March 28, 1939. P. S. MENOUGH 2,152,076

HIGH TEMPERATURE SHAFT OR ROLL

Filed July 15, 1936

Fig.1

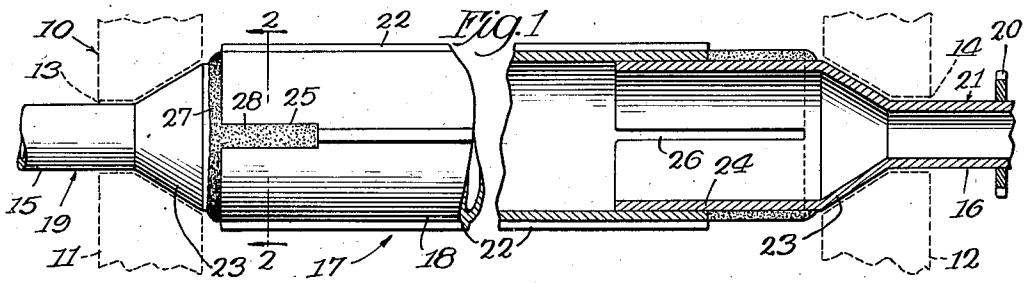


Fig.2

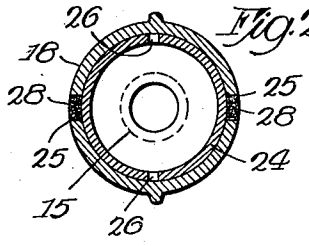


Fig.4

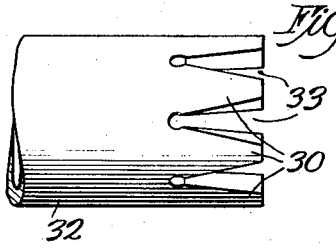


Fig.5

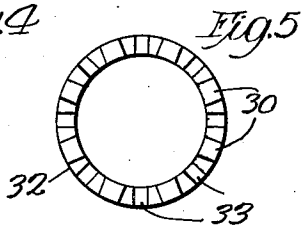


Fig.3

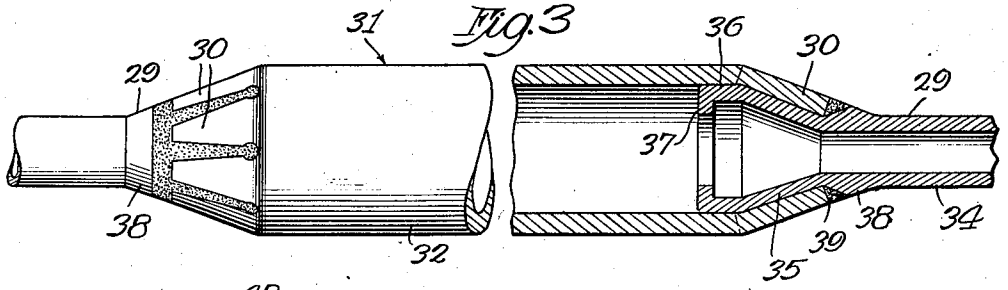


Fig.6

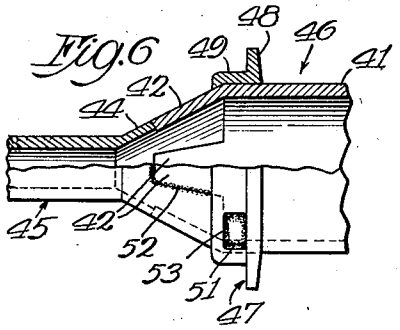


Fig.7

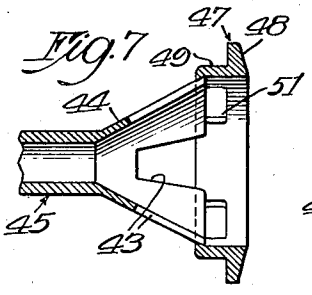


Fig.8

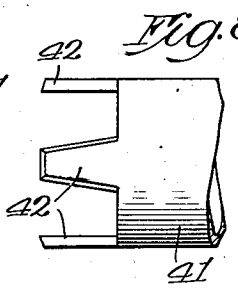
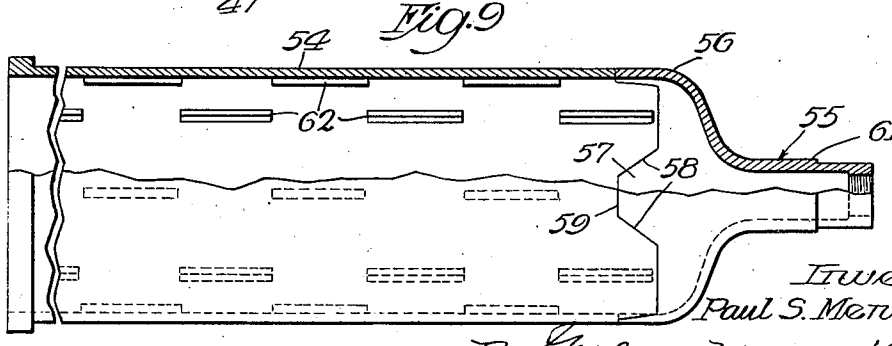


Fig.9



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HIGH TEMPERATURE SHAFT OR ROLL

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Application July 15, 1936, Serial No. 90,754

6 Claims. (Cl. 263—6)

This invention relates to shafts or rolls for use under high temperature conditions and more particularly for use in high temperature furnaces.

One of the objects of the invention is the provision of a new and improved high temperature shaft or roll that is formed from sections provided with novel means for connecting the sections together.

Another object of the invention is the provision of a new and improved furnace shaft having a cast central portion and having end portions welded thereto by a weld that is so arranged that only portions of the weld extend in the direction of rotation of the shaft or roll whereby the parts will be more nearly permanently connected together.

A still further object of the invention is the provision of a new and improved furnace shaft having a centrifugally cast central portion, provided with reduced end portions attached thereto by welds arranged at an angle to the direction of travel of the shaft whereby the welds will more firmly hold the parts together and reinforce the carrying capacity of the shaft.

A further object of the invention is the provision of a new and improved sectional furnace shaft having novel means for connecting the sections together, that is inexpensive to manufacture, strong, rugged, efficient in use, and that is not likely to become bent, distorted, broken, or the parts become disconnected, while in operation.

Other and further objects and advantages of the invention will appear from the following description taken in connection with the accompanying drawing, in which

Fig. 1 is a vertical section of a furnace, shown in dotted lines, showing the invention in position therein, with parts in section and parts broken away;

Fig. 2 is a section on the line 2—2 of Fig. 1;

Fig. 3 is a front elevation of a modified form of the shaft, with parts in section and parts broken away;

Fig. 4 is an elevation of one end of the central section of the shaft of Fig. 3 before the shaft is assembled;

Fig. 5 is an end elevation thereof;

Fig. 6 is an elevation of an end portion of a modified form of shaft, with parts broken away and parts in section;

Fig. 7 is a vertical section of the end section of the shaft shown in Fig. 6, with parts broken away;

Fig. 8 is an elevation of the central portion of the shaft shown in Fig. 6, with parts broken away; and

Fig. 9 is an elevation of a carbonizing retort, with parts in section and parts broken away.

It is common practice to employ a plurality of rotating shafts which form conveyors for transferring material through the furnace while the same is being heat treated.

More or less difficulty has been experienced in the use of these shafts due to the intense heat to which they are subjected in certain types of furnaces. The qualifications for the shafts are rather exacting. They must have sufficient strength under high temperatures so that they will not bend, break or become distorted while in use. They must be symmetrical, strong and durable, and free from defects in their construction.

The present invention has for its principal object, the provision of shafts of superior quality. This is accomplished by centrifugally casting the central portion of the same from heat resisting alloys, and by securing the end portions to the central portion in a novel manner.

These shafts have been made by casting metal in conventional stationary molds. Numerous weaknesses have developed in castings so made. It is very difficult to hold a heavy core in the center of the mold while molten steel is being poured around it. If the core does not remain in the center of the mold, the walls of the casting will not be uniform in thickness. This means that the metal in the walls will freeze or solidify at different rates. As molten metal solidifies, it shrinks. Consequently, the lighter sections of the wall, as they freeze first, will draw molten metal from the heavier sections to compensate for this liquid shrinkage. This will cause shrinkage voids or at least porosity to be formed in the heavier wall sections which freeze last. Also, the low melting segregates will migrate to the portion of the casting which is the last to freeze and there will be present in these heavy sections not only shrinkage cavities, but also, in the same locality, a concentration of segregates. Moreover these shrinkage voids and their accompanying segregations will be buried in the middle of the wall and cannot be detected by any surface inspection. After continued service at high temperatures, shafts made in the above manner, if they contain concentrations of segregates as described above, have a tendency to form blisters on the surface of the casting. These blisters are caused apparently by oxidation of the segregates which, as they oxidize, increase in size forcing the outer surface of the casting to blister.

Again, because the casting cools at different

rates, the thin side will shrink ahead of the thick side. This will cause the casting to warp.

The above difficulties which appear to be quite exaggerated in chrome nickel steel castings are automatically corrected by making such castings centrifugally. The wall thickness is determined by centrifugal force and is uniform in all portions of a centrifugal casting. This means there will be no heavy sections, the casting will freeze uniformly and there will be no shrinkage, no concentration of segregations, and no warpage.

The present invention seeks to remedy these difficulties by the provision of shafts made in sections, the central or principal section being centrifugally cast, and the end section or sections being rigidly connected thereto by welding or the like. This central section, being centrifugally cast, will be symmetrical about its longitudinal axis; the best of the material will be on the surface thereby adding materially to the strength and heat resisting property of the shaft; there will be no blow holes or defective parts in the surface of the rolls; the dross and lighter material will be on the inner surface; and the entire material will be equally distributed about the axis of the shaft.

I have found that shafts made from heat resisting alloy, such as iron-chromium-nickel, give the best results when centrifugally cast, but due to the fact that the openings in the furnace walls through which the ends of the shafts extend, must be limited in area in order to prevent the escape of the furnace heat therethrough, it is common practice to reduce the ends of the shafts to extend through these openings.

Since these shafts are tapered at the ends and the walls of the central portion are of such thickness that the axial opening is not of uniform diameter throughout the length of the shaft, the shaft, when centrifugally cast, must be made in sections. They are preferably made in three sections, the central portion only is centrifugally cast and the end sections are connected thereto by means including welding. In order that these welds may resist both the torque of the operating mechanism and also support the load of the material that is being treated, the weld or welds are so arranged that they extend not only circumferentially around the shaft but also at an angle or angles to the direction of rotation.

This is considered an important feature of the invention. If the centrifugally cast barrel and the separately cast end portion are joined only by a circumferential weld, the bending movement of the shaft has a tendency to become a maximum on the weld. The reason for this is that when a single circumferential weld is employed one section is telescoped within the other and since any looseness whatever in the joint will tend to permit the shaft to bend slightly at the joint, such bending will, of course, tend to disrupt the weld. It will be noted that such a butt weld, when it is at the top of the shaft will be in compression. A half revolution later when it will be at the bottom of the shaft, it is in tension. This constant reversal of stress with the bending load, which is present at this section, has a tendency to break down the weld. By utilizing a series of welds, which are at an angle to a circumferential weld, this weaving stress, as the shaft rotates, is effectually resisted. It will be noted that with a weld extending longitudinally on the shaft, there is a very considerable leverage developed on the welded material which will resist the bending stress of the shaft and its superimposed load. If the end sections are telescoped within the ends of the central body section, it would appear at first glance, that the same result as outlined above would be achieved, namely: a leverage which would act against the bending load of the shaft. This, however, is not true. All the heat which reacts on the male portion of this joint must come through the central shaft which encloses it. The heat conductivity of chromium nickel steel is very poor. Consequently, the end of the central or body section will get hotter than the inserted end of the end section and will expand away from it, allowing the bending load to be concentrated in a weaving stress on the weld itself.

This means that by extending these welds not only circumferentially, but also longitudinally, it has been found that this weaving stress is effectually resisted.

Referring now to the drawing, the reference character 10 designates a furnace having the walls 11 and 12 shown in dotted lines. These walls are provided with openings 13 and 14 through which the reduced ends 15 and 16 of a furnace shaft 17 extend, as is usual in such constructions. A sprocket or the like 20 on the reduced portions of the shaft is provided for operating the shaft in the usual manner.

It is common practice in heat treating furnaces to provide a plurality of parallel shafts or rolls extending transversely across the furnace and rotating the same by suitable mechanism to form a conveyor for transferring material that is being treated through the furnace. Since the details of the furnace constitute no part of the present invention, it is not thought necessary to further illustrate or describe the same.

Each of the shafts 17 comprises a central section 18 and end sections 19 and 21. The central section 18 is cylindrical in cross section and is centrifugally cast from any suitable heat resisting ferrous alloy; such, for instance, as an alloy of iron-chromium-nickel. It has been found that alloy containing iron and from 15% to 40% of chromium gives good results. Other alloying metals may be used in the ferrous alloy, as for example, nickel. But, where nickel is employed, it is desirable that the nickel and the chromium together shall be not less than 20% and not more than 60%. This alloy is preferably centrifugally cast to form the blank for the central section 18 of the shaft. The central section blank is cylindrical and may, if desired, be cast with ribs 22 thereon for splining material transporting disks to the shaft as is usual in such constructions. These ribs will materially reinforce the shaft.

By centrifugally casting the alloy, the heavier and consequently the tougher and stronger portions of the alloy will be at the outer surface of the shaft or roll thereby adding materially to the strength of the shaft or roll in resisting bending or distortion thereof. By casting the ribs 22 on the surface of the shaft or roll the thickness of the metal of the shaft may be reduced since the ribs will contain the best and strongest portions of the metal, thereby adding materially to the resistance to bending of the shaft or roll.

The end sections 19 and 21 of the shaft or roll have reduced portions 15 and 16, each of which terminates at its inner end in a flared portion 23 which merges into a cylindrical portion 24 which is of such diameter that it may be inserted in one end of the central section 18. The

end sections after they have been inserted in the ends of the tubular central section, 18, are secured in position by welding. The parts are so arranged that at least some of the welds extend in a direction at an angle to the direction of rotation of the shafts. This may be accomplished in any suitable manner.

In the form of the construction selected to illustrate one embodiment of the invention, which is by way of example only, the ends of the central section 18 are provided with slots 25 extending longitudinally of the section. These slots are of any appropriate length, but, of course, do not extend inwardly beyond the inner ends of the cylindrical portion 24 of the end section. Any suitable number of these slots may be provided, two being shown for each end.

In order to compensate for the difference in expansion of the central section and the inner protected ends of the end section, slots 26 may be provided in the inner ends of the end sections which will permit radial expansion of the latter as the central section expands thereby more or less relieving the welds from the stresses caused by this differential radial expansion.

After the parts are assembled, welds 27 and 28 are applied around the edges of the central section 18 and around the edges of the slots 25, respectively.

It will thus be seen that the welds 27 and 28 will not only resist the torque of the operating mechanism, but the welds 28, which extend longitudinally of the central portion will resist any bending or radial movement of the end sections relative to the central section. These welds, in other words, will hold the end and central sections from relative rotation and will also retain them in co-axial relation.

The form of the construction shown in Fig. 3 differs from that just described in that the end sections 29 of the shaft 31 are of a slightly different construction from the corresponding ends 19 and 21 described above and the end portions of the middle section 32 are formed differently and are attached in a different manner. In this form of construction, the central section 32 is preferably, though not necessarily, centrifugally cast and its ends are of such a contour that the welds, for the most part, will extend at an angle to the direction in which the shaft is rotated.

In the form of the construction shown, the ends of the central portion 32 are scalloped, that is, triangular sections are removed to form V-shaped recesses 33 and tapered portions 30 extending about the ends of the section so that the edges at the end of the section will form a more or less zig-zag line around the section.

Each of the end sections 29 is provided with a reduced portion 34 and a flared portion 35 terminating in a cylindrical portion 36 having an inner inwardly extending annular flange 37, as clearly shown in the drawing. Between the reduced portion 34 and the flared portion 35 is an enlarged angular portion 38 extending around the end section, as clearly shown in Fig. 3 of the drawing.

In fabricating the device, the end sections are inserted in the ends of the central section 32, and the tapered portions 30 bent down onto the flared portions 35. Their length is such as to leave a recess 39 between their ends and the enlarged portion 38. The recess 39 and the space between the tapered portions 30 may then be filled with welding material as shown at the left in Fig. 3.

In the modified form of the construction shown in Figs. 6, 7 and 8, the ends and central portions are so constructed that there is an interlocking connection between the same. By means of this arrangement, the welds are relieved of the torque action of the rotating mechanism. Such an arrangement is desirable for use in furnaces which require a high starting torque on the shafts.

In this form of construction, each end of the central section 41 may be provided with a plurality of projections or tongues 42 which may be spaced from each other a suitable distance as may be desired. These projections or tongues may be of any suitable shape. In the form shown, they are tapered outwardly and are adapted to engage in corresponding tapered recesses 43 formed in the flared portions 44 of the end sections 45 of the furnace shaft 46. The end sections 45 may be, and preferably are, provided with integral cylindrical portions 48 for telescoping the ends of the central or body portion 41 and with radial flanges 48 for limiting the lateral movement of the material as it passes through the furnace. The horizontal web 49 is provided with a plurality of openings 51 for receiving the weld as will presently appear.

When the parts are assembled, the projections or tongues on the flared portion 44 and on the central section 41 engage in the corresponding recesses, the projections or tongues 42 being bent inwardly to engage in the recesses 43. The parts are so constructed and arranged that the projections or tongues 42 are flush with the flared walls 44 and the meeting line of the parts constitutes a more or less zig-zag line around the end of the shaft.

It will be noted that in this form of the construction, the parts of the shaft that abut are telescoped as in the previous constructions but the end sections are on the outside. The parts are held in position by welds 52 and 53 which extend along the abutting line of the two sections and in the recesses 51, respectively.

In Fig. 9 is shown a further modified form of construction. This form of construction is shown as applied to a retort which is adapted to be used for carbonizing and the like. In this form of the construction, the retort is in two sections, a body 54 and an end section 55. The end section 55 has one end 56 of substantially the same diameter as the body portion 54 and is provided with outwardly extending tongues 57 which may have tapered sides, as shown at 58, for engaging in correspondingly shaped recesses, or complementary recesses 59 formed in one end of the body portion 54. The end section 55 has a reduced portion 61 which constitutes a bearing for one end of the retort. The body portion 54 is preferably provided with agitating ribs 62 which may be welded to the inner side thereof.

In this form of the construction, the parts are assembled by inserting the tongues 57 in the corresponding recesses in the body portion 54, after which the parts are welded together along the line formed by the tongue and the recesses.

It will thus be seen that in all forms of construction there are certain of the welds that extend in a direction at an angle to the direction of rotation of the shaft, that is, there are welded portions spaced longitudinally of the shaft or roll. Just what form or shape the weld may

have is immaterial so long as certain portions of it or certain welds extend at an angle to the direction of rotation or are spaced longitudinally of the shaft or roll, is all that is necessary.

The open end of the retort is adapted to extend through a corresponding opening in the furnace wall as is usual in such constructions. This end of the retort is provided with thickened portion forming a flange or ring to which the cover may be attached.

While I have disclosed the invention in the form of shafts or rolls for use in heat treating furnaces, it is understood that rolls for use in rolling mills for rolling metal bars, sheets, commercial iron, or rolls for use in manufacturing plate glass and the like, may be made by centrifugally casting the same, or at least the central sections thereof, and have the end sections comprising the journals attached by serrated welds or welds having portions arranged longitudinally of the shaft or roll, as indicated above. It is also understood that the terms "shaft" or "roll" include these various structures.

It is thought from the foregoing taken in connection with the accompanying drawing, that the construction and operation of my device will be apparent to those skilled in the art and that changes in size, shape, proportion and details of construction may be made without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. A conveyor shaft for heat treating furnaces comprising a central section centrifugally cast of high heat resisting material and end sections provided with reduced ends forming journals for said shaft, the end sections lapping the central sections and at least a part of the lapping portion being telescopic, one of the lapped portions at each end of the shaft having open end recesses therein extending longitudinally of the shaft, and a weld extending along said recesses for connecting said sections together, said weld having portions thereof extending longitudinally of the shaft and other portions extending around said shaft in a circumferential direction.

2. A sectional tubular shaft for use in heat treating plants comprising a central section of heat resisting alloy, end sections each having portions telescoping the adjacent end of the central section and having a reduced portion constituting a journal for said shaft, and welds connecting said central and end portions together, said welds having portions extending longitudinally and other portions extending circumferentially of the shaft rigidly securing each end section to the central section.

3. A rotatable roll comprising a sectional tubular conveyor shaft of high heat resisting alloy having reduced end portions forming journals for said shaft, the central portion of said shaft being centrifugally cast from a heat resisting alloy, said sections having telescoping portions having interlocking projections on their adjacent ends connected together by welds, certain of which extend circumferentially of the shaft and others in a direction longitudinally of the shaft, the interlocking portions of said sections being flush on their outer surfaces.

4. A sectional tubular shaft for use in heat treating furnaces comprising a central section cast from a heat resisting alloy, end sections each having a tapered portion merging into a reduced portion, said reduced portion forming a journal for said shaft, the outer ends of said central section having tongues directed inwardly and forming tapered ends for said central section, the tapered portions of the end sections being provided with recesses receiving said tongues, said tongues and the material surrounding said recesses being of substantially the same thickness and interlocked, and welds connecting said interlocking tongues and material together at each end of the central section of the shaft.

5. A rotatable roll for use in heat treating furnaces comprising a sectional tubular shaft including end sections and a central section of high heat resisting material, each end section having its outer end reduced and coaxial with the central section to form journals for said roll and its inner end portion flared, the ends of said central section being complementally tapered and slotted to provide tongues, said tongues lapping the flared portion of the adjacent end section, and welds extending along the marginal edges of said tongues and securing said sections together.

6. A conveyor shaft for heat treating furnaces comprising a central section of high heat resisting material and end sections provided with reduced ends forming journals for said shaft, the end sections lapping the central section at each end of the central section and at least a part of the lapping portions being telescopic, the portions of said shaft sections that are telescoped being welded together at intervals about their circumference at the inner and outer marginal portion of a zone the width of which is substantially the same as the length of the lapping portions.

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