April 14, 1942. L. A. PATT 2,279,486

SEGMENTAL ABRASIVE WHEEL FOR PULP GRINDING

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Fig. 1.

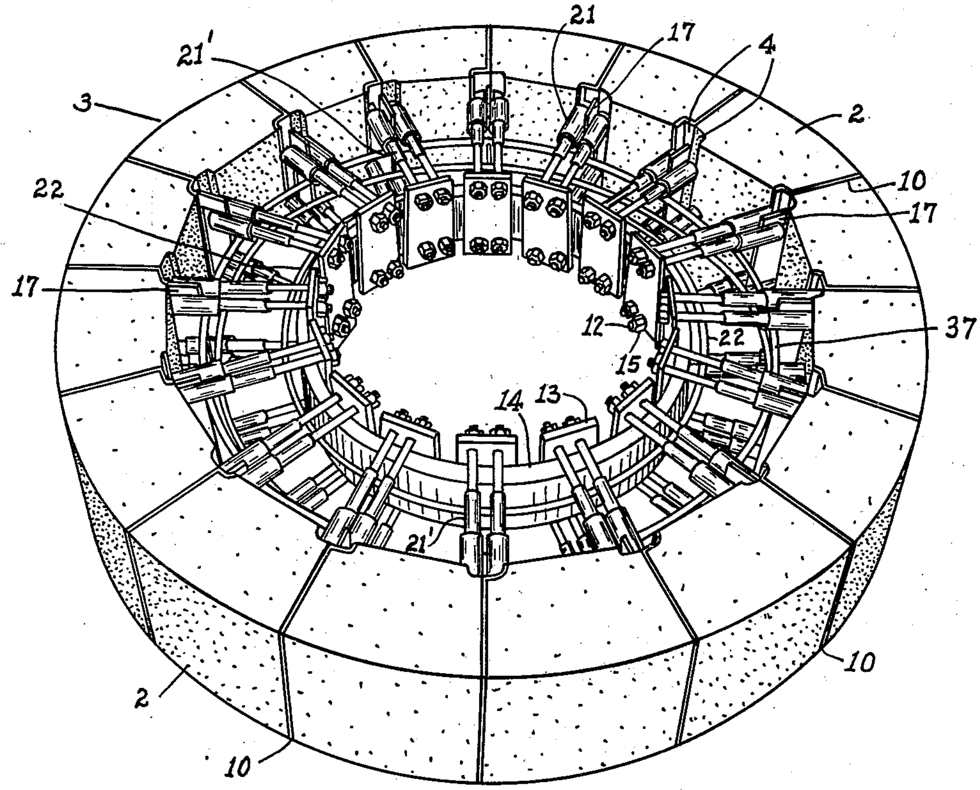

Fig. 5

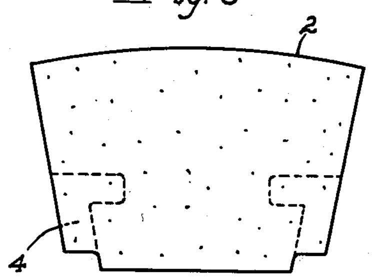

Fig. 6.

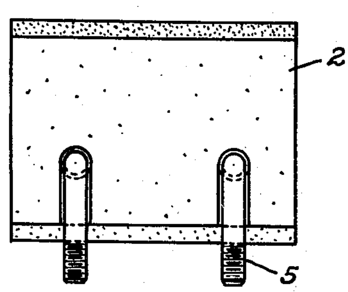

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Fig. 3.

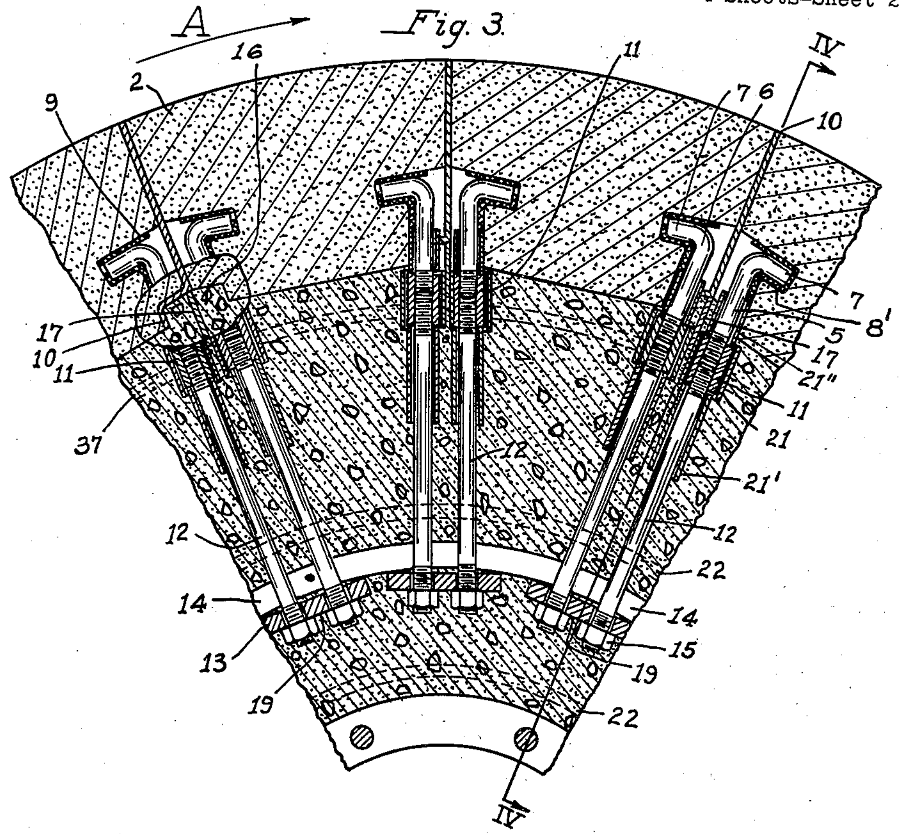

Fig. 2.

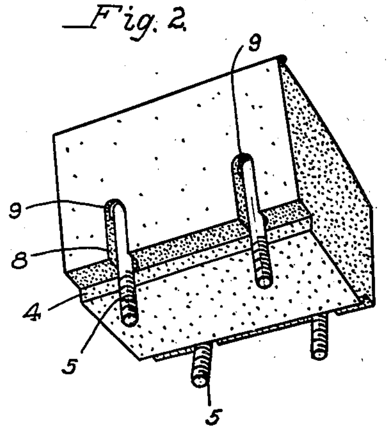

Fig. 7.

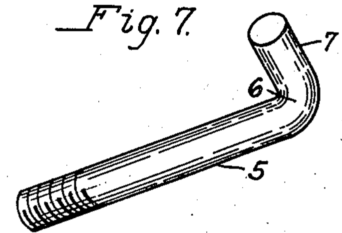

Fig. 7A.

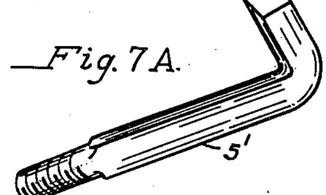

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Fig. 4.

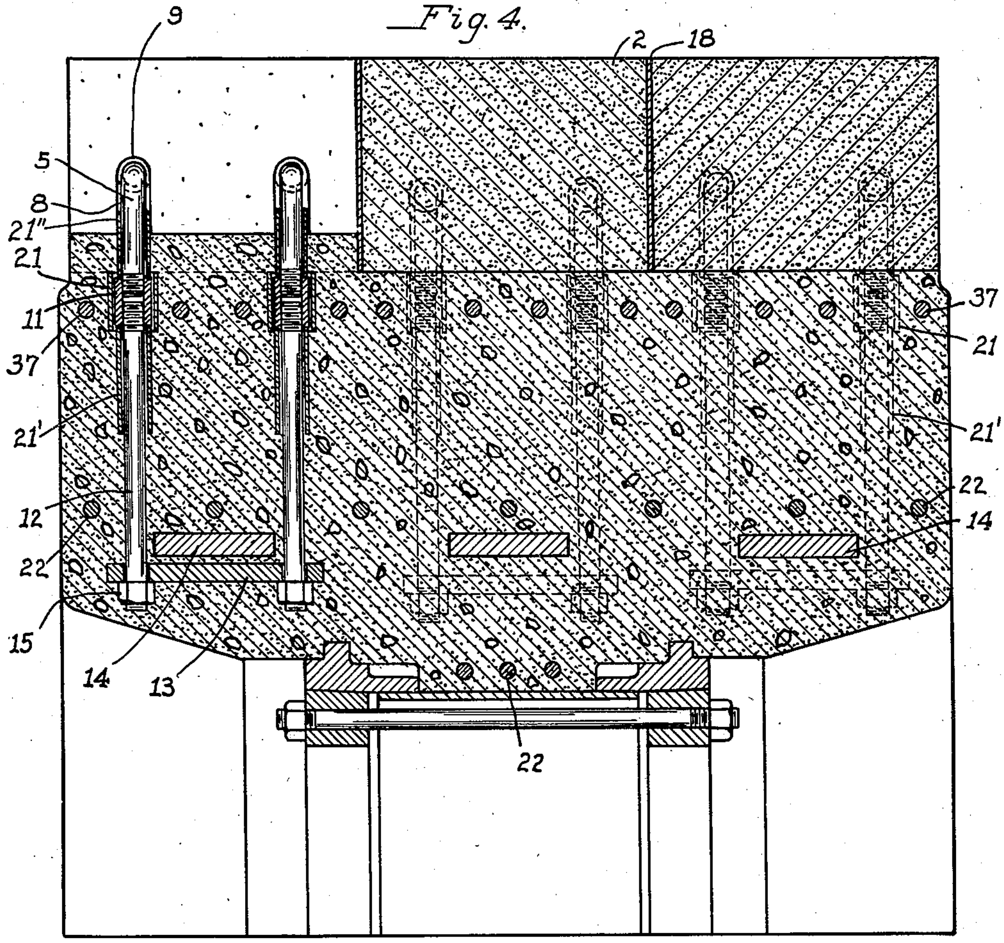


Fig. 8

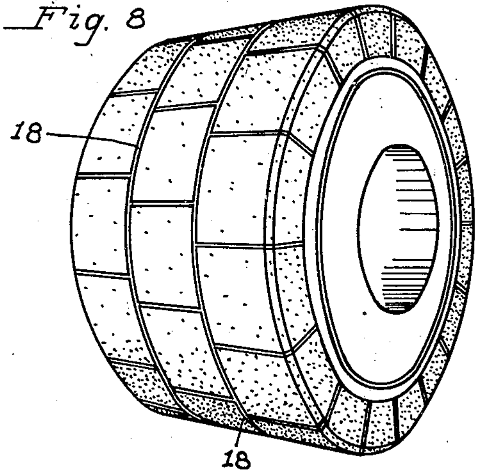
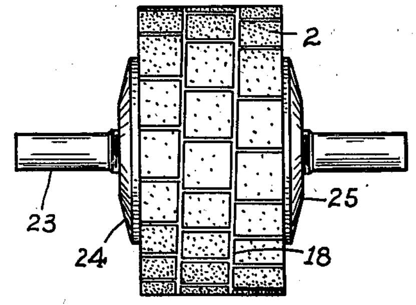


Fig. 9.



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SEGMENTAL ABRASIVE WHEEL FOR PULP GRINDING

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Fig. 10.

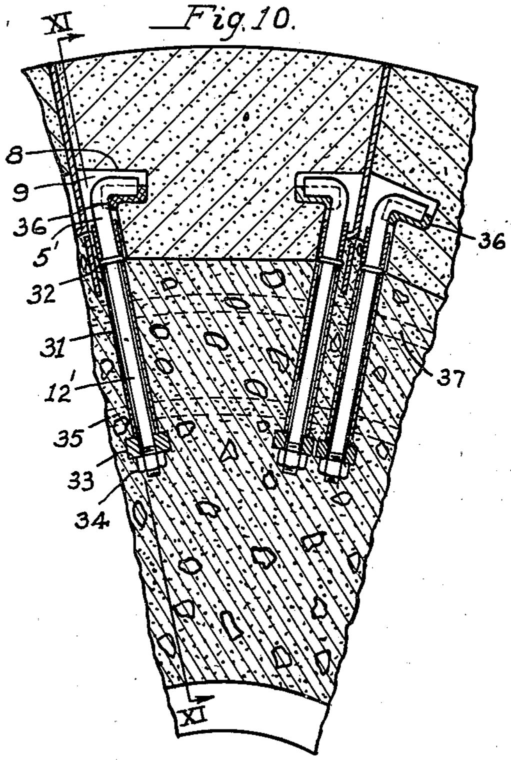


Fig. 11.

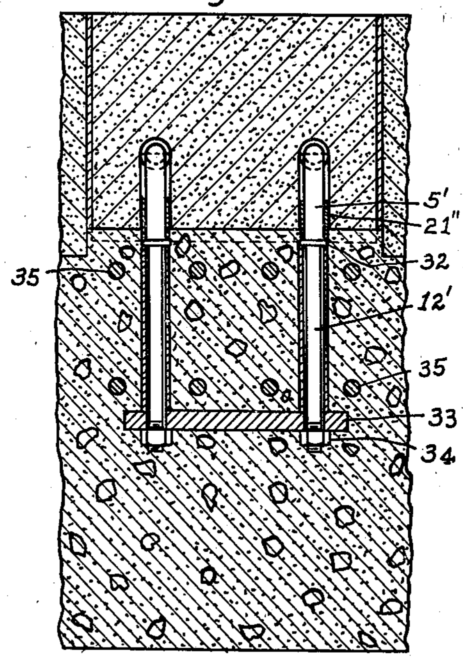
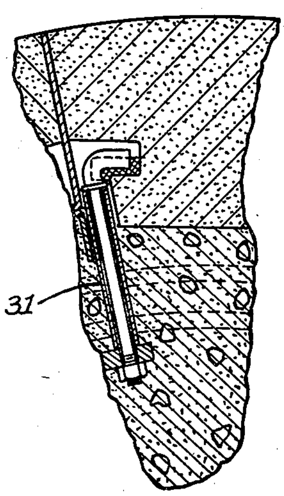


Fig. 12.



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UNITED STATES PATENT OFFICE

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SEGMENTAL ABRASIVE WHEEL FOR PULP GRINDING

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Application December 14, 1939, Serial No. 309,217

7 Claims. (Cl. 51—207)

This invention relates to the manufacture of segmental abrasive wheels and particularly to segmental abrasive wheels which are used for the manufacture of wood pulp.

One of the objects of the present invention is to anchor the abrasive segments as strongly as possible to a metal hub whose mean radius or mean distance from the axis of rotation of the wheel is smaller than the mean radius of the abrasive segments.

It has been a common expedient to clamp abrasive segments on a steel drum or reinforced concrete center by means of clamping members which press on shoulders of the abrasive segments and which extend through the hub where nuts are used on the inside surface of the hub to apply the necessary clamping pressure. Such methods of mounting the abrasive segments usually involve extensive reduction of size of the segmental bases with consequent danger of breakage of the segments under the stresses caused by the work of grinding, by changes of temperature, and by the pressure of the clamping means on shoulders disposed in the bases of the segments. If the supporting drum is close to the bases of the abrasive segments the mounting for the abrasive annulus is made correspondingly heavy. On this account reinforced concrete centers are frequently provided for segmental wheels, and clamping means are extended from shoulders on the bases of the segments through the concrete to steel hubs or supports of comparatively small radius. One object of the present invention is to provide a set of very strong anchors for each segment in wheels of this type.

Another object is to provide connections between the segments and the hub or driving support, which connections are substantially free from stress fluctuations due to temperature variations in the normal operation of the wheel. These connections are obtained by using a metallic anchor hook or an anchor hook composed of a combination of metals to connect the abrasive segments to the driving hub. These metallic connections are designed so that the accumulated thermal elongation of the metallic connection is substantially equal to the accumulated thermal elongation of the surrounding material that extends between the seat of the hook in the segment and the driving hub of the abrasive wheel.

Improved means are also provided for transmitting torque from a concrete center to the segments in the abrasive annulus.

The improvements in the mounting for the abrasive segments are illustrated by means of the accompanying drawings in which:

Figure 1 is a perspective view of an abrasive annulus assembly prior to the pouring of the concrete between the abrasive annulus and the metal hub;

Figure 2 is a perspective view of an abrasive segment with clamping hooks assembled in the segment;

Figure 3 includes two fragmentary sections of an abrasive annulus taken in planes perpendicular to the axis of rotation, the smaller section being in a plane spaced from the clamping hooks;

Figure 4 is a section of the abrasive wheel on the line IV—IV of Figure 3;

Figure 5 is a side view of an abrasive segment, showing a face which is perpendicular to the axis of rotation when the segment is placed in position on the wheel mounting;

Figure 6 shows a radial face of an abrasive segment with two anchor hooks in position;

Figure 7 is a perspective view of an anchor hook;

Figure 7*a* is a similar view of a modified form of anchor hook;

Figure 8 is a perspective view of a completed abrasive wheel containing a plurality of abrasive annuli;

Figure 9 shows a completed abrasive wheel mounted on a driving shaft;

Figure 10 is a fragmentary section taken in a plane perpendicular to the axis and showing modified anchor hook connections between the concrete core and an abrasive segment;

Figure 11 is a fragmentary section on the line XI—XI of Figure 10; and

Figure 12 is a view similar in part to Figure 10, showing a slight modification of the latter.

Referring to the drawings in detail, abrasive segments **2** are assembled on a horizontal surface as shown in Figure 1 to form an abrasive annulus **3**. Each segment **2** is a bonded abrasive mass whose base is cut away to form grooves as indicated at **4** in Figure 2. Before the segments **2** are laid in the position shown in Figure 1 their lower surfaces are sealed against water penetration from the concrete center by means of a coating of a suitable sizing material, and they are provided with a number of anchor hooks **5**. These hooks may be made of a nickel-steel alloy which has approximately the same coefficient of thermal expansion as the abrasive segments to which the hooks are attached. The hooks are bent (as shown at **6** in Figures 3 and 7) so that the short arm **7** of each hook is substantially parallel to the base of the abrasive segment in which it is seated. The short arm of the hook is inserted in a slightly larger opening 8 in its abrasive segment. One or more strips of resilient material 9 are inserted in the openings 8 between the hooks 5 and the wall of the opening 8 in the abrasive segment as indicated in Figures 2, 3 and 4. These resilient strips may be made of felt or of rubber-bonded fibrous material. Sisal is an example of fibrous material which may be used. The object of these strips is to prevent the accumulation of destructive stresses between the anchor hook and the segment in which it is subsequently seated in the following manner. Low-melting metal, such as Babbitt metal, is poured into the openings 8 to form seats for the short arms of the hooks 5. The location of the hooks with respect to the segments and of the seats for the short arms of the hooks is illustrated in Figure 3, where seats are indicated at 8′.

In the abrasive annulus shown in Figure 1 the joints 10 between the segments are composed of a resilient composition which can be made by inserting one or more sheets of fibrous material that has been impregnated with rubber and vulcanized. These resilient sheets are cemented to the adjacent surfaces of the segments which are being joined. As shown in Figure 2, the ends of the hooks which extend from the abrasive segment toward the concrete center are threaded. Internally threaded sleeves 11 are screwed onto the projecting ends of the hooks and are used to couple extension rods 12 to the hooks 5 as shown particularly in Figures 3 and 4. The extension rods 12 pass through plates 13 which are disposed in contact with the inside surface of the hub rings 14. Nuts 15 on the threaded ends of the rods 12 are used to hold the plates 13 against the rings 14. The sleeves 11 are covered with yieldable tubes 21, and portions of the extension rods 12 are covered with similar tubes 21′ in the view shown in Figure 1 which illustrates the mounting of an abrasive annulus prior to the pouring of the concrete within the ring of segments. Tubes 21″ surround the long arms of the hooks 5.

The grooves 4 in the bases of adjacent abrasive segments are combined in pairs to permit the formation of concrete projections 16 when the concrete is poured, as indicated in Figure 3 near the upper left-hand corner of the drawings. Metal plates 17 are indicated in Figures 1 and 3 as disposed in the grooves lying between the bases of adjacent segments and as extended between the sleeves 11. These plates 17 serve to reinforce the portion of the concrete which is poured into the grooves 4 and around the projecting stems of the hooks and their extensions. The concrete core is shown in Figure 3 as extending not only between the abrasive segments and the ring 14 but also inside the ring and around the nuts 15 which are thus held in locked position.

Before the concrete is poured, each of the nuts 15 is tightened by means of a calibrated torque indicating wrench to give a definite predetermined compression on the seat that separates the short arm 7 of the anchor hook 5 from the segment to which the anchor hook is connected. Thus each ring of segments is tightly secured before the concrete core is poured. This method of assembly therefore distinguishes it from certain methods known in the prior art where clamping rods extending through a concrete core are tightened up after the concrete core has been poured. In the case of a pulp wheel manufactured by the applicant's method, the setting of the concrete core takes place under favorable conditions for obtaining a balanced condition of the segmental wheel.

Also, before the pouring of the concrete core, the bases of the abrasive segments are coated with a layer of waterproofing material which prevents the water from leaching into the abrasive segments in that region of the concrete core which is adjacent to the abrasive segments. This arrangement has the general effect of preserving the solidity and strength of the concrete adjacent the abrasive segments, as well as preventing shrinkage of the concrete. This waterproofing material impregnates a layer of each abrasive segment adjacent the coated surface.

The concrete core is reinforced by means of metal rings or hoops 22 as shown in Figures 1 and 4. Sufficient metal reinforcement is used to adequately restrain the concrete core from appreciable or destructive expansion due to centrifugal stresses when in operation. In this way the segments in the abrasive annuli are not required to in any way restrain the concrete core from bursting.

Toward the left of Figure 3 a small section removed from but parallel to the main section is shown. The small section shows particularly the driving key 16 reinforced with the metal plate 17. The resilient layer 10 is shown only on the trailing face of the key 16. The leading face of the key 16 is in contact with the adjacent segment 2. The arrow A in Figure 3 shows the direction in which the wheel is operated. The concrete projections 16 reinforced by the radially disposed plates 17 have an important function in transmitting torque from the concrete core to the abrasive annulus which is made up of the abrasive segments 2.

In Figure 8 there is shown in perspective an abrasive wheel made up of three abrasive annuli. These annuli are separated by resilient annular joints indicated by the reference character 18. These are similar to the joints 10 described in some detail above. A plurality of abrasive annuli can be assembled by providing them with a common ring or tube formed by joining the rings 14 in an axial direction. The abrasive annuli can also be provided with a common core, in which case the concrete is not poured until all the annuli have been assembled, along with the ring and the anchor hook connections.

In the view shown in Figure 8 the segmental abrasive annuli are so assembled that the joints between the segments of the first annulus are offset from those in the second annulus, while the joints between the segments in the third annulus are offset from the joints of the second annulus and also from those of the first annulus. This same progressive offset relationship between segments in adjacent and successive abrasive annuli can be maintained in assemblies that require a larger number for convenience in construction.

It is also distinctly advantageous to have the planes between the intermediate annulus (or annuli) and the end annuli inclined at a slight angle to the end planes of the wheel as illustrated in Figure 9. The interannular planes are therefore not quite perpendicular to the axis of the wheel. This arrangement tends to prevent the formation of grooves between the segments and to reduce the localized wear on the wheel. In Figure 9 there is also shown means for driving the completed abrasive wheel. The driving shaft 23 has a left-hand threaded engagement with the driving flange 24 and a right-hand threaded engagement with the oppositely disposed driving flange 25. Increase of load on the wheel therefore tends to screw the driving flanges more tightly against the wheel.

A resilient material is provided between all adjacent faces of the abrasive segments. These resilient joints afford a compensating factor for differential expansion of the concrete core with respect to the abrasive segments. These resilient joints also afford a compensating factor for expansion of the abrasive segments when they are subjected to the operating temperatures produced by heat generated by abrasion at the periphery of the stone when in use. The temperatures of the outer parts of the abrasive segments may approximate those of boiling water.

One of the principal advantages of the anchor hook attachments to a segment (illustrated particularly in Figures 2 and 7) is found in the fact that only a small amount of material is removed from the segments to provide for the insertion of the hooks. The thickness of the abrasive between the seat of the hook (which may be made of Babbitt metal) and the base of the abrasive segment may vary nearly half an inch without seriously weakening the abrasive segment. The radial thickness of one of the abrasive segments such as is shown in Figure 8 may be seven inches or more. The applicant has made a number of tests of the tensile strength of such an anchorage, the outer portion of an abrasive segment being gripped and pulled in one direction while the four hook arms that extend from the base of the segment are simultaneously pulled in the opposite direction. Under such conditions, a pull of about twice that obtained by the applicant in tests with several other known forms of segmental anchorage, can be developed without indication of a failure of the abrasive segment or of the anchor hooks or of their seats.

The anchor hooks are disposed near the radial faces as is shown clearly in Figure 3. This location of the segment anchorage is quite advantageous as it places the anchoring means at the best geometrical points in the abrasive segment to effectively resist centrifugal forces and to secure each segment against the forces produced by the work load of grinding. These forces tend to twist or rotate the segments out of their assembled positions within the grinding wheel. These forces are often far in excess of the centrifugal forces acting on the segments since they are the resultants of the centrifugal forces and the reactions of the materials that are being ground and crushed. It is apparent, therefore, that the combination of a strong means of anchorage and the best mechanical application of that anchorage to individual segments in the abrasive annuli is such as to provide a distinct improvement in the design and construction of segmental grinding wheels; for when so made they will withstand to an unusual degree the stresses incident to normal operation. It is evident, therefore, that the applicant's segmental anchorage is of such a character that it can resist very great centrifugal forces when the abrasive wheel is in operation.

The segment anchorage means in this new and improved construction of abrasive wheels consists of a plurality of units which are here shown and described as bimetallic members. Each bimetallic member consists of a special nickel steel alloy anchor hook 5 connected to an extension rod 12 by means of a threaded sleeve 11. To meet certain special dimensional requirements, the anchor hooks may be joined to the extension rods by other well known means such as electrical butt welding. Plates 13 are arranged with their flat sides 19 normal to the axes of the rods 12 so that the nuts 15 may be properly engaged therewith to obtain a reliable assembly. Rings 14 confine all plates 13 as indicated in the drawing and hold them in definite position. The working loads which are imposed on the segment anchorage will be transmitted back to the rings 14. This transmission of forces to the rings will be readily appreciated on inspection of Figure 1, from which it can be seen that, when the assembled annulus is rotating, the various forces acting on the abrasive segments are transmitted to and borne by the strong rings 14. Consequently the size and proportioning of these rings are vital and basic factors which can be adjusted to meet the variations in speed or other operating requirements.

The concrete center of the pulp wheel is provided with metal coils or rings 22 which serve to reinforce the concrete center. The size, number and location of these reinforcing members are controlled principally by the size of the assembled grinding wheel, as well as by the speed and other operating conditions to which it may be subjected. In the design of the reinforcing structure of this pulp wheel, the actual amount of reinforcing of the concrete center will be principally that required to prevent the concrete center from any bursting caused by centrifugal stresses which occur in normal operation of the wheel. The concrete center could be rotated safely at operating speeds without the abrasive segments. The wheel is designed so that in the completed assembly normal operation of the wheel will not cause rotational expansion of the center that would produce undue outward pressure on the abrasive segments.

Another important feature of the wheel design is to be found in the outside layer of steel coils or rings 37 which are located very close to the outer surface of the concrete center for a purpose which will now be explained. The disposition of these rings or coils 37 is very important since they actually act as compression members which have been found to effectively prevent appreciable shrinkage of the concrete while it is curing or setting. This is believed to be a novel feature of the design. Others have built concrete centered pulp stones, but have found it necessary to tighten the abrasive segments onto the center after the concrete had cured and shrunk. The compression of rings of the present design eleminate any loosening up of the final assembly, as well as any tightening or adjusting such as has just been described in connection with prior practice.

The segmental abrasive annular assembly shown in Figure 1 is essentially a self-sustaining member, as is also the concrete center. The concrete center is indicated in Figures 3 and 4. When a grinding wheel so assembled is mounted as shown in Figures 8 and 9, the flanges 24 and 25 grip the ends of the concrete center with sufficient pressure to cause it to revolve. The reinforced driving keys 16, being integral with the concrete center, exert a driving torque on the abrasive segments 2, each of which is in contact with the leading edge of a corresponding key 16 as shown in the upper left portion of Figure 3, where the arrow A above the abrasive segments indicates clockwise rotation.

Work load pressures in pulp grinding are applied (for example, by means of a hydraulic piston) in a direction toward the axis of the wheel. Friction of the logs (being ground) against the grinding surface tends to move the abrasive segments 2 in a direction opposite to the rotation of the wheel. The lugs 16, being in contact with the segments, prevent such dislocation and transmit driving torque from the concrete center to the abrasive annulus or annuli. The principal function of the anchoring means is to hold the abrasive segments tightly on the surface of the concrete center. The anchoring means is protected from shearing stresses by the reinforced concrete keys 16. These keys also help to protect the abrasive segments from the building up of an accumulation of destructive stresses during the operation of the wheel.

The bimetallic anchorage means (in addition to its anchoring function) eliminates any necessity for compensating in any way for differences in thermal expansion between the abrasive segments and the concrete center. The abrasive segments have a lower coefficient of thermal expansion than the concrete center. Assuming uniform increase of temperature, the abrasive segments will expand radially at the same rate as the anchor hooks 5, and the concrete center will expand radially at the same rate as the extension rods 12. This arrangement in which the anchor hooks 5 have the same coefficient of thermal expansion as the surrounding abrasive segments and in which the extension rods 12 have the same coefficient of thermal expansion as the surrounding concrete center therefore protects the abrasive segments and the anchoring means from radial stresses during change of temperature. During increase of temperature there will be a tendency for the abrasive segments to separate in both axial and circumferential directions. It is desirable, therefore, that the combined member 12 and 5 should be able to bend slightly. To accomplish this result, the long arm of the anchor hook 5, the sleeve 11 and the radially outward portions of the rod 12 are mounted within yieldable tubes 21'', 21, and 21' as shown in Figures 1, 3 and 4 so as to actually separate these metal parts from rigid surrounding materials. The tubes 21, 21', and 21'' may be made of paper or other compressible material as their function is to permit the rods 12 to remain in a straight line or to bend slightly so that undue stresses will not be built up in the abrasive segments or in the anchoring means during changes of temperature.

The actual length of the tube-encased portion of the anchorage means is only such as to avoid dangerous stress concentration in the anchorage means. Even though the encasing tubes will eliminate actual contact between the concrete and the sleeve 11, there is another factor that must be recognized. The length of the encased portion of the anchorage means is related to the stress concentration at the ends of the threaded portions of the hooks 5 and rods 12. If nearly the entire length of the rod 12 were free to move laterally, the flexural stresses within the anchorage means would be small.

On the other hand, if the rods 12 and the sleeves 11 were to be embedded directly within the concrete for their entire length, then the flexural stresses in the anchorage means would reach such high values as to be unsafe, since there would be excessive stress concentration at the threaded portion of the long arm of the anchor hook 5. It has been found that when approximately one-half of the combined length of the sleeve 11 and the rod 12 are encased in the tubes 21 and 21', as shown in the drawings, the flexural stresses within the anchorage means remain within the limits usually considered safe for mechanical members of this class. Factors such as the size of the assembled wheel, fluctuations in the operating temperature, and the thermal expansion or other physical characteristics of the construction materials must all be considered and evaluated when determining the actual lengths of the tubes 21 and 21'. For the purpose of elimination of vibration, it is preferred to embed the inner portions of the rods 12 substantially as shown in the drawings. In any case the long arm of the hook 5 is partially encased within a tube made of yieldable material. Due to the relatively short length of the hook in the member 5 it is essential that freedom for lateral movement be provided for the hook within the recess in the abrasive and particularly where it passes through the driving key 16. Hence the tube 21'' surrounds this portion of the hook.

It will be noted that in the case of pulp wheel structures of the type disclosed in this application, thermal stresses within an assembly may build up to destructive values in the absence of suitable means for reducing such stresses. The magnitude of such stresses is often far greater than the purely mechanical stresses incident to normal operation. Such stresses are likely to cause failure, especially near the junction of the abrasive segments and of the concrete center. The use of yieldable tubes to greatly reduce or to prevent the building up of such stresses to a dangerous point is therefore considered a vital part of the invention.

In the modification illustrated in Figures 10 and 11 the anchor hooks 5' are integral with the bolts 12'. Each bolt 12' is surrounded by a strong metal sleeve 31. The sleeve 31 extends between a shoulder 32 on the anchor hook and a plate 33. By tightening the nut 34 the bolt 12' can be put under tension.

While the segments (with the attached anchor hooks, bolts, plates and nuts) are being assembled into an abrasive annulus, preloading of radial joints is accomplished by external application of radial pressure by means of clamping bands, etc. The bolts 12 are placed under tension by means of the nuts 34. The concrete is poured within the abrasive annulus and around the inwardly projecting sleeves 31 and the annular reinforcements 35. The external pressure is removed after the concrete has set. The hooks 5 project into openings 8 in the sides of the segments in the same manner as shown in Figure 3. The hook is seated on the abrasive segment by means of Babbitt metal or the like at 36. Resilient strips 9 are used as described in connection with Figures 2 and 3.

In the modification shown in Figure 12 the sleeves 31 project beyond the concrete to the bends in the anchor hooks.

Other advantages of the applicant's improved segmental wheel will be apparent from the foregoing description taken in connection with the drawings. The invention is defined within the compass of the following claims.

I claim:

1. A segmental wheel having a rim comprised of a plurality of abrasive segments, a concrete center supporting the segmental rim and having

a substantially larger coefficient of thermal expansion than the abrasive segments, a plurality of anchor hooks each having a curved end that is seated in an opening in the side of an abrasive segment and having the opposite end adapted for a coupling connection, a plurality of inwardly extending rods each of which has an outer end that is adapted to be attached to said coupling connection and an inner end partially embedded in the concrete center, the anchor hooks having approximately the same coefficient of thermal expansion as the abrasive segments, and the inwardly extending rods having approximately the same coefficient of thermal expansion as the concrete center.

2. A segmental abrasive wheel comprising a plurality of abrasive segments, a concrete center for supporting said abrasive segments, and a plurality of bimetallic anchor hooks in each of which a short arm rests on a seat in a corresponding abrasive segment while the long arm forms an angle with said short arm and is attached to a strong support embedded in the concrete center, the stresses in the hook due to changes in temperature being rendered substantially free from fluctuation by making the hook of two materials, one of which has approximately the same coefficient of thermal expansion as the surrounding abrasive segments while the other part has substantially the same coefficient of expansion as the surrounding concrete, and the intermediate portion of the anchor hook being separated from its rigid surroundings by means of tubes of yieldable material.

3. A segmental wheel comprising a plurality of abrasive segments, a concrete center for supporting said abrasive segments, and a plurality of bimetallic anchor hooks for holding each segment to the concrete support, each of said hooks having a short arm seated in an opening in its abrasive segment, the opening being only slightly larger than the enclosed portion of the hook and of small dimensions as compared with the dimensions of the segment, and the portion of the hook which is surrounded by the segment having substantially the same coefficient of expansion as the segment while the remainder of the hook has substantially the same coefficient of expansion as the surrounding concrete.

4. A segmental abrasive wheel having a rim comprised of a plurality of abrasive segments connected by means of resilient joints, a hub ring for the abrasive wheel disposed within the abrasive rim, a concrete core connecting the abrasive rim with the wheel hub rim, one or more reinforced concrete keys projecting from the concrete core into the abrasive rim, the leading face of the key being in direct contact with the rim while the trailing face of the key is connected to the rim by means of a resilient layer, and anchor hooks connecting the abrasive segments with the wheel hub ring, each of said hooks having a bent portion seated in a lateral face of a segment and an inwardly extended portion which is clamped to the wheel hub ring and surrounded by the concrete core.

5. A segmental abrasive wheel comprising a plurality of segments forming an abrasive rim, a concrete core for said abrasive rim, an annular hub coaxial with said abrasive rim and separated therefrom by the bulk of the concrete core, a plurality of hooks which grip each segment in positions distributed symmetrically about the segment by insertion in cylindrical openings in radial faces of the segments, said hooks being composed of material having substantially the same coefficient of expansion as the abrasive segments and extending to the concrete core, connecting rods attached to the gripping hooks near the bases of the segments and extending through the concrete core and the annular hub, said connecting rods having about the same coefficient of expansion as the concrete, and means for placing said connecting rods under tension to draw the gripping hooks tightly against seats in the cylindrical openings in the faces of the abrasive segments.

6. A segmental abrasive wheel having a rim comprised of a plurality of abrasive segments connected by means of resilient joints, a hub ring for anchoring the abrasive rim, and a plurality of anchor hooks connecting the abrasive segments with the hub ring, each of said anchor hooks having a bent portion seated in an opening in a lateral face of a segment and an inward extension which is connected to the supporting hub ring, the portion of the anchor hook which is seated in and adjacent to any abrasive segment having approximately the same coefficient of expansion as the abrasive segment.

7. A segmental abrasive wheel having a rim comprised of a plurality of abrasive segments connected by means of resilient joints, a hub ring for the abrasive wheel disposed within the abrasive rim, a concrete core connecting the abrasive rim with the wheel hub ring, and anchor hooks connecting the abrasive segments with the wheel hub ring, each of said hooks having a bent portion seated in a lateral face of a segment and an inwardly extended portion which is clamped to the wheel hub ring and surrounded by the concrete core, the portion of the anchorage means that is surrounded by the concrete having approximately the same coefficient of expansion as the concrete.

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