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PROCESS FOR ACID PICKLING

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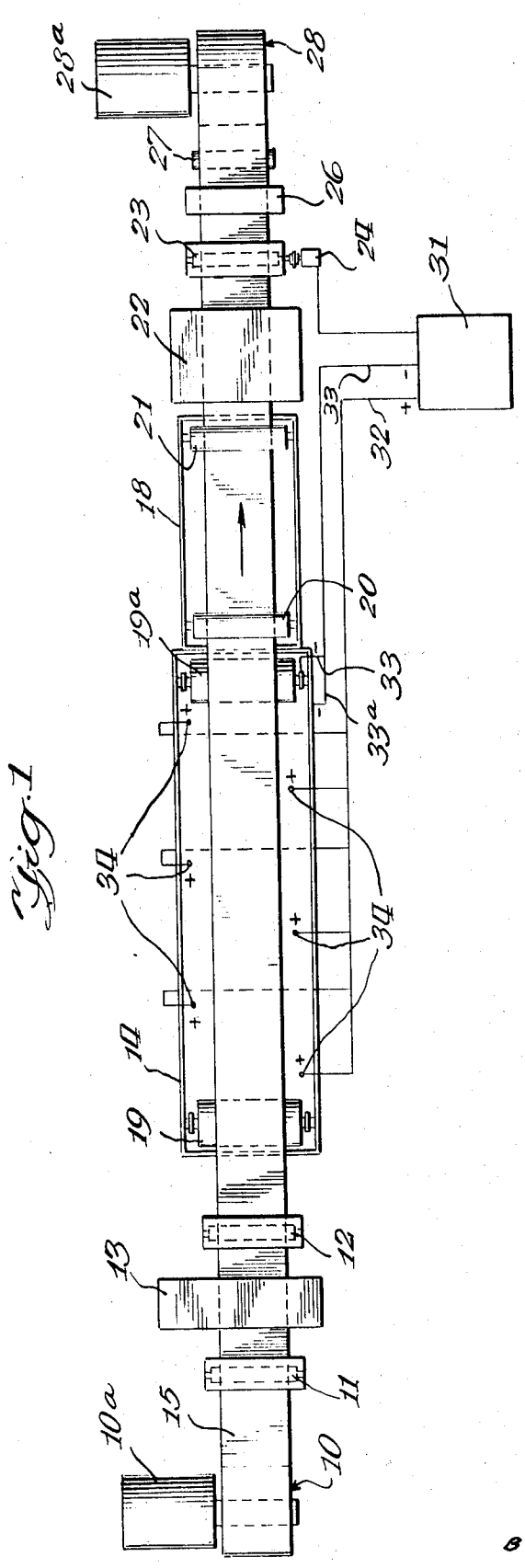

Fig. 1

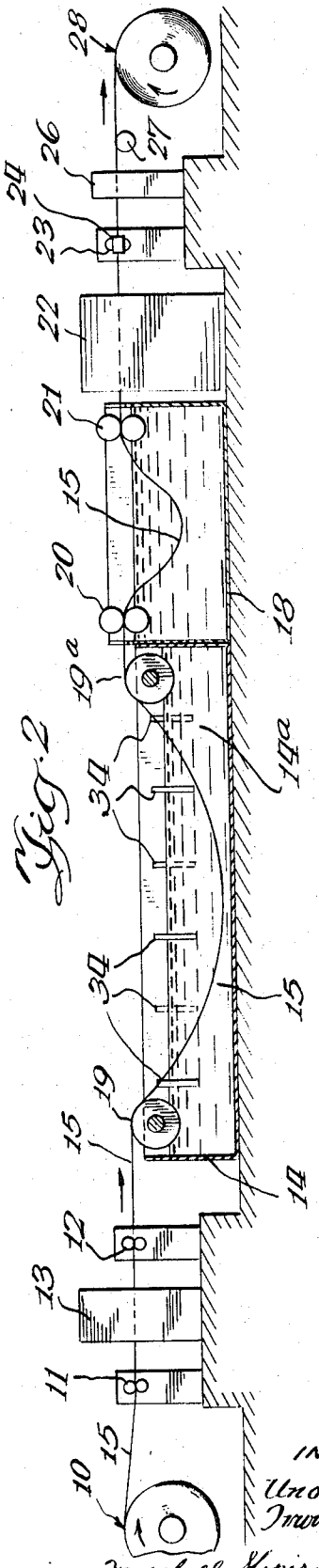

Fig. 2

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PROCESS FOR ACID PICKLING

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ABSTRACT OF THE DISCLOSURE

Method and apparatus for inhibiting excessive acid attack in the pickling of iron and steel products, particularly steel strip, caused by extended dwell time in the acid bath. A DC inhibiting voltage is impressed between the product and the acid bath, the magnitude of the voltage correlated to and varying inversely with the speed of the product through the acid bath.

This invention relates to a process and apparatus for pickling of ferrous metals and alloys. More particularly, it relates to an improved pickling process and apparatus which permits controlling the extent of pickling achieved in the continuous pickling of ferrous metals and alloys regardless of variations of speed of the product through the acid pickling bath.

In the pickling of ferrous metal and alloy products, it is desirable to limit the extent of acid attack which occurs on the metal after the surface layer of oxides has been removed. It is conventional in pickling operations to include for this purpose in the pickling bath small concentrations of chemical inhibiting agents, such as amines, phosphates, sulfides or colloidal materials. The use of chemical inhibiting agents, however, has certain disadvantages, particularly in continuous pickling operations. Many of the chemical inhibitors react with the metal to produce undesirable compounds which are contaminants in subsequent processing of the metal. Further, at the relatively high line speeds at which continuous pickling operations are designed to operate, chemical inhibitors have an undesirable retarding effect on the pickling process. If the inhibitor is present in sufficient quantity to give a desirable inhibiting effect in the event that the line speed drops substantially, it at the same time inhibits the pickling process when the line is operating at its design rate of speed. Accordingly, in order to achieve high line speeds, the concentration of chemical inhibitor in the pickling bath must be kept to a minimum. Under these circumstances, however, difficulties arise when for any reason it is necessary or desirable to stop or substantially reduce the speed of the line. When such slowdown or stoppage occurs, the section of the metal in contact with the acid bath is excessively attacked by the acid and for this reason may have to be discarded.

In the design of continuous pickling lines for treatment of steel strip, it is conventional to provide for a constant high speed through the line. In order to maintain a continuous supply of strip through the line, it is also conventional to provide duplicate holders for coils of the strip at each end of the line. In order to avoid stopping the line to switch from one roll or coil of strip to another, it is conventional to make provision for storing strip in the line during the time required for switching. It is usual to provide this storage by means of one or more looping pits, free hanging loops, looping towers or looping cars at each end of the line. In addition to the initial expense of construction, the use of looping cars, towers, or pits in this manner also has certain inherent disadvantages, in that the strip can be damaged by scratching in the storage facility resulting in a loss of yield or deterioration in quality. In addition, the relatively severe bending of the material which occurs in its passage through such devices tends to cause undesirable work hardening of the strip.

In accordance with the invention, the disadvantages which have heretofore existed in the pickling of ferrous metals and alloys, particularly in continuous pickling of steel strip, is avoided by means of an electrical inhibition system for the acid bath which is correlated to the speed of the line, so as to give maximum inhibition when the strip is stopped in the acid bath or moves only very slowly and to give little or no inhibitions when the strip is passing through the pickling bath at its normal high speed. Since the line can be stopped with no damage to the material remaining in the acid bath it is unnecessary to provide the usual storage space necessary for switching feed coils and therefore the disadvantages and difficulties inherent in such storage space are avoided when the process of the invention is used.

In accordance with the invention, a variable DC voltage is impressed between the acid bath and the strip passing therethrough, with a polarity such that the strip is negative with respect to the acid solution. The magnitude of the DC voltage is correlated to the speed of the line so that the amount of inhibiting effect produced by the voltage is a minimum (or zero) when the line is traveling at a selected high speed and is a maximum value sufficient to prevent undesired acid attack when the strip is stopped in the acid solution for any reason.

The invention will be better understood from the following detailed description thereof, taken in conjunction with the accompanying drawings, in which FIG. 1 is a top view in schematic form of a typical continuous line for the pickling of steel strip, in which provision for carrying out the invention has been made; and

FIG. 2 is a side view of the same pickling line shown in FIG. 1.

Referring to FIGS. 1 and 2, much of the apparatus used in carrying out the process of the invention is conventional in form. As shown, a coil **10** of steel strip **15** to be treated is mounted on payoff reel **10***a* at the feed end of the line. The strip **15** passes through pairs of pinch rolls **11** and **12** which are used to assist in moving the strip and maintaining the proper tension thereon. Between pinch rolls **11** and **12**, is a conventional strip joiner **13** used to connect consecutive rolls of strip by stitching or welding. Elongated acid tank **14** contains an acid bath **14***a* comprising any of the mineral acids, such as sulfuric, nitric, or hydrochloric, conventionally used for pickling iron and steel products. The length of tank **14** is correlated with the normal speed of the strip **15** passing therethrough, as well as with the concentration and temperature of the acid bath, as will be apparent to those skilled in the art, so as to achieve the desired degree of pickling during normal operation of the line. Although only one acid tank **14** is shown in the drawings, it should be understood that more than one may be used as necessary to accomplish the desired pickling. In its passage through acid tank **14**, strip **15** is supported at each end of the tank by rolls **19** and **19***a*. At least one of rolls **19** and **19***a* is made electrically conducting, and, being in contact with strip **15**, transmits to the strip any voltage applied to the roll.

Leaving acid tank **14**, the roll **15** passes through pairs of pinch rolls **20** and **21**, which guide the strip in its passage through rinse tank **18** in which the acid bath remaining on the strip is removed, as by suitable sprays (not shown) or by the contact with a rinsing solution contained within the tank.

Continuing on its route, strip **15** passes through dryer **22** (shown schematically), in which the strip is dried, and then through pinch rolls **23**, shear **26**, support roll **27** and is wound as a coil **28** on tension reel **28***a* in a conventional manner.

Attached to pinch rolls **23** is a tachometer **24** (not shown in FIG. 2) which measures the speed of the strip **15** passing through the line and supplies an instantaneous control signal to voltage controller **31**, which in turn emits a DC voltage which is inversely proportional to the speed as measured by tachometer **24**. This DC voltage is impressed by lines **32** and **33** between electrodes **34** and electrically conducting roll **19***a*.

The output of voltage controller **31** has a polarity such that a positive voltage appears on conductor **32** while a negative voltage is present on conductor **33**. In this way, electrodes **34** which are positioned to make electrical contact with solution **14***a* in acid tank **14** are made positive with respect to roll **19***a*. Electrodes **34** are suitably made of graphite or carbon or any other electrically conducting materials which will not be adversely affected by contact with the acid solution within tank **14**. Since strip **15** is in contact with roll **19***a*, the same voltage difference exists between strip **15***a* and acid solution **14***a* in contact with electrodes **34**, and the strip **15** is therefore made negative with respect to the acid solution.

Voltage controller **31**, shown schematically in the drawing, is a known commercially available device which produces a variable DC output voltage in response to a suitable control signal, in this case supplied by tachometer **24**.

The output voltage from controller **31** varies inversely with the speed of strip **15** as measured by tachometer **24**. In general, as the speed of strip **15** decreases, the output voltage and thus the degree of inhibition of acid bath **14***a* increases. An inverse proportional (linear) relationship between the speed and the voltage will generally be satisfactory, although other arrangements, e.g., logarithmic, may also be found advantageous and can be used in the invention.

In accordance with the invention, as the speed of strip **15** increases, the output voltage from controller **31** decreases in some prearranged manner, as described above, until at the maximum design speed contemplated for operation of the line voltage controller **31** produces either a very low inhibiting voltage or none at all. On the other hand, if for any reason the line is stopped, voltage controller **31** applies a voltage between strip **15** and acid solution **14***a* which is sufficiently large to inhibit the strip in contact with the solution against further acid attack for the period during which the line is stopped.

It will be apparent to those skilled in the art that the absolute magnitude of the voltage emitted by controller **31** is a function of the extent of inhibition necessary to protect the strip during periods when it is stationary in the acid tank. This in turn depends on the nature and concentration of the acid used for pickling and the temperature and other variables, of the pickling operation, as will be apparent to those skilled in the art. The important consideration is that the voltage controller must produce a sufficiently large voltage to protect a stationary strip within the acid tank for any desired period of time.

Although in FIG. 1, the connection between line **33** (the negative conductor from controller **31**) is shown connected to roll **19***a*, it should be appreciated that this connection could also have been made either to roll **19** or to both of rolls **19***a* and **19**. In FIG. 1 there is also shown a connection **33***a* between conductor **33** and the tank **14**. This is a generally desirable expedient which will inhibit attack of the acid on the acid tank itself, assuming that the tank is made of a corrodible metal. It is not a necessary aspect of the invention.

Although as previously mentioned, the absolute magnitude of the inhibiting voltage is dependent on operating conditions, it will be found that the necessary voltage is not large. A suitable voltage difference of less than about 5–6 volts between the acid solution and the strip will be found to give suitable protection even during periods when the strip is stationary within the tank, although under extreme conditions higher voltages may be found necessary.

The foregoing detailed description has been given for clearness of understanding only and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What is claimed is:

1. In the pickling of a ferrous metal or alloy product wherein said product is immersed in and moved through an acid pickling bath at a speed which can very between a minimum and a maximum value, the improvement comprising controlling the degree of acid attack on said product by impressing a DC voltage between said product and said acid bath, said product being negative with respect to said acid bath, and correlating the magnitude of said impressed voltage inversely with the speed of said product through said bath so as to provide a relatively high voltage when the speed is at its minimum value and a relatively low voltage when the speed is at its maximum value, whereby substantially uniform pickling of said product is achieved regardless of variations in said speed.

2. The method of claim **1** wherein said product is an elongated steel strip.

3. The method of claim **2** wherein said strip passes continuously through said bath at a variable speed and said impressed voltage is inversely proportional to the speed of said strip.

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