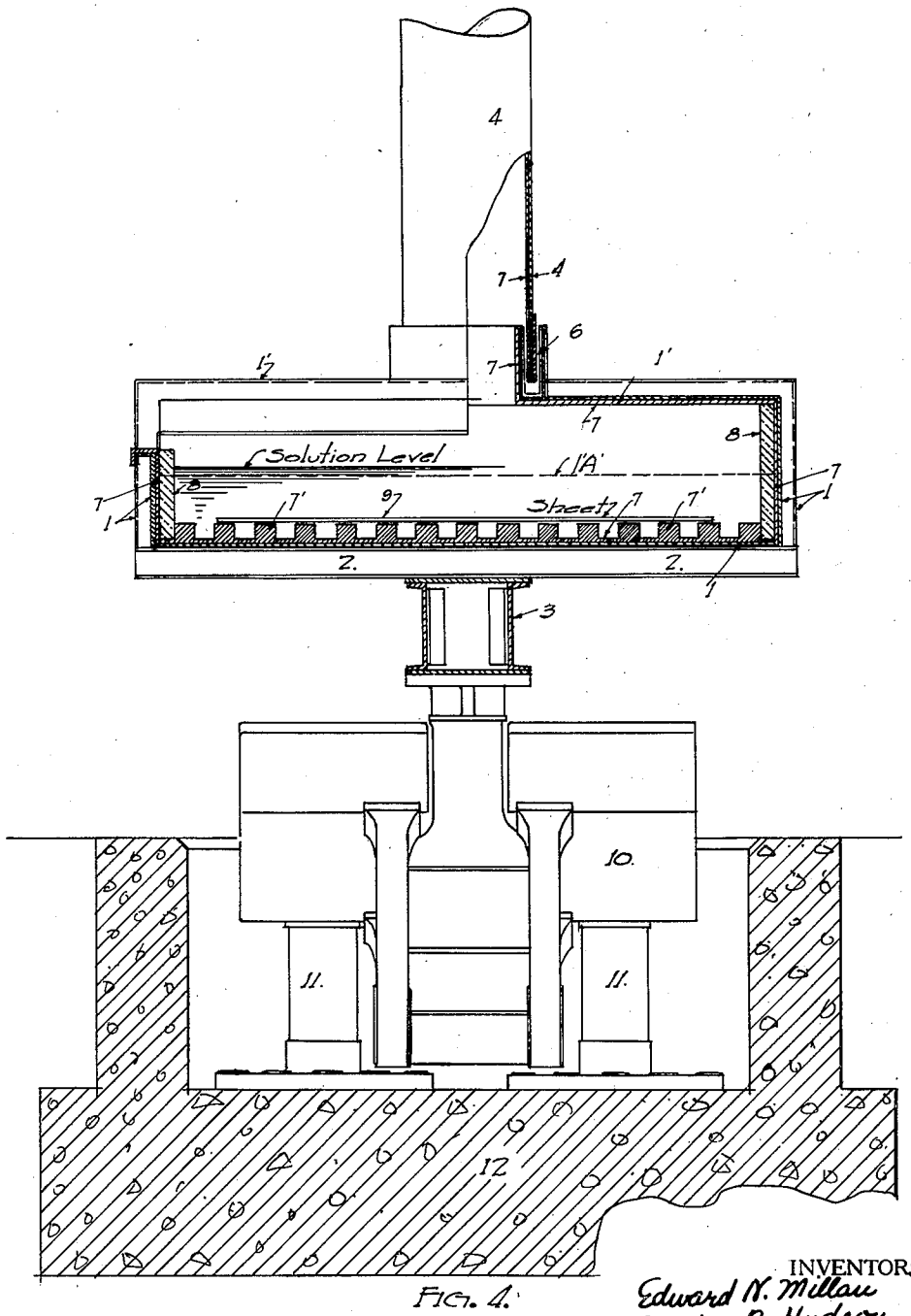

FIG. 4.

INVENTORS,
Edward N. Millan
Edwin B. Hudson
BY
Allen & Allen
ATTORNEYS.

Patented Jan. 23, 1934

1,944,607

UNITED STATES PATENT OFFICE

1,944,607

PICKLING DEVICE EMPLOYING VIBRATION

Edward N. Millan and Edwin B. Hudson, Middletown, Ohio, assignors to The American Rolling Mill Company, Middletown, Ohio, a corporation of Ohio

Application October 22, 1932. Serial No. 639,136

15 Claims. (Cl. 266—7)

Our invention relates to pickling equipment for metallic pieces or sheets, and in the exemplary embodiment herein chosen for purposes of a full disclosure, it will be described in connection with the pickling of iron or steel sheet metal, preferably in the form of flat sheets; but our invention is by no means limited thereto. In modern methods of manufacturing metal sheets it is necessary at certain times during the manufacturing process to remove scale or oxide from the metal by immersion in an acid solution. A common method of accomplishing this result calls for suspending the sheets edgewise in a cradle made of acid resisting metal, and dipping the cradle into a tank of acid solution, agitating the cradle by mechanical means until the sheets are cleaned. This method is a batch method, since the sheets have to be carefully separated and loaded into the crates. It involves the use of expensive equipment, the necessity of using expensive acid-resisting metals, a considerable amount of labor in loading and unloading the crates, expensive replacement of parts due to acid attack, and the mechanical damage to the equipment arising from the mechanical agitation. There are, moreover, certain types of acid treatments for which this method is impracticable, because of the very rapid acid attack upon the equipment.

Pickling devices have also been proposed and employed in which mechanical means are used to carry the sheets individually through the acid tank. These likewise involve relatively expensive equipment, and have the disadvantage of exposing much of the conveying means directly to acid attack in the tank. Picklers for continuous bands of metal have also been used, involving dragging the metal through the tank. Here again considerable mechanical equipment is exposed to direct acid attack.

It is an object of our invention to provide a new type of pickling device in which all mechanical equipment is located outside the tank and is not subject to acid attack.

It is also an object of our invention to provide in our novel pickler an extreme simplicity of design and the complete elimination of such parts as bearings, chains, sprockets, gears and the like, which parts are responsible for the mechanical delays and maintenance cost of the present types of pickling devices.

Our invention relates, and it is its object to produce a continuous pickling machine of a simple and practical design, capable of pickling sheets or other objects continuously.

Another of our objects is the complete elimination of acid resisting metal parts which must be submerged in the acid in conveying the sheets.

Still another object is to produce a continuous pickler of such simple mechanical design that operating and maintenance costs are greatly reduced. This is accomplished by the application of a principle of conveying which has not hitherto been applied to pickling equipment.

Still another object is to produce a continuous pickler that can be operated by unskilled labor and without the aid of expensive auxiliary equipment such as overhead cranes, narrow gauge track and cars, or such other unusual handling equipment.

Still another object is to provide ways and means to discharge acid fumes from the pickler building for the protection of men and equipment, in an effective manner without the use of an exhaust fan.

Our invention further contemplates the use of a vibrator pickling tank capable of conveying through the tank upon the floor, without the use of conveying equipment within the tank, the conveyor tank being preferably of a shallow type of sufficient length to provide the proper pickling time, and containing only a small per cent of the total acid solution, whereas the remaining acid solution, amounting possibly to 90%, is held in an auxiliary tank.

Our invention further contemplates an acid solution circulating system consisting of the necessary piping, valves and pump to circulate the acid solution from the auxiliary tank through the conveyor tank in a direction opposite to the movement of the work.

These and other objects of our invention which will be pointed out hereinafter, or will be apparent to one skilled in the art upon reading these specifications, we accomplish by that certain arrangement and construction of parts, with respect to which we shall now give a full, clear and exact description of the aforesaid embodiment, reference being had to the drawings wherein:

Fig. 1 is a longitudinal section of our machine taken approximately on the center line thereof.

Fig. 2 is a cross-section taken along the line 1—1 in Fig. 1, showing the storage tank circulating system in conjunction with the pickler in section in Fig. 1.

Fig. 3 shows our improved pickler with part in plan taken on the section line III—III of Figure 2 with its auxiliary apparatus, such as the storage tank and circulating system.

Fig. 4 is a composite section of the pickling

machine on a larger scale and in more detail, the left half being taken along the lines II—II in Fig. 1 and parts being broken away to a central plane.

Broadly, in the practice of our invention, we provide a pickling tank usually of elongated form and of sufficient length to provide adequate pickling time as the material moves through the tank. This tank does not contain conveying equipment of any kind. On the contrary, the tank itself is moved or vibrated quickly in one direction and slowly in the other in such a way as to cause a progressive travel of the material to be pickled therethrough. This is a complete novelty in pickling equipment, and at once eliminates conveying devices and other members exposed to acid attack. Our tank is mounted in such a way as to permit of this vibration. Since large quantities of acid solution must be employed in pickling operations, due to the depletion of the acid in the process, it would be mechanically inconvenient and would consume more power than necessary to vibrate a tank and a quantity of solution sufficient for a pickling operation over a great length of time. Hence our invention contemplates the employment and vibration of a tank only sufficient to hold enough solution for immediate needs, the provision of a much larger stationary storage tank, and the continuous circulation of the solution between the tanks, whereby the pickling tank is kept full of fresh solution. Preferably, though not necessarily, the solution in the pickling tank will move in countercurrent to the metal being treated. We also provide a cover for the pickling tank, and means for carrying away the acid fumes.

Referring to the drawings, and particularly to Fig. 1, the pickling tank is shown at 1. It is provided with cover 1' which cover is connected to a stack 4 by means of a water seal 6. The tank is lined with a suitable acid resisting lining 7, which may be made if desired in the form of skids or slabs for the floor portion, as indicated at 7'. The skids 7' slope from the bite of the pinch rolls 14 to the bottom of the tank. The sheets are thereby moved along the skids 7' from the entering pinch roll 14, under the edge 1'A of the cover and through the solution. At the exit end of the tank, the skids carry the sheets again under the cover and up to the bite of the set of pinch rolls 14 at the exit end of the tank. There is sufficient clearance between the ends 1'A of the cover and the skids 7' to permit the movement of the sheets between them. The pinch rolls 14 may be constantly driven so that the movement of the sheets into and through the tank will be continuous. As soon as a sheet leaves the entering pinch roll 14, it is carried along by vibration until it enters the bite of the pinch roll or the exit end of the tank, which in turn carries it out of the tank. Fastened to the side walls of tank 1 are replaceable acid resisting guides 8 to protect the lining, and to guide the sheets. A sheet in process of pickling is shown at 9 resting on the skids 7'. The cover 1', at its ends, projects below the surface of the solution at 1'A, forming an effective seal to keep the fumes from escaping at the ends thereof and forcing the fumes upward through the stack 4.

The tank 1 is supported by cross rails 2, upon a beam or beams 3. The beam 3 may be suspended or supported for vibratory movement independently of the vibrating means, but it is more convenient to support it directly upon a plurality of vibrating motors indicated at 10, which are in turn mounted to the foundation 12 as by means of supports 11.

The tank 1 is vibrated slowly in one direction, which in this case would be substantially toward the exit end of the tank, and quickly in the opposite direction. The inertia of the sheets in the tank, prevents them from moving back with the quick movement of the tank and consequently they slide along the skids toward the exit end of the tank.

While any motor capable of producing the necessary vibration may be employed, including, but without limitation, fluid pressure motors, and while the vibration may also be produced through appropriate mechanical supporting and moving means actuated by an external source of power, yet we prefer to use electric vibrating motors of the type set forth in U. S. Letters Patent Numbers 1,772,596, and 1,779,454, to which reference may be had for a description thereof. These are direct acting reciprocatory motors actuated in accordance with the pulsations of alternating current. They eliminate the necessity of changing rotary to reciprocatory motion; and since they are capable of supporting and guiding the tank, there is no need of suspending the tank otherwise, or guiding it for reciprocatory motion.

The vibrator motors are fixed to member 3 at the proper angle, and are capable of vibrating the tank at 3600 vibrations per minute when supplied with 60 cycle alternating current power. Each vibration of the tank causes the sheet to move forward in the direction of the arrow 13 approximately ⅛'', giving a forward movement of 18 to 20 feet per minute, thereby agitating and conveying the sheet through the tank. Pinch rolls 14 are provided at each end of the vibrator tank to facilitate the entry and exit of the work. The length of tank 1 is determined by the time that the work is to remain in the solution, at the particular speed chosen. The speed may be varied, of course, by changing the amplitude of the stroke or the frequency of the vibration. The use of the storage tank 15 makes it possible to reduce the size and weight of the vibrator tank 1. The circulating system connecting vibrator tank 1 and storage tank 15 may comprise an acid resisting pump 16 driven by an electric motor 17 and mounted on base 18. An intake pipe 19 is connected between the pump 16 and the tank 15; and a discharge pipe 20 delivers the solution through a pipe having a bend 21 of 180 degrees. The solution is thus discharged into the delivery end of the tank 1 leaving the tank free to vibrate. An overflow pipe 22 maintains the solution level in tank 1, discharging the excess into a receptacle 23' connected to a pipe 23 which returns the solution to the storage tank 15. The organization and mounting of these several parts in the exemplary embodiment described will be clear from the drawings. It will be understood that the circulatory system and storage tank not only make it unnecessary to vibrate all of the pickling solution, but also contribute to the agitation of the portion thereof employed in the actual pickling. Usually 90 to 95 percent of the total pickling solution will be held in the storage tank, the pickling tank containing but 5 to 10 percent of it.

During the operation the pump 16 will usually be run continuously, circulating the solution from the exit to the entrance end of the tank in the direction of the arrow, giving a counterflow of the acid solution to the direction of sheet movement. All heating of the acid solution is done

in the tank 15. The tank 15 may be located outside of the pickler building, as indicated by wall 25.

Modification may be made in our invention without departing from the spirit thereof. The essential novelty of our invention and what we desire to secure by Letters Patent we set forth in the appended claims. It will be understood that our pickling equipment may include washing devices and the like, or that several tanks may be combined in one apparatus for successive treatments with acid, neutralizing, and/or washing.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In a pickling device, an elongated tank adapted to contain a pickling solution, said tank having a floor, and means for so vibrating said tank that material to be pickled will be conveyed over said floor by an inertia effect.

2. In a pickling device, an elongated tank adapted to contain a pickling solution, said tank having skid members adapted to support material to be pickled within said tank, and means for imparting vibratory motion to said tank bodily so that the material will be conveyed over said skids by an inertia effect.

3. In a pickling device, an elongated tank adapted to contain a pickling solution, said tank having a floor, and means for so vibrating said tank that material to be pickled will be conveyed over said floor by an inertia effect, and means for continuously withdrawing and adding to the pickling solution in said tank.

4. In a pickling device, an elongated tank adapted to contain a pickling solution, said tank having a floor, and means for so vibrating said tank that material to be pickled will be conveyed over said floor by an inertia effect, a cover on said tank, a stack, and means connecting said cover and said stack to permit vibration of said cover.

5. In a pickling device, an elongated tank adapted to contain a pickling solution, said tank having a floor, and means for vibrating said tank that material to be pickled will be conveyed over said floor by an inertia effect, a storage tank for pickling solution, and means for continuously delivering solution from said storage tank to said pickling tank, and means for withdrawing solution from said pickling tank and returning it to storage.

6. In a pickling device, an elongated tank adapted to contain a pickling solution, said tank having a floor, and means for so vibrating said tank that material to be pickled will be conveyed over said floor by an inertia effect, a storage tank for pickling solution, and means for continuously delivering solution from said storage tank to said pickling tank, and means for withdrawing solution from said pickling tank and returning it to storage, said means comprising a pump, a delivery pipe, overflow means for maintaining the level of the solution in said pickling tank, and return means for receiving said overflow.

7. In a pickling device, an elongated tank adapted to contain a pickling solution, said tank having a floor, and means for so vibrating said tank that material to be pickled will be conveyed over said floor by an inertia effect, and feeding and receiving means for said material located at the ends of said tank.

8. In a pickling device, a foundation, an elongated tank adapted to contain a pickling solution, said tank having a floor, supporting means for said tank, and a vibratory device located between said supporting means and said foundation, and bearing said tank.

9. In a pickling device, a foundation, an elongated tank adapted to contain a pickling solution, said tank having a floor, supporting means for said tank and a vibratory device located between said supporting means and said foundation, and bearing said tank, said vibratory device arranged to vibrate said tank, advancing the same in the respective directions of the length of the tank at unequal rates.

10. In a pickling device, a foundation, an elongated tank adapted to contain a pickling solution, said tank having a floor, supporting means for said tank, and a plurality of vibrating electric motors located between said supporting means and said foundation, and bearing said tank.

11. In a pickling device, a foundation, an elongated tank adapted to contain a pickling solution, said tank having a floor, supporting means for said tank, and a plurality of vibrating electric motors located between said suporting means and said foundation, and bearing said tank, said motors arranged to reciprocate in accordance with the cycles of an alternating current whereby synchronism is maintained.

12. In a pickling device, a foundation, an elongated tank adapted to contain a pickling solution, said tank having a floor, supporting means for said tank, and a plurality of vibrating electric motors located between said suporting means and said foundation, and bearing said tank, a storage tank for pickling solution, and means for continuously delivering solution from said storage tank to said pickling tank, and means for withdrawing solution from said pickling tank and returning it to storage.

13. A process of pickling which comprises providing a tank with a pickling solution therein, and causing material to move through said solution and tank by so vibrating said tank that the material will be conveyed through said tank by an inertia effect.

14. A process of pickling which comprises providing a tank with a pickling solution therein, and causing material to move through said solution and tank by so vibrating said tank that the material will be conveyed through it by an inertia effect, and circulating and continuously replenishing the solution in said tank.

15. A process of pickling which comprises providing a storage quantity of pickling solution, continuously withdrawing a portion of said pickling solution to a pickling tank, carrying material to be pickled through said pickling tank by vibrational means advancing said tank in the respective directions of the length of the tank at unequal rates, and returning said portion of pickling solution to storage.

EDWARD N. MILLAN.
EDWIN B. HUDSON.