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MAGNETIC ROLL STRUCTURE

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2 Sheets-Sheet 1

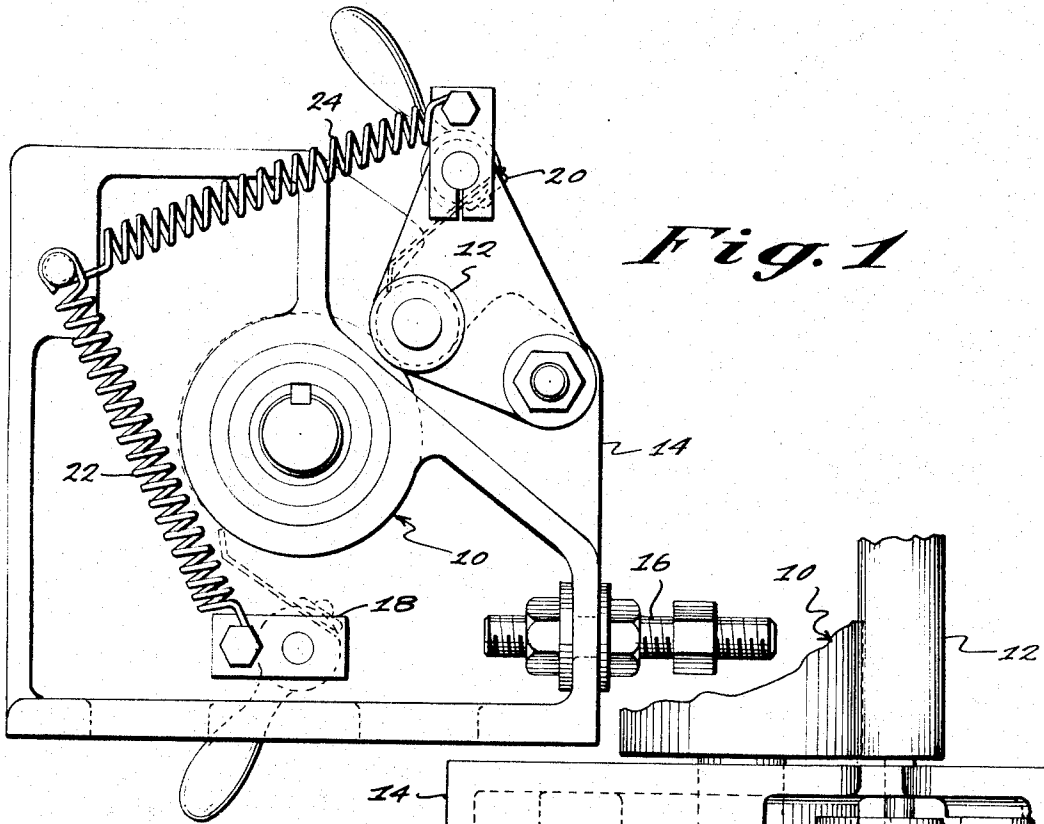


*Fig. 1*

*Fig. 3*

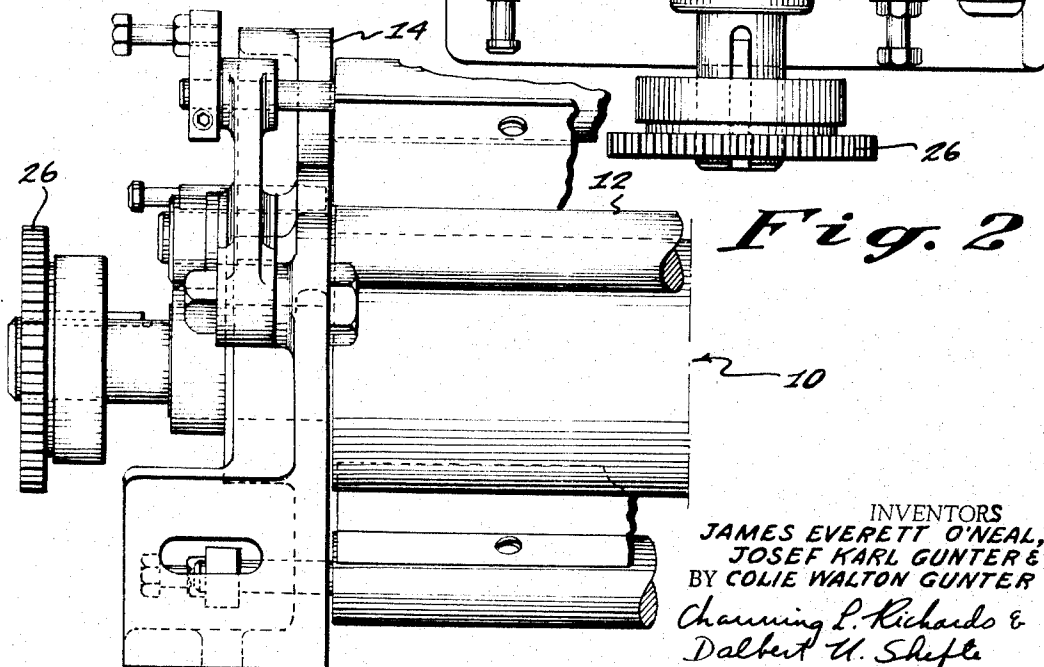


*Fig. 2*

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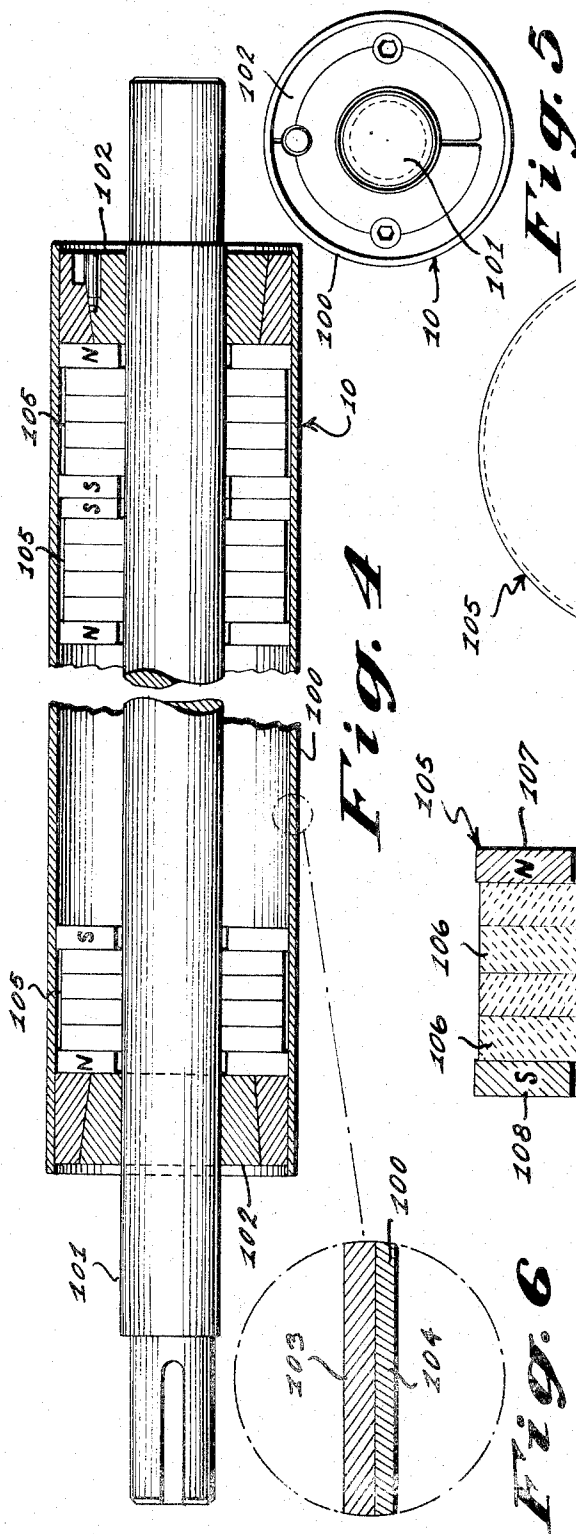
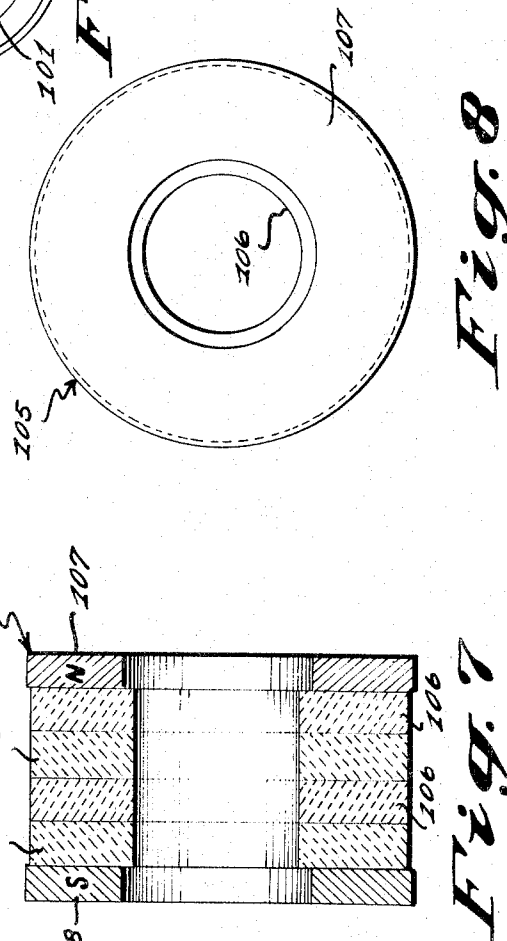
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## MAGNETIC ROLL STRUCTURE

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### ABSTRACT OF THE DISCLOSURE

A magnetic roll structure adapted for forming and loading a nip, the roll structure being formed by a metallic shell of tubular form having a nonmagnetic base portion coated exteriorly with a nonmagnetic hard surfacing material and housing a plurality of metal ferrite permanent magnet modules, so as to present a roll surface of excellent hardness that will accept a high finish, while maintaining the roll shell nonmagnetic so that the housed magnet modules are not required to saturate the shell.

This invention relates generally to roll structures, and in particular to roll structures equipped with magnet means for exerting a magnetic influence at the surface thereof, and more particularly to roll structures of this sort adapted for forming and loading a nip.

The magnetic roll structure provided by the present invention has special significance for use as the magnetic member of a carding machine crush roll arrangement such as is disclosed by copending application Ser. No. 401,274, filed Oct. 2, 1964, and is described further below in particular relation to the exceptional advantages it offers for such use to illustrate representatively the unique features of magnetic roll structure that are involved and that may be employed to like advantage for other purposes.

The crush roll arrangement of the above-noted copending application comprises first and second smooth-surfaced and elongated rolls rotatably opposed to form a nip having an extent sufficient to receive a carded web at doffed width, and loaded by magnetic means incorporated in one of the rolls to act on the carded web prior to gathering it into sliver so that any trash remaining therein is crushed to a condition in which it tends to be freed from the fiber during subsequent processing.

For effective crushing action on the web, the smooth-surfaced condition of the opposing rolls must be provided and maintained at a level that requires a high degree of surface hardness because of working influences having a severe tendency toward attrition. These working influences result not only from the wear capabilities of the carded web material to which the crushing action is being applied, but also from the magnetic loading of the crush roll nip which renders the magnetic roll subject to surface scoring at the pole position.

Ordinarily, the degree of surface hardness required to withstand these working influences could be provided by conventional heat treating techniques, but the magnetic roll employed does not lend itself to normal hardening treatment because it must have a tubular body structure in order to house the magnet means by which the crush roll nip is loaded, and it is not possible as a practical matter to maintain satisfactory dimensional tolerances if the tubular body is hardened by heat treatment.

The present invention overcomes this difficulty by constructing the tubular body with a metal tube base portion on which a relatively thick exterior coating of a hard surfacing material is applied and then ground smooth to obtain a roll surface of excellent wear resistance. The roll structure thus obtained is additionally significant because, as it does not require the base portion used to be subject

2

to subsequent hardening, the base portion may be non-magnetic in character to allow effective use of sintered ferrite magnet means within the roll structure and thereby provide a number of consequent advantages.

These and other features of the present invention are described at further length below in connection with the accompanying drawings, in which:

FIG. 1 is an end elevation illustrating the use of a magnetic roll structure embodying the present invention in a crush roll arrangement of the type disclosed by the above-noted copending application;

FIG. 2 is a fragmentary plan detail corresponding generally to FIG. 1;

FIG. 3 is a fragmentary right side elevation corresponding generally to FIG. 1;

FIG. 4 is a longitudinal section of a representative magnetic roll structure embodying the present invention;

FIG. 5 is an end detail as seen from the right in FIG. 4;

FIG. 6 is an enlarged detail of the circled wall section in FIG. 4;

FIG. 7 is an enlarged section detail of the magnet means module employed in the roll structure of FIG. 4; and

FIG. 8 is a right side elevation corresponding to FIG. 7.

In FIGS. 1, 2, and 3, the reference numeral 10 indicates the relative disposition of a magnetic roll structure as arranged in association with a rotating take-off roll 12 according to the previously noted copending application Ser. No. 401,274. Such disposition is provided for by means of mounting brackets 14 arranged to be installed at each side of a carding machine frame (not shown) as journal supports for the rolls 10 and 12, with suitable relative setting of the mounting brackets 14 with respect to the doffer section of the card (not shown) being afforded by lead screw means as at 16. The mounting brackets 14 additionally support doctor means 18 and 20 for each of the rolls 10 and 12 together with spring biasing therefor as seen at 22 and 24 in FIG. 1, and the magnetic roll 10 has one end thereof fitted for driving as indicated at 26.

The form of magnetic roll structure 10 that is provided according to the present invention is illustrated in particular by FIGS. 4 through 8 of the drawings. FIG. 4 shows the composite roll structure 10 to comprise a shell 100 of tubular form having an axial shaft member 101 assembled concentrically therewith by means of taper lock bushings 102 (see FIGS. 4 and 5) that leave an annular space between the shaft member 101 and the tubular shell 100 throughout almost the full length of the latter for housing magnet means as will be noted in further detail presently.

As previously mentioned, the tubular shell 100 is constructed with a metal tube base portion 103 on which a relatively thick exterior coating of a hard surfacing material is applied as indicated at 104 in FIG. 6. The metal tube base portion 103 is suitably formed of welded steel tubing having the internal diameter needed for housing the magnet means to be used and an adequate wall thickness for the ultimate structural strength required. For carding crush roll use, #304W stainless steel welded tubing has been employed satisfactorily at an internal diameter of 2.870" and wall thickness of .065". A 300 series stainless steel should be employed as a proper base for the exterior hard surface coating 104 to be added, and the 304W is usually the most readily available in proper form for present purposes. If it is desired that the metal tube base portion 103 be magnetic, 1018 cold rolled steel tubing may be used.

In order to be properly formed for the subsequent exterior coating, the steel tubing used for the base portion 103 should be of highly uniform inner diameter and wall thickness and of closely true longitudinal straightness. A carding crush roll must be about 42" in length, and the

tubing blank for the base portion 103 should be straight within .015" over this length. The tubing blank is initially provided about  $\frac{1}{16}$ " oversize in length to allow stock for final end finishing.

Having a suitable blank for the base portion 103 provided, the exterior hard surface coating 104 is applied by flame spraying in the general manner described, for example, by U.S. Patent No. 2,875,043. The advantage of this technique as employed according to the present invention is in providing an exceptional hardness at the finished roll surface, while avoiding the dimensional distortion normally incident to heat treating procedures, and while making it unnecessary to employ a roll structure shell 100 that is subject to hardening by heat treatment. By flame spray application of the exterior coating 104, a Rockwell C-scale hardness in the range of 60-63 is readily obtainable by proper selection of the hard surfacing material used. A wide variety of such materials are commercially available. The Metco E-15 composition available from Metallizing Engineering Co., Inc., is a suitable one. A representative composition is (by weight): C-1%; Si-4%; B-3.5%; Fe-4%; Cr-17%; Ni-balance.

The flame spray application is carried out so as to deposit an exterior coating 104 of substantial thickness on the metal tube base portion 103. Starting, for example, with a base portion wall thickness of .065", as previously noted, the hard surfacing application should be thick enough to provide for a finished aggregate wall thickness in the order of .090" to .100". After a hard surfacing deposit of adequate initial thickness has been applied, it is fused in place on the base portion 103 by heating the coated tubular base to about 1900° F. and allowing it to air cool. This heating may be done with torches or in a furnace.

The composite tubular shell 100 thus obtained by coating and fusing a hard surfacing deposit thereon is then finished exteriorly by grinding, which must be done specially because of the exceptional hardness of the coating deposit. To begin with, the grinding must be done with a #50 grit silicon wheel or the equivalent in order to work the coating deposit at all. In addition, a solvent-type grinding coolant must be supplied at high velocity to prevent the wheel from loading with particles ground from the coating and becoming dull. Even so, the grinding is difficult and relatively slow, but the result is a surface of exceptionally high finish, hardness and wear resistance on a tubular shell 100 that may be depended on to maintain consistent dimensional stability for assembly in completing the magnetic roll structure 10 of the present invention.

If it is desired to use Alnico units as the magnet means to complete the roll structure 10 along the lines particularly described in the previously noted copending application Ser. No. 401,274, then the base portion 103 for the tubular shell 100 should be of magnetic material to provide a keeper structure for the Alnico modules. Such a base portion 103, if properly selected, may be effectively hard surfaced according to the present invention at the full advantage of surface finish, hardness and wear resistance otherwise obtainable, but the invention offers the further advantage of obviating the need for using any structural component that is hardenable by heat treatment, which means that the roll structure may be made non-magnetic in character, so that the magnet means is not required to saturate a magnetic roll shell, and the power available with sintered ferrite magnet means becomes sufficient for effective use.

FIGS. 4, 7 and 8 illustrate an arrangement of sintered ferrite magnet modules 105 for such use in a roll structure in which all components (i.e., shaft 101, bushings 102, and shell base portion 103) are formed of a 300 series stainless steel so as to be non-magnetic, and the shell base portion 103 is hard surfaced with a coating 104 of the previously described type to produce a composite roll shell 100 that remains non-magnetic.

The magnet modules 105 comprise a plurality of sin-

tered ferrite magnet wafers 106 assembled between a pair of pole pieces 107 and 108.

The ferrite magnet wafers 106 are of the sort described by U.S. Patent No. 2,980,617. They consist of a mixture of iron oxide and the oxide of a bivalent metal that has been sintered and then oriented and compacted in a magnetic field. A common and preferred mixture employed for this purpose has the empirical formula  $\text{BaO} \cdot 6\text{Fe}_2\text{O}_3$ . Permanent magnets formed in this way have a high persistence and do not require a keeper to maintain their coercive force, as Alnico magnets do, so that their use provides considerable handling convenience and service advantage.

Magnet wafers 106 of annular form are used so as to allow for assembly over the axial roll shaft 101. Axially oriented wafers 106 are employed and the number used in each module is determined by the number needed to produce a magnetic field sufficient for the degree of nip loading desired at the surface of roll 10. A sufficient number of wafers 106 for this purpose are arranged and secured between the pole pieces 107 and 108, suitably with an epoxy adhesive, to form each module 105. Dimensionally, the pole pieces 107 and 108 are proportioned so that their outer diameter slidably fits the inner diameter of the roll shell 100, while the magnet wafers 106 are shaped with a somewhat lesser outer diameter to be certain of a clearance fit. The wafers 106 are also formed for a free fit at their inner diameter over the axial roll shaft 101, and the inner diameter of the pole pieces 107 and 108 is made sufficiently greater than that of the wafers 106 to avoid the establishment of any inwardly reaching magnetic field by the magnet modules 105.

As thus constituted, the magnet modules 105 are alternately reversed as they are placed in longitudinal series within the roll shell 100, so that adjacent pole pieces 107 and 108 are of opposite polarity. The placing of the magnet modules 105 is done before one of the taper lock bushings 102 is installed to complete assembly of the roll 10. Upon completion of the assembly, the roll 10 presents an exterior surface of exceptional finish and hardness at which the inwardly arranged series of magnet modules 105 establishes a corresponding series of radially oriented magnetic fields reaching outwardly of the roll structure 10 at longitudinal portions thereof having a lengthwise extent related to the size of the modules 105.

For a roll structure 10 having a tubular shell 100 of 42" length, modules 105 having a lengthwise dimension of 1.800" have been used effectively, with a resulting maximum of 22 modules in place between end bushings 102 that are 1" lengthwise.

When the annular housing space provided within the roll shell 100 is completely filled with modules 105, as indicated in FIG. 4, the outwardly reaching magnetic fields will be established at adjacently spaced longitudinal portions throughout substantially the entire length of the roll structure 10. But one of the special advantages of the sintered ferrite magnet modules is the ease with which they may be handled and stored for optional use in the roll structure 10. Accordingly, if a continuous series of the modules 105 acts in aggregate to produce a magnetic loading that is too great for particular conditions, it is only necessary to remove one or more of the modules 105 in order to reduce the magnetic loading to a proper level. The removed modules 105 may be stored readily without deterioration for replacement whenever needed, or for use in other roll structures 10; and the reduced number of alternately reversed modules 105 that remain within the roll structure 10 will react to establish air gaps therebetween so as to relocate themselves in a more widely spaced series lengthwise of the roll structure to maintain the reduced magnetic loading uniform from end to end of the roll 10.

A roll structure 10 formed in accordance with the present invention as just described provides excellent service as a carding crush roll, can be consistently and de-

pendably prepared for this purpose, and makes possible a very desirable flexibility in selection of the magnetic loading to be brought to bear by the roll structure.

This invention has been described in detail above for purposes of illustration only and is not intended to be limited by this description or otherwise except as defined by the appended claims.

We claim:

1. A magnetic roll structure comprising a metallic shell of tubular form having a nonmagnetic tubular steel base portion coated exteriorly with a nonmagnetic nickel base hard surfacing material; the coating on said base portion being of substantial thickness, being fused in place thereon, and being ground smooth; and a plurality of permanent magnet modules housed within said tubular shell base portion, said permanent magnet modules being formed of sintered barium ferrite having the formula  $\text{BaO} \cdot 6\text{Fe}_2\text{O}_3$ .

2. A magnetic roll structure for use in forming and loading a nip, said roll structure comprising a nonmagnetic tube base portion of highly uniform inner diameter and wall thickness and of closely true longitudinal straightness, an exterior coating of a nonmagnetic hard surfacing material fused on said base portion, said exterior coating being of substantial thickness and being ground smooth in concentric relation to said base portion inner diameter, and a plurality of metal ferrite permanent magnet modules disposed within said base portion for establishing radially oriented magnetic fields reaching outwardly of said roll structure at longitudinal portions thereof.

3. A magnetic roll structure for use in forming and loading a nip, said roll structure comprising a tubular base portion of nonmagnetic steel, said tubular base portion being of highly uniform inner diameter and wall thickness and having a closely true longitudinal straight-

ness, an exterior coating of a nonmagnetic, nickel base, hard surfacing material fused on said base portion, said exterior coating being of substantial thickness and being ground smooth in concentric relation to said base portion inner diameter, and a plurality of axially oriented sintered ferrite permanent magnet modules fitted within said base portion for establishing radially oriented magnetic fields reaching outwardly of said roll structure at longitudinal portions thereof.

4. A magnetic roll structure as defined in claim 3 and further characterized in that each of said permanent magnet modules comprises a plurality of annular barium ferrite wafers adhesively secured in an axially aligned series between a pair of annular pole pieces, the outer diameter of said pole pieces slidably fitting the inner diameter of said tubular base portion and said barium ferrite wafer having a slightly smaller outer diameter, and the inner diameter of said pole pieces being sufficiently greater than that of said barium ferrite wafers to avoid the establishment of any inwardly reaching magnetic field by said modules.

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