Sept. 19, 1933. F. A. FAHRENWALD 1,927,633

APPARATUS FOR HEAT TREATING FERROUS METAL

Filed Jan. 25, 1929

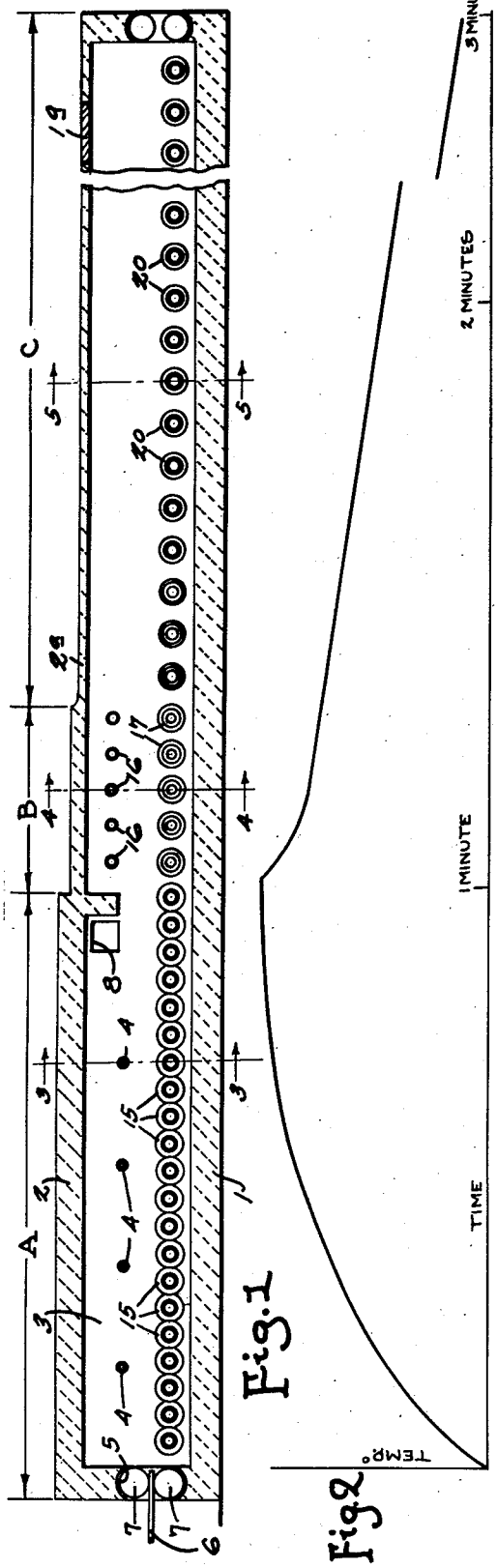


Fig. 1

Fig. 2

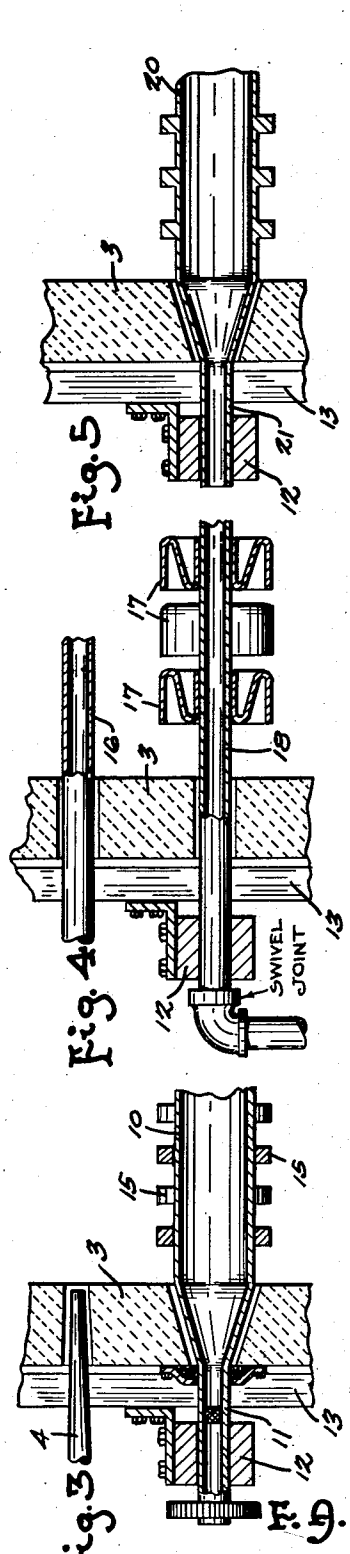


Fig. 5

Fig. 4

Fig. 3

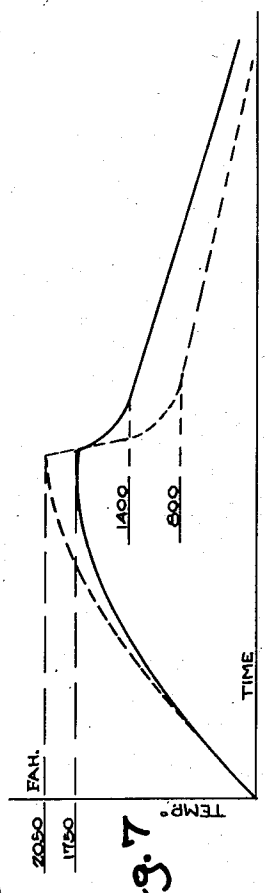


Fig. 7

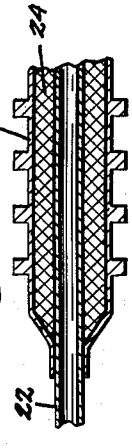


Fig. 6

F. A. Fahrenwald
Inventor
by Smith and Freeman
Attorneys

Patented Sept. 19, 1933 1,927,633

UNITED STATES PATENT OFFICE

1,927,633

APPARATUS FOR HEAT TREATING FERROUS METAL

Frank A. Fahrenwald, Chicago, Ill.

Application January 25, 1929. Serial No. 335,043

1 Claim. (Cl. 263—6)

This invention relates to an apparatus for heat treating ferrous metal and has for its object the provision of a continuous operation furnace whereby strips, sheets, strands, rods, wires, and other articles may be rapidly, accurately, and controllably heat-treated, which is to say hardened, tempered, toughened, or as sometimes expressed "normalized". While primarily designed and intended for operation upon thin sheet steel, said apparatus is not limited to this use, since other ferrous metal articles and ferrous metal alloys can be treated to advantage therein, such as articles cast from iron, manganese steel, etc. This apparatus is devised particularly for performing the processes described and claimed in my Patent No. 1,787,977, dated January 6, 1931. although it is not limited to the maintenance of the atmospheric and temperature conditions therein recited.

For example, in the manufacture of automobile bodies, fenders, and other parts it is customary to employ sheet steel by drawing and pressing the same in dies, and the proper, uniform, and reliable formation of these parts, as required in mass production, requires the employment of steel having a high degree of toughness, ductility, and uniformity. Furthermore the requirements for subsequent repair of accidents necessitates that this steel be so free from brittleness as to enable it to be smoothed out, unbroken, after having been crumbled or crushed into extreme shapes. This softness, toughness and uniformity can be obtained only by heating the metal to such temperature as shall allow all strains produced therein by the previous manipulation of the metal to be entirely released, and afterwards cooling the metal at a strictly controlled rate. Previously it was customary to heat these sheets in batches or piles laid either on the furnace floor or on a car movable therethrough. More recently it was suggested to pass the sheets singly through the heated zone of the furnace by means of a mechanical conveyor of some kind, afterwards discharging them immediately into the open air. According to my invention the quenching and cooling steps are performed in the furnace chamber itself where they can be accurately controlled, the length of the chamber being greatly increased for the purpose, and provisions made for the regulated abstraction of heat at different points or regions.

In the drawing accompanying and forming a part of this application I have shown, although somewhat diagrammatically, a furnace containing my present improvements; Fig. 1 is a vertical longitudinal sectional view through a furnace containing my improvements; Fig. 2 is a time-temperature chart showing the temperatures in the different parts of the furnace outlined in Fig. 1; Figs. 3, 4, and 5 are vertical, cross-sectional views corresponding to the lines 3—3, 4—4, and 5—5, respectively, of Fig. 1; Fig. 6 shows a modified kind of roll; and Fig. 7 is another time-temperature diagram showing the nature of the heat treatment performed by this apparatus.

My improved furnace comprises an elongated chambered structure having a bottom wall 1, top wall 2, and side walls 3, defining an elongated chamber placed horizontally. Mechanical conveyor devices located in this chamber serve to transport from end to end the metal to be treated. In the present embodiment this conveyor comprises a large number of horizontal rolls mounted transversely of the furnace chamber close to the bottom wall thereof and having their tops all tangent to the same horizontal plane so that sheets or plates of metal can be transported from end to end of the furnace without becoming wrinkled or deformed in any way, all of said rolls being rotated in the same direction and at the same peripheral speed by means of suitable driving devices connected thereto in any suitable manner as will be well understood by those skilled in the art.

Interiorly this furnace chamber is divided into three distinct zones indicated at A, B, and C in Fig. 1. The zone A is the high temperature zone and is provided with suitable heating means, here typified by gas burners 4, penetrating the side walls 3 at suitable intervals, although electricity or solid fuel heating can obviously be employed. I have shown this part of the furnace as having an ingress opening 5 for the sheets 6 to be treated, heat-loss and air-admission being impeded by closure rolls 7—7, and the combustion products escaping by means of a flue 8. The rolls in this part of the furnace are preferably of the non-cooled variety described and claimed in my Patent No. 1,623,469, dated April 5, 1927, or in my Patent No. 1,840,661, dated January 12, 1932. A cross-sectional view of such a roll is shown in Fig. 3 and each comprises a hollow body 10 having a reduced, axial, shaft-extension 11, one or both ends being journaled in bearings 12 mounted upon the framework 13, conveyance of the furnace heat to the bearings being inhibited by suitably limiting the cross-section of the metal, and by inhibiting the movement of hot gas from inside the furnace, either through or around the roll. These rolls are necessarily made of an alloy which will withstand the full furnace temperature and are preferably surrounded inside the furnace by spaced alloy disks or rings 15 so arranged as to form closely adjacent supports for the moving sheet. The reasons that I advocate the employment of non-cooled rolls are because of the big saving of fuel, because of the greater uniformity of temperature within the furnace, because of the greater speed of move-

ment possible, and because the sheets are less scratched and injured thereby.

The intensity of the heating means and the speed of the rolls are so adjusted that, during their passage through the zone A, the metal articles are heated to a point above the critical point of the metal and maintained there for such a length of time as shall enable the internal strains to become thoroughly released and the condition of the carbon content to become stabilized to that temperature. This temperature depends to some extent upon composition of the metal and the amount of carbon, and the time required depends upon the composition of the metal and its thickness; and in addition the time and temperature are mutually connected, since a short period at a high temperature exhibits the same effect as a longer exposure to a lower temperature. In general, however, the minimum temperature for this strain-release and carbon solution is approximately 1750° Fahrenheit and the maximum temperature for convenient operation is about 2050° Fahrenheit (and even this is seldom reached in practice) and a successful time for automobile steel is from one and one-half to two minutes.

The next succeeding zone B is provided with means for abstracting the heat of the moving metal so as rapidly to depress the temperature slightly below the critical range though preferably not unduly far therebelow. This quenching is effected by means of bodies of metal cooled by circulating fluid and located sufficiently closely to the sheet to absorb its radiations at the desired speed. To this end I have shown horizontal pipes 16 traversing the chamber close above the moving sheet; and in order to equalize the cooling of the two sides of the sheet I have also shown the rolls in this part of the furnace as of fluid cooled nature, consisting of circular metal bodies 17 mounted on hollow shafts 18 through which water is circulated. The bodies 17 are preferably of the same diameter as the disks 15, and the shafts 18 are journaled in bearings 12. The number of these cooled rolls and the number of the pipes 16 depends upon the speed and extent of quenching required, which in turn depends upon the thickness and composition and speed of the sheet and the purpose for which it is to be used. For example, however, it is feasible that the sheet should spend ten to forty seconds in passing through this zone, and be chilled to a temperature somewhere from 1400° to 800° Fahrenheit.

Next after the zone B is the cooling zone C, which generally is made considerably longer than either or both the first zones, and is so arranged and constructed as to abstract heat from the metal at a slower rate than in the zone B, with the result that the sheets when finally discharged into the open air have been reduced to such a temperature as not thereafter to be changed either physically or chemically by such exposure. A good temperature for emergence is about 400° Fahrenheit, although I do not limit myself thereto excepting that I prefer it to be below about 600°, although metals of different composition will stand different exposures. The walls of this part of the furnace are generally made thinner than other parts (as shown at 2^a), and may have metal sections 1^a therein if necessary to secure the proper rate of heat dissipation. The rolls are preferably of the same external dimension as the rolls of the first zones and are preferably of a non-cooled variety as shown in Fig. 5, lest the heat should be abstracted too rapidly. I have here shown them as plain cylindrical, thin-walled metal bodies 20 having shaft extensions 21, journaled as before. Owing to the lower temperature of this part of the furnace few precautions in the way of composition are required. In case the all-metal rolls abstract heat too readily, insulated rolls as shown in Fig. 6 can be employed, comprising a central shaft 22 surrounded by a hollow shell 23 between which and the shaft non-conducting substance 24 is located. It will also be understood that in case the dissipation of heat in the zone C of the furnace is too rapid, heating means can be employed such as gas-jets or electric-resistance devices.

Ordinarily this part of the furnace is longer than the other parts. The over-all length of the furnace depends in part upon the speed of production desired, and also upon the thickness of the metal sheet to be treated. To a certain degree it is possible to shorten the furnace by reducing the speed of movement of the sheets, but with sheets of thin gauge there is a minimum speed required to be maintained to prevent the sheets from sagging in the high temperature part of the furnace due to their own weight. However, to obtain high production it is preferable to increase the speed, and with it the length of the furnace which in the best installations extends from 200 to 300 feet.

Such furnaces are oftentimes run continuously upon a single gauge of metal, but to change from one to another ordinarily requires merely a change in the number of the rolls and cooling pipes in the zone B, increasing or decreasing these rolls by the elimination or substitution of added rolls 15 or 20.

It will be understood, of course, that I do not limit myself to the horizontal roll type of furnace since any other type of mechanical conveyor can be employed, such as that illustrated and described in my Patent No. 1,827,079, dated October 13, 1931; and that other types of heating and cooling can be employed, and other temperature relations; so that I do not limit myself in any wise except as specifically recited in my claim which I desire may be construed broadly.

Having thus described my invention what I claim is:

A furnace for continuous treatment of steel, comprising a heating zone, a quick cooling zone and a slow cooling zone arranged in series in the order in which they are named; the heating means of said heating zone being adapted to raise the temperature of the treated steel to a degree above the critical temperature of the steel and providing therein a protective atmosphere; said quick-cooling zone having communication with the heating zone which admits to the quick cooling zone a portion of said protective atmosphere and being provided with means for rapidly reducing the temperature of the treated steel through the critical range; said heating zone having an outlet through which passes a sufficient proportion of its protective atmosphere to avoid delivery into said quick cooling zone of sufficient heat to defeat the said rapid cooling; and said slow cooling zone being of such length as to lower the temperature of the treated steel through the scaling range before the treated steel is discharged into outer atmosphere.

FRANK A. FAHRENWALD.