May 21, 1929. H. M. NAUGLE ET AL 1,714,040

CONTINUOUS ANNEALING PROCESS

Original Filed April 4, 1924 4 Sheets-Sheet 1

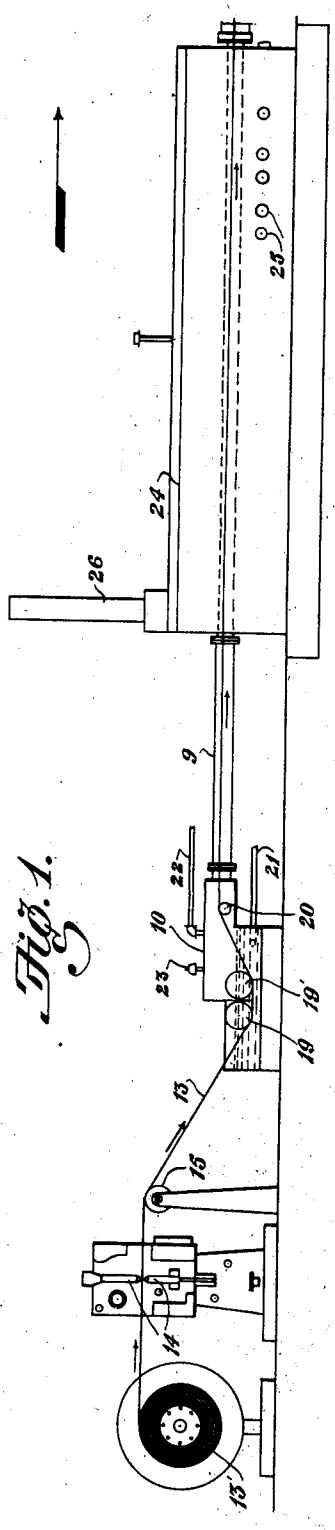
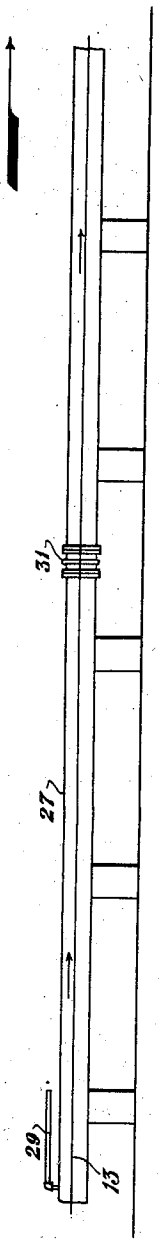
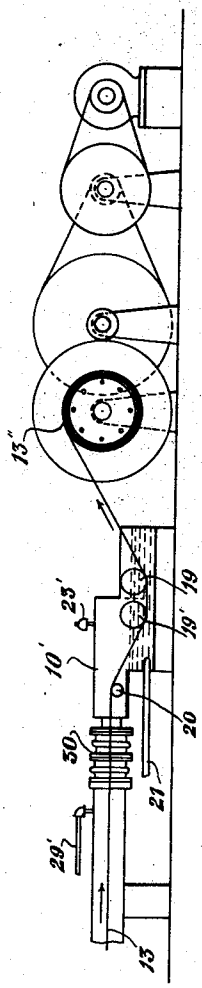



Fig. 1.




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CONTINUOUS ANNEALING PROCESS

Original Filed April 4, 1924 4 Sheets-Sheet 2

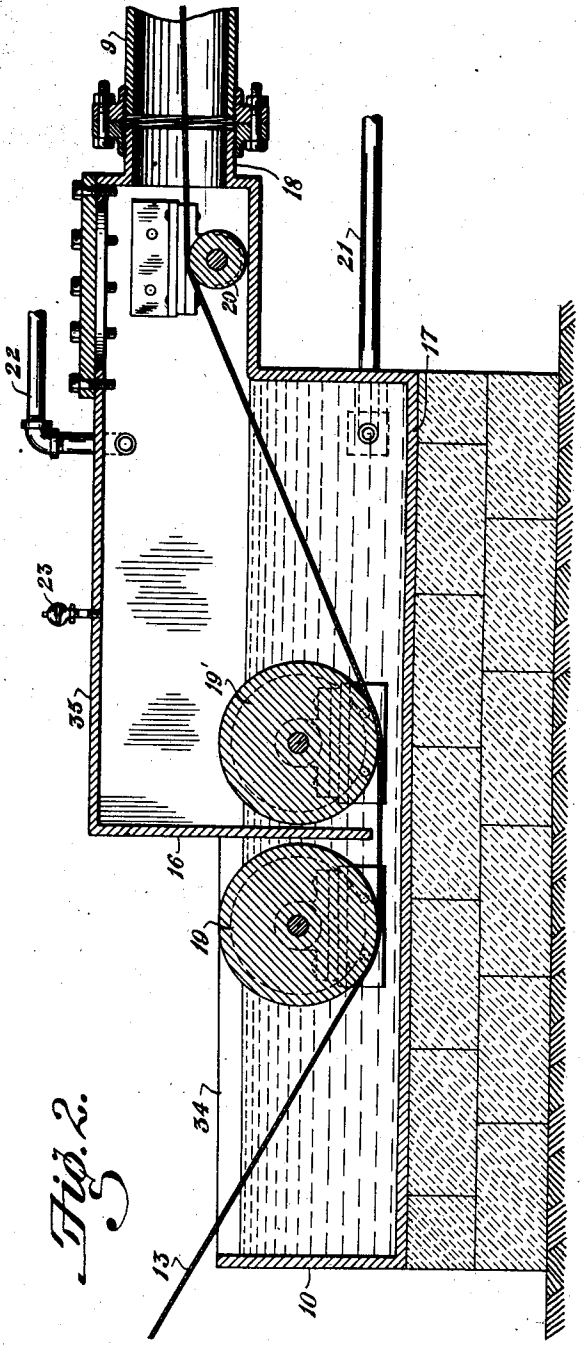



Fig. 2.

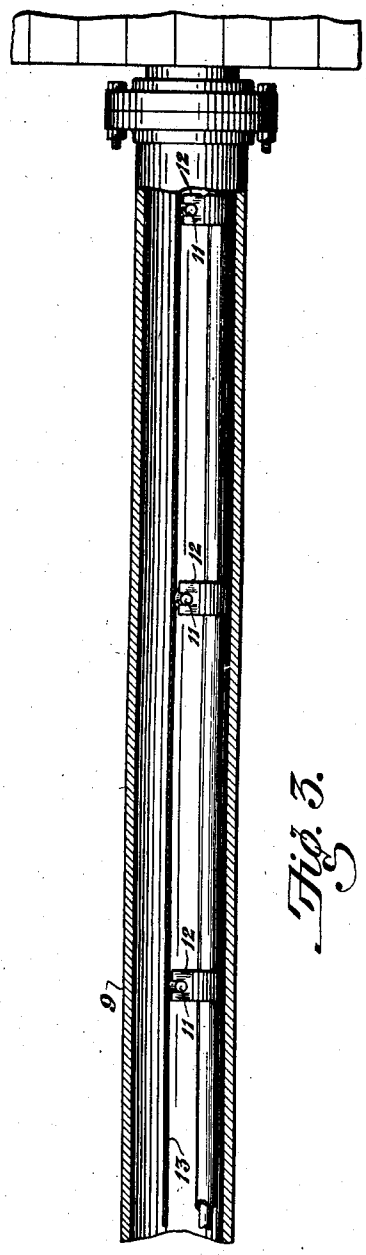



Fig. 3.

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CONTINUOUS ANNEALING PROCESS

Original Filed April 4, 1924. 4 Sheets-Sheet 3

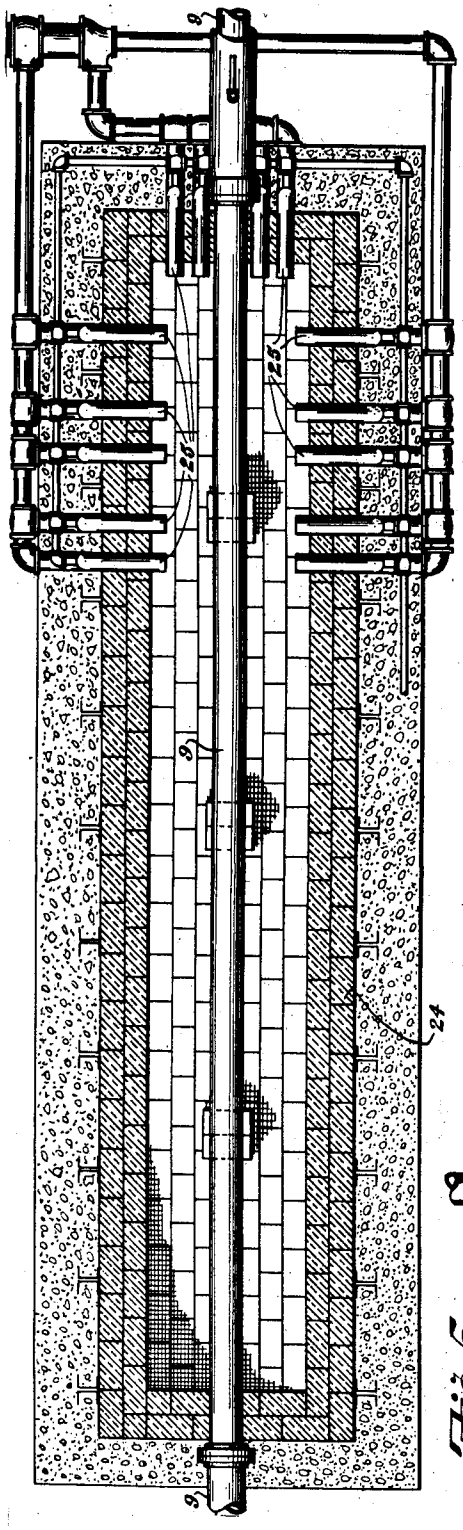



Fig. 5.

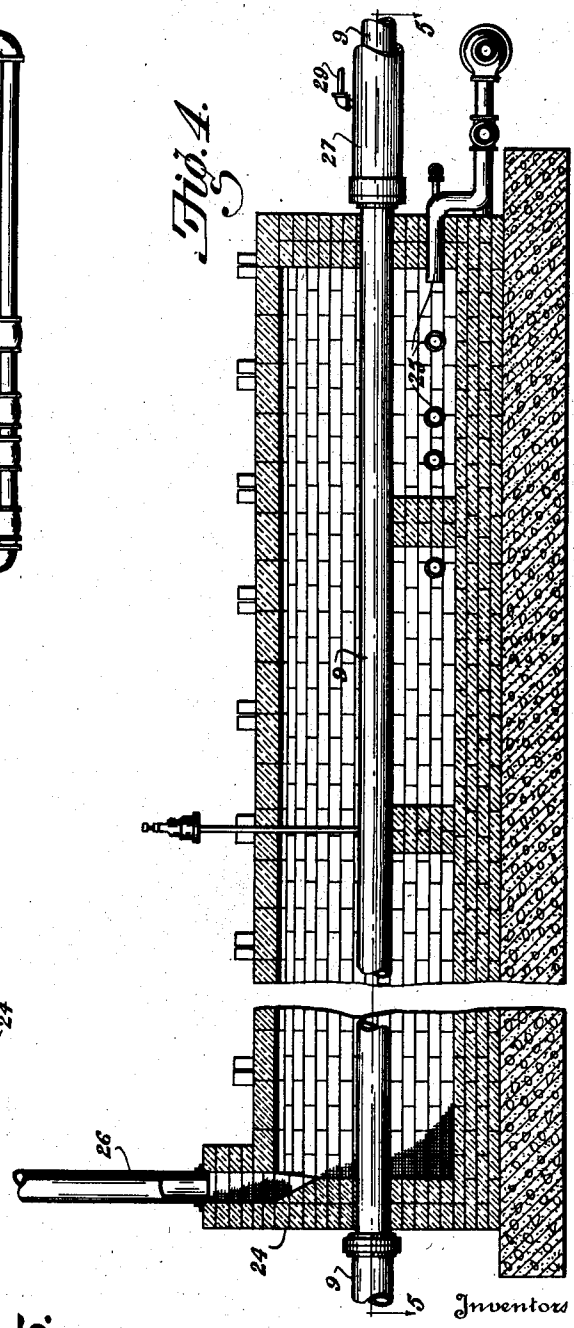



Fig. 4.

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CONTINUOUS ANNEALING PROCESS

Original Filed April 4, 1924 4 Sheets-Sheet 4

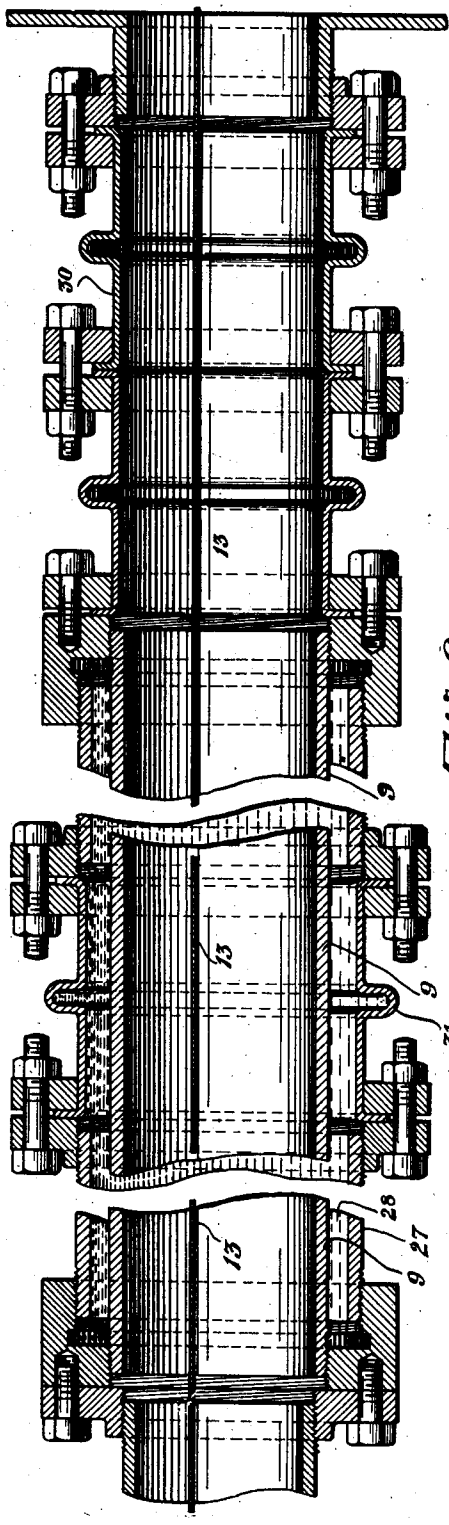



Fig. 6.

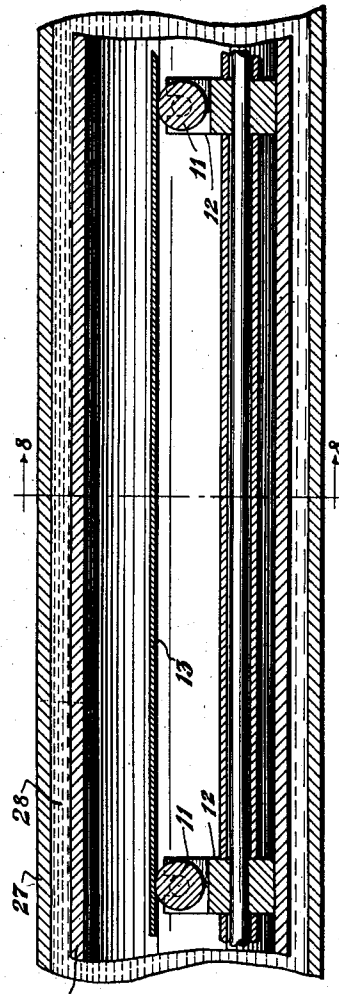



Fig. 7.

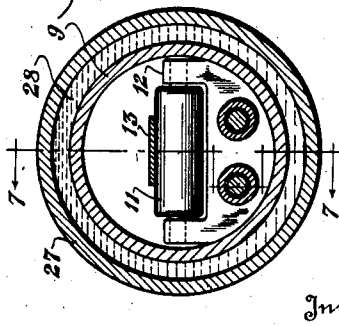



Fig. 8.

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Patented May 21, 1929. 1,714,040

# UNITED STATES PATENT OFFICE.

HARRY M. NAUGLE AND ARTHUR J. TOWNSEND, OF CANTON, OHIO, ASSIGNORS, BY MESNE ASSIGNMENTS, TO THE COLUMBIA STEEL COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENSYLVANIA.

## CONTINUOUS ANNEALING PROCESS.

Application filed April 4, 1924, Serial No. 704,157. Renewed October 13, 1928.

The invention relates to a continuous method of annealing highly finished strips of steel and like ferrous metal; and the object of the improvement is to properly and uniformly anneal such a strip throughout its length and breadth, by passing it through a tubular annealing chamber sealed at both ends against the admission of air, and at the same time to clean the surface of the metal from scale and oxidation and preserve it from discoloration and abrasion during the annealing process.

The use of sand and similar materials for sealing the ends of an annealing chamber, abrades and otherwise defaces the surface of highly finished metal; the use of oil and like liquids for sealing purposes, coats the strip with an adhering film which is objectionable in the annealing chamber; the use of molten metal for sealing purposes plates the surface of the metal; and an important feature of the present invention is the use of a water seal at each end of the annealing chamber.

The use of water and like liquid, however, for sealing the ends of an annealing chamber, impairs the surface as well as the structure of a highly finished steel strip, unless the same is reduced to a low temperature before passing through the outlet sealing medium; and a further feature of the present invention is to cool the strip in the rear end of the annealing chamber to a temperature of less than 100° C. before passing it through the outlet water seal, so as to prevent a discoloration of the surface or an impairment of the structure of the metal.

The improved process may be carried out by the apparatus illustrated in the accompanying drawings, forming part hereof, in which—

Figure 1 is a diagrammatic side elevation of the apparatus, in three sections, showing the line of travel of a metal strip by a solid line;

Fig. 2, a longitudinal elevation section of the water sealed box at the forward end of the annealing chamber;

Fig. 3, a similar section of the annealing chamber in front of the annealing furnace;

Fig. 4, a similar view of the annealing furnace, showing the heating portion of the annealing tube therein;

Fig. 5, a plan section of the annealing furnace on line 5—5, Fig. 4;

Fig. 6, a longitudinal elevation section of the cooling end of the annealing chamber, omitting the conveyer rolls therein;

Fig. 7, a similar view showing the conveyer rolls therein, as on line 7—7, Fig. 8; and

Fig. 8, a cross section of the cooling end of the annealing chamber on line 8—8, Fig. 7.

Similar numerals refer to similar parts throughout the drawings.

The annealing chamber for carrying out the improved process may be in the form of a cast or wrought iron tube 9, extending continuously from the water seal box 10 at the front or inlet end of the tube to the water seal box 10′ at the rear or exit end thereof, and within the chamber may be provided a series of rollers 11 mounted on standards 12 upon which a steel strip 13 may travel through the chamber.

The steel strip 13 to be annealed may be taken from a coil 13′ mounted for unwinding in front of the apparatus, and may be delivered to a coil 13″ mounted for winding at the rear end of the apparatus. In front of the inlet water seal box the strip may pass between electrodes 14 of a spot welding machine for connecting the ends of successive strips together, whence the strip may pass over a roller 15 to properly guide it into the inlet water seal box, all as shown diagrammatically in Fig. 1.

The water seal at the forward or inlet end of the tubular chamber may include a box 10 open at the top 34 of its lower forward end, with a covered top 35 at its higher rear end and a pendent cross partition 16 extending downward from the rear end of the cover 35 to a point near the bottom 17 of the box. The rear end 18 of the box is coupled to and communicates with the forward end of the chamber 9.

A pair of guide rolls 19 and 19′ are mounted in the box, one in front and the other in rear of the pendent partition 16, for guiding the steel strip 13 downward and freely under the lower end of the pendent partition 16; and a roll 20 is mounted in the rear end of the box for guiding the steel strip upward into the forward end of the tubular chamber 9. The box is filled through a pipe 21, with water or other suitable sealing liquid, to a point

well above the lower edge of the pendent partition 16 so as to seal the end of the chamber from the admission of air, and the steel strip is entered into the forward end of the chamber by passing first down and thence upward through the water under the pendent partition 16, as shown in Fig. 2.

A similar water seal box 10′ is coupled to and communicates with the rear or exit ends of the tubular chamber 9, with a reverse arrangement of its parts substantially as described for the front or inlet box 10, and the enclosed portions of the boxes as well as the entire length of the chamber are completely filled with either a neutral or a reducing gas; that is to say, a non-oxidizing gas. This gas may be received into the front sealing box 10 through a gas inlet pipe 22, and may be discharged from the sealing boxes and the chamber or its presence determined therein, by pilot valves 23 and 23′.

A heating furnace 24 may be built around the forward end portion of the tubular chamber 9 at an interval in rear of its forward end, by means of which the annealing chamber may be heated by the combustion of gas entering through burners 25 at one end of the furnace and discharging through a chimney flue 26 at the other end thereof; and a tubular jacket in the form of a pipe 27 may be provided around the tubular chamber in rear of the heating furnace to form an annular chamber 28 around the tubular chamber, through which cooling water may be circulated through inlet and outlet pipes 29 and 29′.

The length of the tubular chamber between the inlet sealing box and the front end of the heating furnace is proportioned to prevent a heating of the forward inlet box to a temperature approaching the boiling point of the sealing liquid, and also to permit a drying of the liquid from the surface of the steel strip before it enters the heating section of the chamber.

The length of the tubular chamber from the rear end of the heating furnace to the exit water sealing box is so proportioned that the steel strips will be cooled to a temperature well below the boiling point of the water or other sealing liquid, before emerging from the rear end of the apparatus.

An expansion coupling 30 may be provided at the rear end of the tubular chamber 9 and an expansion coupling 31 may be provided in the tubular jacket 27, as shown in Fig. 6, to accommodate expansion and contraction caused by the varying temperature of these tubes.

In the operation of the described apparatus for carrying out the improved process, a steel strip is passed continuously through the annealing chamber as above described, and is heated by the furnace so as to bring the strips to an annealing temperature while passing through the portion to the chamber within the furnace; the length of the furnace being proportioned to maintain the strips at the proper temperature during the length of time necessary or desirable for annealing the same. During this period of the operation, the presence of the reducing gas may serve to remove any scale or oxides which are present on the surface of metal, and will at least serve to prevent any discoloration thereof.

After leaving the heated portion of the tubular chamber, the steel strip is gradually cooled as it passes through the rear end of the chamber until the temperature thereof is reduced to below the boiling point of the sealing liquid, being 100° C. when water is used; whence the strip emerges through the exit water seal into the atmosphere, in a cleaned, bright, annealed condition, ready for any ordinary commercial use.

We claim:

1. The method of annealing the body and preserving the surface of a strip of ferrous metal which consists in heating the metal in a non-oxidizing gas to an annealing temperature and then cooling the metal to a temperature less than 100° C. while still in the non-oxidizing gas, all during a continuous endwise movement of the strip.

2. The method of annealing the body and cleaning the surface of a strip of ferrous metal, which consists in heating the metal in a reducing gas to an annealing temperature and then cooling the metal to a temperature less than 100° C. while still in the reducing gas, all during a continuous endwise movement of the strip.

In testimony that we claim the above, we have hereunto subscribed our names.

HARRY M. NAUGLE.
ARTHUR J. TOWNSEND.