Feb. 22, 1944. F. D. MORAN 2,342,159

COMPOSITE ROLL

Filed April 1, 1940

Fig. 1

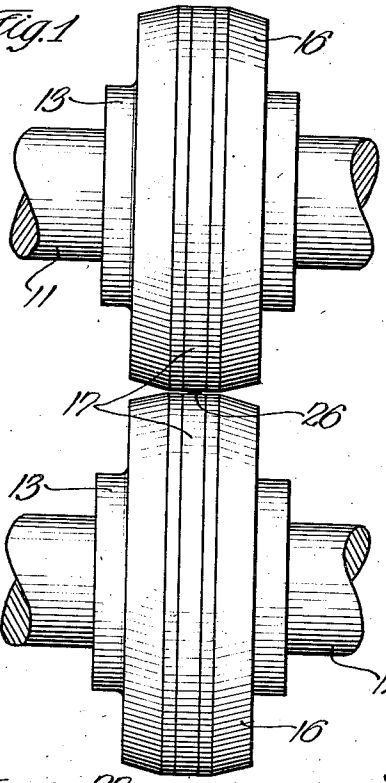


Fig. 2

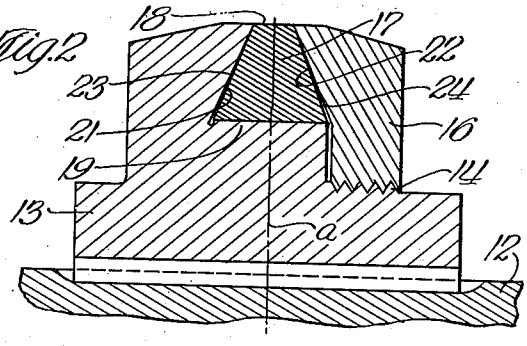


Fig. 5

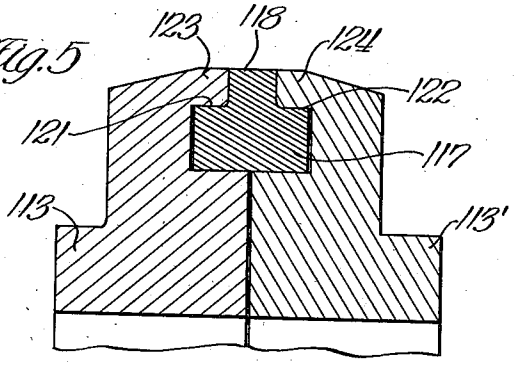


Fig. 3

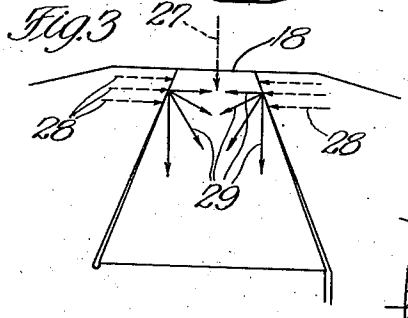


Fig. 4

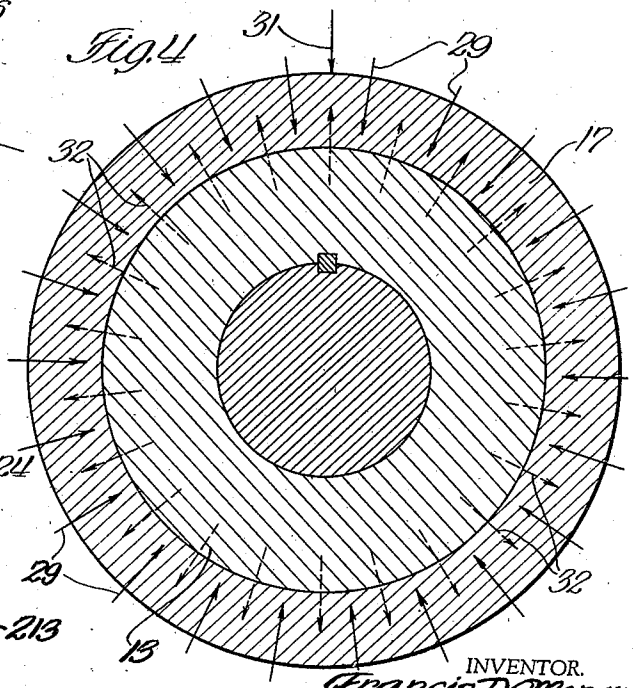
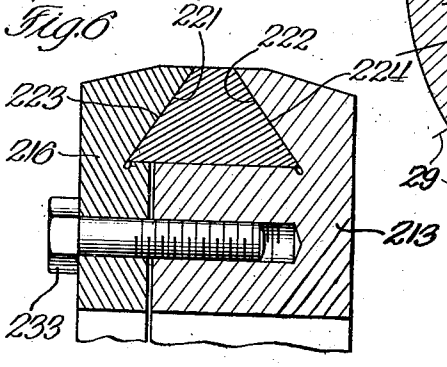


Fig. 6



INVENTOR.
Francis D. Moran

BY McLaughlin & Wallenstein

ATTORNEYS

Patented Feb. 22, 1944

2,342,159

UNITED STATES PATENT OFFICE

2,342,159

COMPOSITE ROLL

Francis D. Moran, Downers Grove, Ill.

Application April 1, 1940, Serial No. 327,370

7 Claims. (Cl. 80—58)

My invention relates in general to composite rolls. It relates more in particular to a roll structure comprising a ring of relatively hard, relatively brittle material supported to prevent breakage thereof during rolling, together with a method for supporting a ring of such material for the purpose of preventing breakage.

Work tools of all kinds utilize the most suitable combination of properties found in a given material, or the most suitable combination of properties which may be obtained by utilizing two or more materials with widely divergent properties. The production of rolls for operating on strip material and the like has followed, in general, the development of tools generally and the selection of materials for use in such tools. As a rule, it is essential that a hard wearing surface be provided at the area where the roll contacts the work, and this has been accomplished, looking at the order in which various types of rolls were developed, by selecting a material which was relatively hard throughout and forming the roll of such material; by selecting a material and subjecting it to differential treatment, such for example as utilizing a ferrous alloy and separately hardening a surface, leaving behind the hardened surface a body of relatively softer but relatively tougher material; and employing a composite of two different types of material, a hard material in contact with the work and a relatively softer but tougher material forming a backing or support for the hardened material.

There are types of operations conventionally carried out which employ rolls of the type outlined hereinabove but which are capable of improved results if better rolling equipment is made available. An illustrative operation is the rolling of hard drawn copper wire, nickel chromium wire, stainless steel wire, or the like, to produce a ribbon of the material rolled. This operation at times must be carried out. There are many situations, however, where such operations could be performed suitably with a saving in over-all manufacturing costs if suitable rolling equipment were available. At the present time, it is the usual practice to employ relatively small rolls which are case hardened and often brought into contact with the work through a backing roll of much larger diameter. By this means, adequate flattening operations are carried out, but the rolls must be replaced frequently because of wear. It has been proposed to introduce into a master roll or hub a plurality of segments of a relatively hard material and clamp these segments against the exterior face of the master roll or hub so that stresses applied against the segments in a direction toward the axis of the roll are applied axially against the master roll or hub. It has also been proposed to "shrink" a cylinder of relatively hard material onto a master roll or hub of relatively softer but tougher material in order to provide a hard wearing surface and a tough backing portion. Such proposals have not been satisfactory for many reasons well known to those skilled in the art. One reason is that, if the material in contact with the work is only as hard as ordinary tool steel, there is little advantage over the use of a single case hardened roll. The segment idea is also objectionable in that the relatively small space which necessarily is provided between the ends of the segments produces an undesirable finish on the work.

When relatively very hard materials are employed such as tungsten or tantalum carbide, the methods proposed are absolutely ineffective in preventing cracking, chipping or breaking of the wearing surface. I have found that even though a very hard material, such as tungsten carbide, is held firmly on the surface of a roll, as in common composite roll structure, chipping or cracking will not be prevented. For example, it is impossible to shrink a ring or cylinder of tantalum carbide or similar very hard, relatively brittle material onto a backing roll. If extremely close contact is obtained on cooling, the stresses set up will break the brittle ring. If the stresses set up are not sufficient to break the ring, then application of stresses as in rolling, being applied directly toward the axis in a radial direction, quickly causes a breakage of the ring when the pressure applied by the rolls is adequate to perform a deforming operation such as flattening a relatively hard drawn wire. The result is that, notwithstanding the fact that those skilled in the art have proposed such materials as tantalum carbide to be used as the work engaging members of composite rolls, no satisfactory composite roll employing such material has heretofore been produced.

The principal object of my invention is to overcome in composite rolls the types of problems discussed hereinabove.

Another object is the provision of an improved composite roll employing a ring of very hard but relatively brittle material in such a man-

ner as to prevent breakage, chipping and cracking of the brittle material.

Another object is the provision of an improved method for mounting a work-engaging ring on a roller.

Other objects and features of the invention will be apparent from a consideration of the following detailed description taken with the accompanying drawing, wherein

Fig. 1 is an elevational view showing a pair of rolls constructed in accordance with one embodiment of my present invention;

Fig. 2 is an enlarged fragmentary sectional view taken along the radius of one of the rolls shown in Fig. 1;

Fig. 3 is a general view similar to Fig. 2 but illustrating some of the stresses involved;

Fig. 4 is a partially schematic transverse section taken across the axis and indicating some of the stresses involved;

Fig. 5 is a half section taken longitudinally of the composite roll and along the radius line showing a modified form which the invention may take; and

Fig. 6 is a similar view showing still another modification.

Referring now first to Figs. 1 to 4, inclusive, I show a pair of hubs 11 and 12 which may be journaled in any suitable manner and either or both driven in accordance with usual rolling practice well known to those skilled in the art. With the exception of one particular which will be pointed out, the composite rolls carried on the hubs 11 and 12 are identical and only one need be described. Secured to the hub 11 is a roll body 13 formed of suitable tough, relatively strong but non-brittle material such as a suitably selected steel. The roll body 13 is shown keyed to the hub. It will be understood, however, that it may be secured in position in any suitable manner or may indeed be integral with the hub, depending, however, upon the preferred manner of construction. Secured on the roll body 13, in any suitable manner such as by means of threads 14, is a clamping ring 16. The roll body and clamping ring together form a recess of generally truncated cross section within which a ring 17 of relatively hard and, therefore, relatively brittle material may be clamped. The material comprising the ring 17 is suitably selected for the purpose at hand, a very desirable material being a dense, solid tungsten or tantalum carbide, substantially such as the material known in the industry as "Carboloy."

From a study of Fig. 2, it will be seen that the ring 17 has a work-engaging surface 18, an oppositely disposed inner surface 19 generally parallel with the surface 18, and tapered side surfaces 21 and 22. The roll body 13 and clamping ring 16 have slanting surfaces 23 and 24 disposed, however, at a somewhat greater angle to the surface 18 than the surfaces 21 and 22 which they engage. There is a peripheral surface on the roll body 13 which lies contiguous to the surface 19 of the ring, but, as will be pointed out, it is not required that these surfaces be in contact or, if they are in contact, it is not necessary that the engagement between them be firm enough to take up stresses at this point. The stress is taken up in another manner which will be described. The work-engaging surface 18 is shown as flat, for example a surface which might be employed for flattening a wire indicated at 26 in Fig. 1. This surface 18 obviously, however, may have other shapes not inconsistent with securing the functions which I obtain. Moreover, the peripheral surfaces of the roll body 13 and clamping ring 16 are shown in part as being substantially flush with the surface 18. This is a detail which may be determined by the fabricator, although it is essential that the relation be such that two rolls will not engage at these surfaces and prevent proper engagement of the work by the surface 18.

It is essential that the clamping ring 16 be turned up tightly enough to cause a very firm engagement of the ring 17 and, of course, it is essential that these threads be sufficiently heavy to withstand the strain involved in bringing the clamping ring very tightly into position. Preferably, the hand of the threads 14 is such that in ordinary rolling operations the clamping ring will be tightened rather than loosened. For this reason, also, the hand of the threads on the upper roller will be opposite to the hand of the threads on the lower roller; that is to say, there is one right hand thread and one left hand thread. The result of this construction is that, employing tungsten carbide, the composite roll may be employed for a relatively long period of time with very little wear and with substantially no cracking, or chipping. The utilization of the diverging clamping surfaces, as shown, is an advantage in actual operation as it tends to apply greater radial stress to the clamping ring in the manner shown by the diagrams. The slant given to the clamping surfaces may, of course, be varied depending upon design. As the roll decreases in diameter because of wear and dressing operations, the ring 17 continues to be clamped and the same functions are maintained even though the thickness of the ring is decreased very materially. Because of the divergent clamping surfaces, it is necessary that the clamping ring 16 be tightened further from time to time, but as a rule the tightening action incidental to rolling is adequate for this purpose.

The result of mounting the ring 17 in the manner shown is that the entire ring is held under compression and the compressive force is applied radially and longitudinally. Obviously the longitudinal stresses are in two directions but balanced so that the essential stresses so far as the present invention is concerned are those directed uniformly about the entire ring and toward the axis so as to hold the entire ring in compression.

Those skilled in the art will understand that a complete stress diagram showing the stresses involved when no work is being performed and also when work is being performed as in a rolling operation would involve complications and it is not essential to an understanding of the invention that all of the stresses involved be laid out. In general, however, the stresses involved may be pointed out by a consideration of Figs. 3 and 4. In each of these figures, where appropriate, the reference characters employed in Figs. 1 and 2 are applied.

Looking first at Fig. 3, the dotted arrow 27 indicates generally the resultant radial stress at any given point at or near the surface 18, and this stress is unchanged whether work is being performed or not. Assuming a static condition, the force applied by the clamping action of the ring 16 may, in general, be said to be along the lines indicated by the dotted arrows 28. This force is directed internally of the ring 17 in several directions, as shown by the arrows 29. Looking at Fig. 4, the arrows shown in solid lines are identi-

fied by the reference character 29 to indicate a uniform stress toward the axis. It is at once apparent that the ring 17 is subject to an axial compressive force throughout and, assuming no load, as from a rolling operation, the only significant forces involved may be considered as those indicated by the arrows 29. Now, if we assume that an additional force is applied as in a rolling operation, at the point indicated by the arrow 31, it will be easily understood that there is a resultant force substantially entirely around the periphery of the ring in the direction of the dotted arrows 32. The force applied at 31 is, of course, not all directed exactly radially but, except at substantially the very point at which the force 31 is applied, there is a resultant force directed generally outwardly. The arrows 32 may also be considered as representing the opposing stresses to the compressive force resulting from the force 29, and it will be noted that the resisting stress acts directly in opposition to the added force applied at 31. The result is that the force applied at 31 instead of being opposed at only a single point, as is the case if one were to depend upon the engagement at the surface 19, is distributed over the ring and there is no local stress or strain such as will cause breakage.

According to another form of the invention, a ring 117 of relatively hard material is formed to have a generally T-shaped cross section, with an outer work-engaging surface 118 and surfaces 121 and 122 generally parallel to the surface 118 but positioned below it. A pair of roll body members 113 and 113' have portions 123 and 124 engaging over the surfaces 121 and 122. By shrinking the portions 123 and 124 over the ring at the surfaces 121 and 122, a compressive load may be applied to the ring 117 having the same general function and result as the compressive load applied to the ring 17 in Fig. 2. The parts may be shrunk on in any of the usual ways, such as by assembling, when the portions 123 and 124 are hot, by previously chilling the ring 117, or by having the ring 117 cool and the engaging surfaces hot, depending upon the compression desired in the ring. In Fig. 5, the same general reference characters are used which are employed in Fig. 2 with, however, the prefix "1" before each character. In general, the composite roll shown in Fig. 5 functions like the roll in Fig. 2, although, in general, the roll shown in Fig. 2 is preferred for most purposes.

In Fig. 6, I show still another modification employing the same reference characters used in Fig. 2 to identify like parts, utilizing the prefix "2," however, to indicate that Fig. 6 shows the second modification. The clamping ring 216 is mounted against the roll body 213, however, by means of bolts 233, a sufficient number of bolts being utilized to clamp the ring tightly in position. It will be noted that in Fig. 6, however, the surfaces 221, 222, 223 and 224 have a greater taper than the corresponding surfaces shown in Fig. 2, and also that the engaging surfaces are not divergent but substantially meet over the entire area where the surfaces oppose each other.

The structure in each embodiment consists of a ring or ring-like member, such as a sleeve, having a rolling surface, with two depressed surfaces at the sides thereof engaged by a pair of clamping rings or collars in such a manner as to apply the uniform stress described to the ring. The clamping rings or collars, which may be cast or otherwise fabricated, may form part of the roll body, or may be separate. In the preferred form, the ring has sloping sides forming the two depressed surfaces, and the clamping rings or collars are undercut at an angle to provide surfaces engaging over the sloping sides of the ring to apply forces radially and longitudinally when the collars are clamped together. The angles of the engaging surfaces on the clamping collars and ring may be the same so that they engage throughout, but preferably the angle between a radial line *a* and sloping surface 21 of the ring is less than the angle between the radial line *a* and the sloping surface 23 on the collar. This causes the principal area of contact to be such that the compressive force exerted by the collars is concentrated at or near the periphery of the hard ring. With this form of support, then, pressure or force applied at one point on the ring is distributed substantially entirely throughout the ring rather than being concentrated at the one point. Breakages, therefore, do not occur. Chipping at the edges is prevented because of the stress set up longitudinally, that is to say, in a direction parallel to the axis.

It should be understood that the clamping collars or clamping rings may be cast in place around the work-engaging ring, or for that matter, the entire supporting roll body may be chill cast of suitable material. One suitable procedure is to form a roll body of tough load bearing material, such as steel or cast iron, shape it to retain a cast body on its exterior, place the work-engaging ring in position, and then cast a clamping ring structure of relatively low melting point material which will hold the work-engaging ring under a compressive force and retain it on the roll body.

Thus it will be seen that I mount the ring carrying the rolling surface so that it is retained in compression substantially uniformly throughout its circumference. The ring being in compression, the stress produced at the point of engagement with the work during rolling is cushioned and absorbed over substantially the entire ring.

What I claim as new and desire to protect by Letters Patent of the United States is:

1. In a composite roll, a hub, a roll body carried by said hub, said roll body comprising a relatively tough and non-brittle material, a closed ring of hard, relatively brittle material, having high strength in compression but being relatively weak in tension, held substantially entirely in compression in said roll body and adapted for engagement of the work during a rolling operation, said ring having a generally flat peripheral surface for engagement of the work and having separate surfaces at opposite sides of said peripheral surface and shaped to permit engagement to provide a resultant force toward the axis of the hub, and means forming a part of the roll body engaging said separate surfaces with a clamping action to place the aforementioned closed ring of hard brittle material under radially inwardly directed compression and to support the ring against rolling stresses substantially entirely by said compressive forces.

2. A composite roll as defined in claim 1, said closed ring of hard, relatively brittle material having a generally truncated, conical cross section, the surfaces of the roll body engaging said closed ring of hard relatively brittle material being at a more divergent angle to the radius than the side surfaces of said closed ring of hard relatively brittle material, whereby the clamping and compressing action is effective near the extreme periphery of said last-mentioned ring

3. In a composite roll, a closed ring of hard, relatively brittle material comprising a work-engaging member, said ring having a work-engaging surface, and surfaces on each side thereof diverging toward the axis of rotation, and a roll body comprising a plural part assembly of relatively non-brittle load bearing material clamped against said diverging surfaces to support the ring in position and under substantially uniform compression throughout its periphery, the ring engaging surfaces of said roll body being at a more divergent angle to the radius than the diverging surfaces of the ring, whereby the clamping and compressing action is effective near the extreme periphery of the ring.

4. In a composite roll, a closed ring of hard, relatively brittle material, having high strength in compression but relatively weak in tension, comprising a work-engaging member having a generally flat work-engaging surface, said ring having a generally truncated, conical cross section with a base comprising the inner surface of the ring and a load carrying supporting body of relatively non-brittle material including separable members having a pair of surfaces engaging against side surfaces of said ring, and means for clamping said separable surfaces against said ring to place said ring under radially inwardly directed compression and to support the ring against rolling stresses substantially entirely by said compressive forces.

5. A composite roll as defined in claim 4, wherein said ring engaging surfaces on the said separable members are at a more divergent angle to the radius than the side surfaces of the ring, whereby the clamping and compressing action is effective near the extreme periphery of the ring.

6. In a composite roll, a closed ring of hard, relatively brittle material comprising a work-engaging member, said ring having a generally truncated, conical cross section with a base comprising the inner surface of the ring and a load carrying supporting body of relatively non-brittle material including separable members having a pair of surfaces engaging against side surfaces of said ring, and means for clamping said separable surfaces together and against said ring whereby to place said ring under compression, the ring engaging surfaces on the said separable members being at a more divergent angle to the radius than the side surfaces of said ring whereby the clamping and compressing action is effective near the extreme periphery of the ring, the ring and the surfaces of the load carrying supporting body being so constructed and arranged that local rolling stresses on the peripheral surface ring are not transmitted to the supporting body through the base of said ring, but are distributed substantially throughout the ring and transmitted to the supporting body through said pair of ring engaging surfaces.

7. A composite roll comprising a closed ring of relatively hard brittle material, said ring having a relatively narrow outer work engaging portion, a relatively wider inner base, and oppositely disposed slanting sides between the work engaging portion and base, a load carrying supporting body shaped to provide an outer surface concentric with said base, and a surface engageable against only a portion of the surface of one slanting side of said closed ring, a clamping ring having a surface shaped to engage against only a portion of the surface of the other slanting side of said closed ring, and means to draw said clamping ring bodily axially toward said load carrying supporting body to pinch the said closed ring along only the outer portions of the surfaces of said slanting sides to apply pressure on said closed ring toward the axis of rotation thereof, whereby a load applied locally to said work engaging portion is distributed through the said closed ring and to the said supporting body and clamping ring at the surfaces engaging said slanting sides.

FRANCIS D. MORAN.