Dec. 4, 1956 N. B. ORNITZ 2,772,872

FURNACE CONVEYOR ROLL

Original Filed March 11, 1950

Fig. 1.

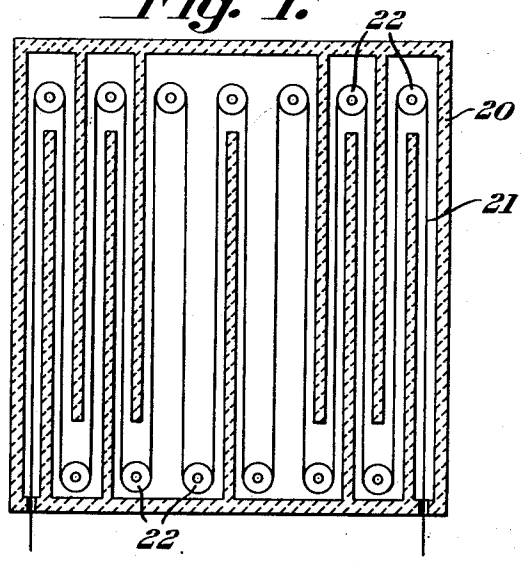


Fig. 2.

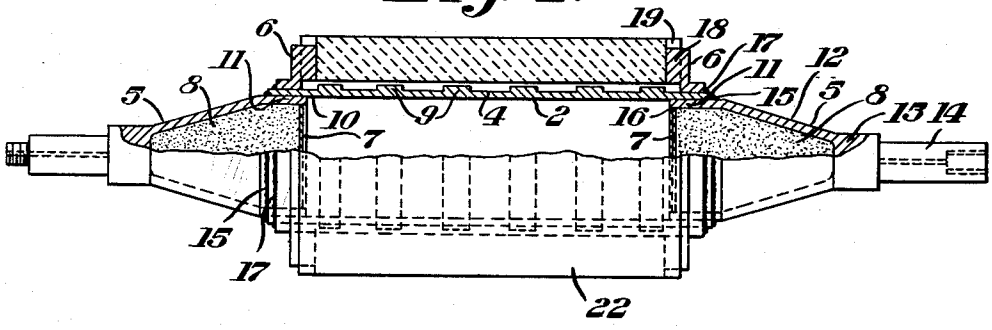
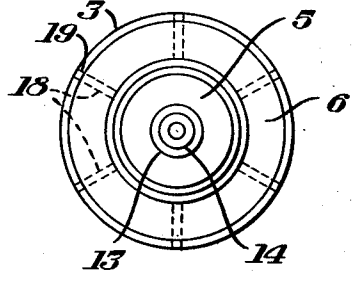


Fig. 3.



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FURNACE CONVEYOR ROLL

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Original application March 11, 1950, Serial No. 149,079, now Patent No. 2,603,578, dated July 15, 1952. Divided and this application December 19, 1951, Serial No. 262,413

7 Claims. (Cl. 263—6)

This invention relates to furnace conveyor rolls. It has to do particularly, although not exclusively, with furnace conevyor rolls around which metal strip is passed and advanced through continuous heating furnaces to be heated therein. A purpose of the invention is to provide furnace conveyor rolls which remain smooth in continued use and have no deleterious effect upon the work carried thereby in the presence of the furnace atmosphere at temperatures above 1200° F., as, for example, in the annealing of ferrous strip at about 1600° F., yet are of relatively simple construction, economical to manufacture and of superior strength.

This application is a division of my copending application Serial No. 149,079, filed March 11, 1950, now Patent No. 2,603,578, which in turn is in part a continuation of my application Serial No. 74,451, filed February 3, 1949, now abandoned.

For purposes of explanation and illustration the invention will be described as embodied in a furnace conveyor roll for passing strip through an annealing furnace.

Those skilled in the art are aware of the difficulties encountered in the use of metallic conveyor elements in heating furnaces. For example, conveyor rolls used in continuous strip annealing furnaces tend to collect accretions of material from the strip which dent the strip passing over or around the rolls. The problem is particularly acute in the treatment of high silicon steels and other steels requiring high annealing temperatures. The phenomenon of accretion formation is complex and is influenced by the tension of the strip passing around the rolls, the composition of the strip carried by the rolls and the composition and temperature of the furnace atmosphere as well as the character of the roll surface. The problem is similar to the handling of sheets in annealing furnaces on carriers or roller tables which is discussed, and a solution given, in my prior Patent No. 1,951,766. That patent teaches the use of refractory inserts such as inserts of silicon carbide in furnace conveyor elements, the refractory inserts supporting the work passing through the furnace. While no oxide coating forms on silicon carbide inserts and such rolls are satisfactory for annealing sheets, it has been found that in continuous strip annealing furnaces where the strip wraps around the rolls under tension, and especially in annealing high silicon steel strip, some accretions form on silicon carbide inserts. Furthermore, the provision and application of the refractory inserts entail substantial labor and expense.

In copending applications Serial No. 65,384, filed December 15, 1948, now Patent No. 2,695,248, and Serial No. 71,886, filed January 21, 1949, now Patent No. 2,663,558, are disclosed furnace conveyor elements comprising metal bodies having oxide coatings on the work-carrying portions thereof, which oxide coatings inhibit the formation of accretions on the conveyor elements. While the conveyor elements of those applications have proved satisfactory, especially in highly oxidizing atmospheres or in the lower ranges of strip tension, I have devised a conveyor roll which is superior thereto in a

number of respects. My conveyor roll has improved accretion inhibiting properties relatively to not only silicon carbide inserts as disclosed in Patent No. 1,951,766, but also the oxide coated conveyor elements disclosed in said applications. Also my improved conveyor roll has materially increased strength for the quantity of costly high temperature alloy used in its manufacture.

My improved furnace conveyor roll has a carbonaceous work-engaging portion. The work-engaging portion of the element may comprise graphite particles bonded together. I preferably employ a baked mass of graphite particles and a binder which may be a bituminous binder such as tar binding the particles together. The body of the roll is preferably of metal, a high temperature alloy of known composition desirably being employed.

My improved furnace conveyor roll may comprise a metal body with a carbonaceous sleeve fitted thereon. The metal roll body may be a hollow alloy metal body, a high temperature alloy of the type used in the manufacture of conveyor elements for use in furnaces in which high temperatures are present being normally used. The carbonaceous sleeve preferably tightly embraces the body when the roll is in use to provide a work-engaging surface and to structurally strengthen the body. The roll desirably comprises a hollow metal body with a cylindrical mass of baked graphite particles and a binder tightly embracing the body.

Other details, objects and advantages of the invention will become apparent as the following description of a present preferred embodiment thereof proceeds.

In the accompanying drawings I have shown a present preferred embodiment of the invention in which

Figure 1 is a diagrammatic view of a heat treating chamber showing how strip may be supported on my furnace conveyor rolls for passage therethrough;

Figure 2 is a view partly in elevation and partly in axial cross section of a furnace conveyor roll; and

Figure 3 is an end view of the furnace conveyor roll shown in Figure 1.

Figure 1 shows a furnace chamber designated generally by reference numeral **20** through which strip **21** is adapted to be drawn, the strip passing over a series of rolls at the top of the furnace and beneath a series of rolls at the bottom of the furnace, all of the rolls desirably being of uniform construction and each being designated by reference numeral **22**, the structures of the rolls being shown in Figures 2 and 3. The rolls **22** may be driven or may turn idly as the strip is drawn through the chamber. The chamber is heated internally by suitable heating means such as electric heating elements (not shown).

Referring now more particularly to Figures 2 and 3, the furnace conveyor roll shown therein comprises a metal body designated generally by reference numeral **2** and a graphite sleeve **3**. The roll body **2** comprises a barrel **4**, two shaft ends **5**, two drive rings **6** and two closure plates **7**, the shaft ends **5** being filled with heat insulating material **8**. The barrel **4**, the shaft ends **5**, the drive rings **6** and the closure plates **7** may be of any suitable ferrous or non-ferrous high temperature alloy such as is used in the manufacture of furnace conveyor elements.

The barrel **4** has axially spaced circumferential projections or lands **9** forming bearings for the sleeve **3** and a vent **10** establishing communication between the outside and the inside of the barrel **4** to permit venting of heated air from within the barrel when the roll is brought up to temperature and entrance into the barrel of air from the outside when the barrel cools and the heated air within contracts. The shaft ends **5** have cylindrical portions **11** fitting within the ends of the barrel **4**, tapered portions **12** and cylindrical end portions **13** and trunnions **14** of relatively great and relatively small diam-

eter. The roll may be mounted for rotation in conventional manner.

The ends of the barrel 4 are welded to the shaft ends 5 by welds 15. The closure plates 7 are welded to the shaft ends 5 by welds 16. The drive rings 6 are welded to the barrel 4 by welds 17, but one of the drive rings is not applied and welded to the barrel until after the sleeve 3 has been put in place on the barrel. Each of the drive rings 6 has a series of circumferentially spaced radially and axially extending projections 18 each of which enters a slot 19 provided therefor in one of the ends of the sleeve 3 thus locking the sleeve to the roll body so that the roll functions as a unit. As clearly shown in the drawings, each of the drive rings 6 interfits with the sleeve 3 and bears against the sleeve circumferentially and axially only to hold the sleeve against turning relatively to the roll body 2.

The sleeve 3 constitutes the work-engaging portion of the roll and its outer cylindrical surface is the work-engaging surface of the roll. The sleeve is made of graphite. Preferably finely divided particles of graphite are bonded with a suitable binder, such, for example, as bituminous material such as tar, compressed into hollow cylindrical shape as shown and baked. The slots 19 may be molded into the sleeve at the time of its formation or may be cut out afterward.

The sleeve 3 may, if desired, be of amorphous carbon instead of graphite. A sleeve of amorphous carbon may be made by baking in a kiln a mixture of anthracite coal, petroleum coke and pitch. An amorphous carbon sleeve may be changed into graphite by being further heated in a graphitizing furnace to effect transition of the carbon to graphite form.

When the parts are cold the outside diameter of the circumferential projections 9 is slightly less than the inside diameter of the sleeve 3 so that the sleeve may easily be applied over the barrel. However, when the roll is brought up to temperature expansion of the barrel results in a tight fit between the barrel and the sleeve so that the sleeve tightly embraces the roll body. This is a feature of consequence of my improved roll. At high annealing temperatures, such as the temperatures at which silicon steel sheets are annealed, graphite is mechanically stronger than any known high temperature alloy and a sleeve such as the sleeve 3 contributes materially to the stiffness and strength of the roll. Assuming a given desired outside diameter of the roll and comparing the graphite roll shown in the drawings with the oxide coated rolls of the applications above referred to, while in the oxide coated rolls the metal roll body has almost the full roll diameter and has the largest section modulus possible, which permits use of a relatively thin wall in the metal roll body, in the roll shown in the drawings, although the section modulus of the metal body is much lower, this is more than compensated for by the reinforcing effect of the graphite shell or sleeve which makes possible the use of a very thin walled body or barrel. As stated above, when the roll is brought up to the temperature at which it is used in supporting and advancing work through a heating furnace the metal roll body expands and forms a tight fit with the inside of the sleeve 3, whereby the reinforcing effect of the sleeve is produced.

In addition to the mechanical advantage of the structure just explained it is found that the graphite work-engaging surface is superior to silcon carbide and also superior to the oxide surfaces disclosed in the above mentioned applications in inhibiting accretion formation so that my roll both has exceptional strength and long life for the quantity of material employed in its manufacture and accomplishes superior results. In fact, even with high strip tension the strip-engaging surface of my graphite sheathed rolls appears to be maintained smooth by use, perhaps even somewhat improved and polished by continued use, which is just the reverse of the behavior of other rolls suggested and used. It is, of course, understood that the furnace atmosphere in which my roll is used should not be excessively oxidizing in character, so as to rapidly consume the graphite shell; but slow oxidation merely gradually reduces the roll diameter, without other harmful effect and does not detract from the advantages which the use of graphite shell provides.

While I have shown and described a present preferred embodiment of the invention it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied within the scope of the following claims.

I claim:

1. A furnace conveyor roll comprising a body of structural material, a work-engaging sleeve of material different from the material of the body disposed about and immediately adjacent a portion of the body and abutment means carried by the body engaging the end portion of the sleeve to maintain the sleeve in position axially of the body, the central portion of the sleeve being slightly spaced from the body at room temperature but through expansion engaging the body at working temperature.

2. A furnace conveyor roll comprising a body of material having a relatively great coefficient of expansion and a work-engaging sleeve of material having a relatively small coefficient of expansion disposed about a portion of the body, the outside dimension of the body being less than the inside dimension of the sleeve at normal atmospheric temperatures to provide clearance between the body and sleeve to facilitate application of the sleeve about the body but the difference between said dimension being limited so that when the roll is heated to a temperature materially higher than normal atmospheric temperatures for heat treating work supported by the roll the body expands relatively to the sleeve into tight fitting engagement with the sleeve.

3. A furnace conveyor roll comprising a body of generally cylindrical shape having annular outward projections spaced apart axially of the body and a work-engaging carbonaceous sleeve disposed about the body and bearing against said projections.

4. A furnace conveyor roll comprising a body of material having a relatively great coefficient of expansion, the body being of generally cylindrical shape and having annular outward projections spaced apart axially of the body, and a work-engaging sleeve of material having a relatively small coefficient of expansion disposed about the body and about said projections, the outside dimension of the body at said projections being less than the inside dimension of the sleeve at normal atmospheric temperatures to provide clearance between the body and sleeve to facilitate application of the sleeve about the body but the difference between said dimensions being limited so that when the roll is heated to a temperature materially higher than normal atmospheric temperatures for heat treating work supported by the roll the body expands relatively to the sleeve bringing said projections into tight fitting engagement with the sleeve.

5. A furnace conveyor roll comprising a metal body of generally cylindrical shape having annular outward projections spaced apart axially of the body and a carbonaceous work-engaging sleeve disposed about the body and about said projections, the outside dimension of the body at said projections being less than the inside dimension of the sleeve at normal atmospheric temperatures to provide clearance between the body and sleeve to facilitate application of the sleeve about the body but the difference between said dimensions being limited so that when the roll is heated to a temperature materially higher than normal atmospheric temperatures for heat treating work supported by the roll the body expands relatively to the sleeve bringing said projections into tight fitting engagement with the sleeve.

6. A furnace conveyor roll comprising a body con-

tinuous from end to end of the roll and having trunnions at its ends for rotatably supporting the roll, the body having a generally cylindrical central portion, a work-engaging sleeve disposed about and mounted directly upon the generally cylindrical central portion of the body and abutment portions carried by the body engaging the sleeve at the respective ends thereof and fastened to the body to maintain the sleeve in position axially of the body, at least one of said abutment portions interfitting with the sleeve and bearing against the sleeve circumferentially and axially only to hold the sleeve against turning relatively to the body.

7. A furnace conveyor roll comprising a body continuous from end to end of the roll and having trunnions at its ends for rotatably supporting the roll, the body having a generally cylindrical central portion, a work-engaging sleeve disposed about the generally cylindrical central portion of the body, the work-engaging sleeve having at an end thereof a radial slot entering axially into the sleeve from the end of the sleeve, and abutment portions carried by the body engaging the sleeve at the respective ends thereof and fastened to the body to maintain the sleeve in position axially of the body, the abutment portion at the first mentioned end of the sleeve having means entering the slot to hold the sleeve against turning relatively to the body.

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