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REINFORCED ABRASIVE WHEEL

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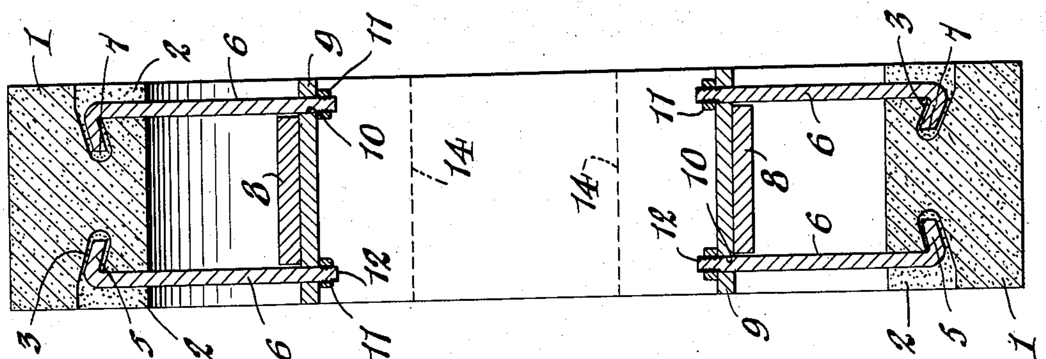

Fig. 2.

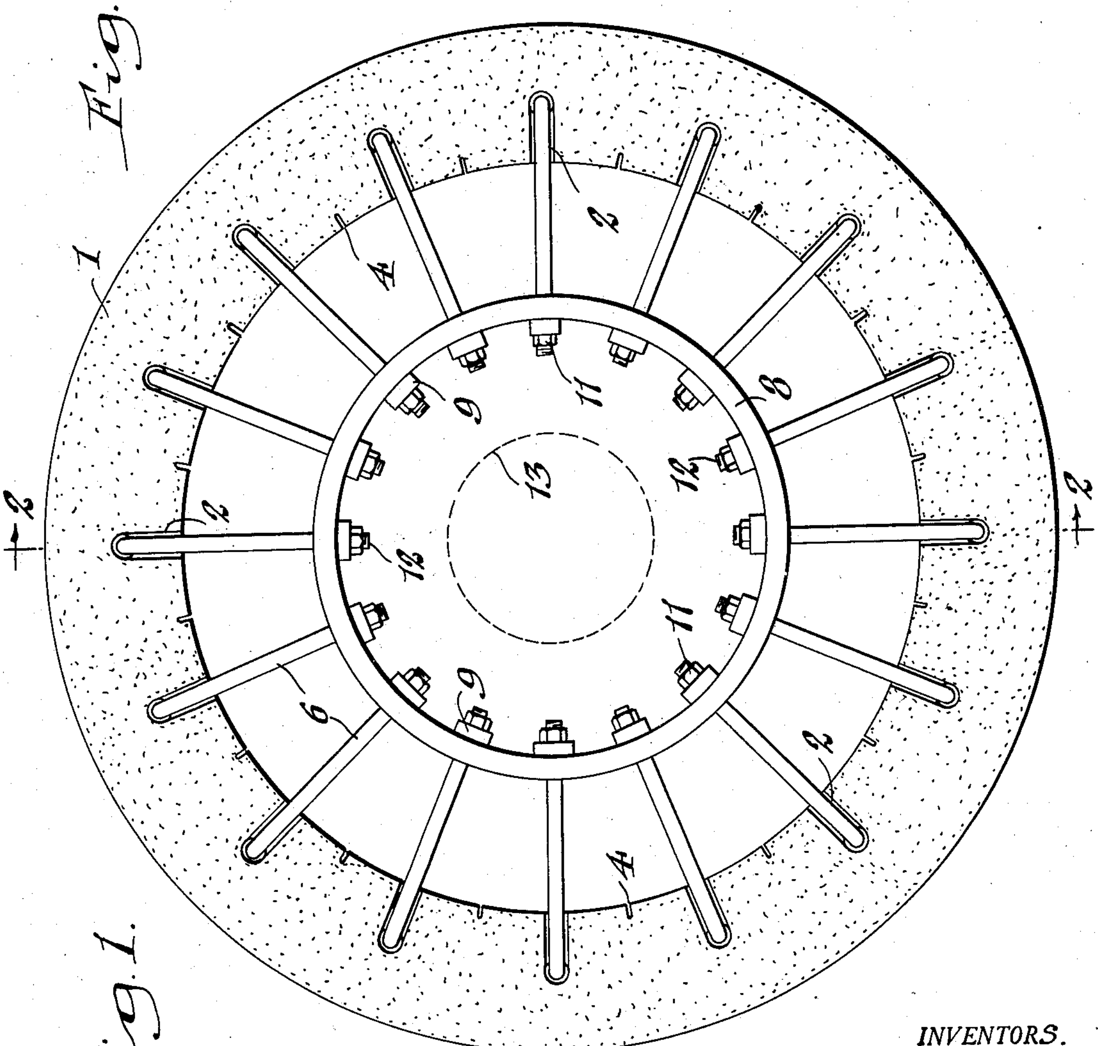

Fig. 1.

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Fig. 3.

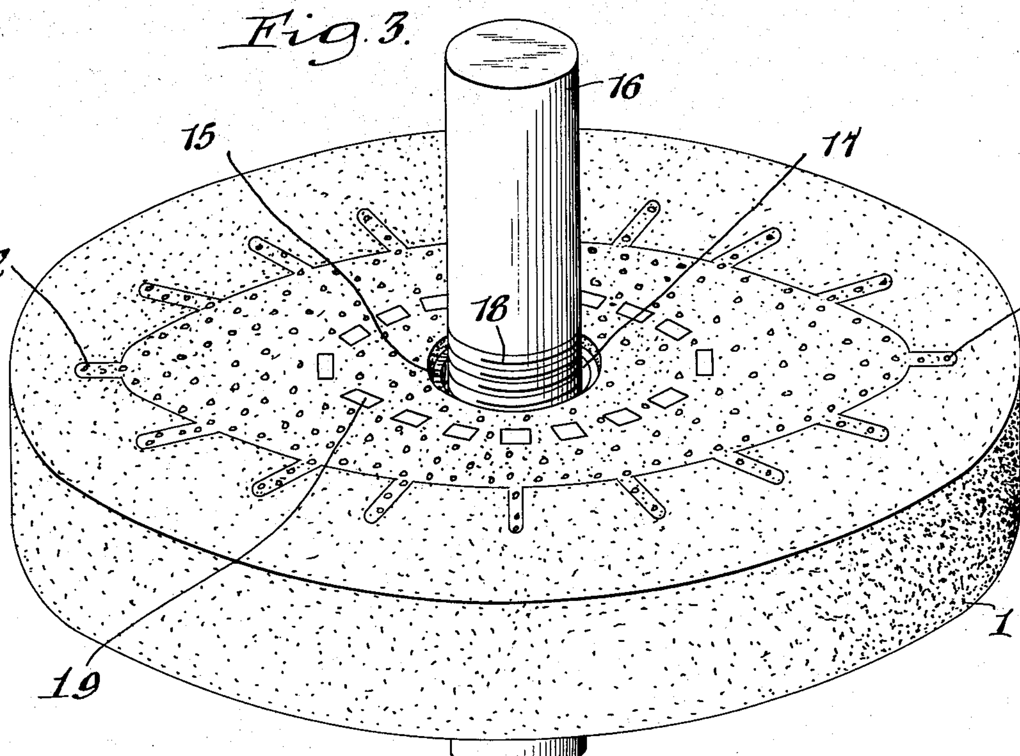
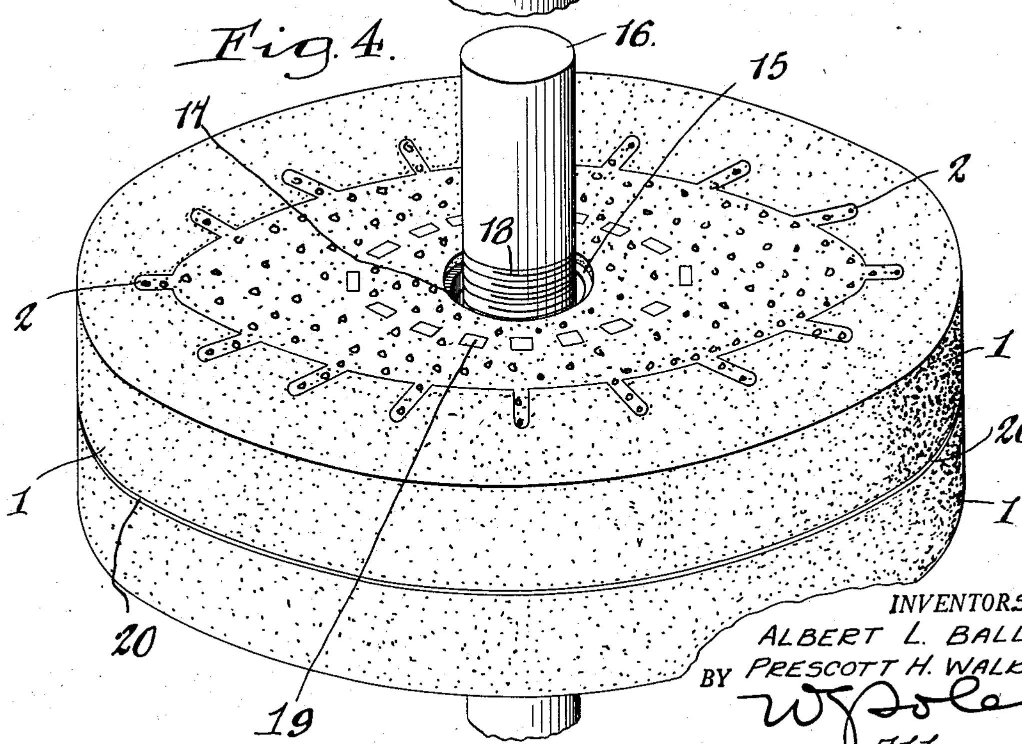


Fig. 4.



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REINFORCED ABRASIVE WHEEL

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15 Claims. (Cl. 51—206)

This invention relates to reinforced abrasive wheels and particularly to large diameter abrasive wheels such as those employed in the manufacture of wood pulp.

One of the objects of the invention is to provide a large diameter wheel so reinforced against centrifugal force and the forces set up by thermal expansion that the abrasive rim can be made in the form of a unitary annulus. Such unitary abrasive structure presents numerous advantages, among the most salient of which are ease of manufacture and the uniformity of grinding action. Although the wheel of the present invention is used advantageously as a pulp wheel, it can also be used to advantage in other applications requiring a large diameter wheel, and presents particular advantages where such wheel is subjected to severe stresses resulting from centrifugal force, the tangential force resulting from the grinding load, and expansive forces resulting from local and over-all heating of the abrasive structure.

The wheel of the present invention will, for ease of understanding the invention, be described in connection with its use as a pulp wheel. In the production of wood pulp by the conventional grinding method it is necessary to provide a very large and strong abrasive wheel, since large and heavy logs are thrust with great force against the wheel thereby producing enormous grinding forces. Pulp wheels are conventionally 5 feet or more in diameter and weigh as much as eight tons. The logs being ground are forced against the face of the wheel under very heavy pressure, so great in fact, that as much as 1500 H. P. or more is required to revolve the wheels at approximately 250 R. P. M. Thus the structure of the wheel must be such that it will withstand the centrifugal force resulting from its great weight and the relatively high surface speed of the abrasive, and also withstand the inward thrust applied by the logs being ground, and the tangential force required to move the wheel past the work.

In addition to these forces the pulp wheel is subjected to relatively high temperatures during use, since besides the local heating developed by reason of the contact of the wheel with the logs, which may reach as high as 400° F., the wheel operates in a pit at least partially filled with hot water which may reach a temperature of 212° F. Such hot water is necessary in order to provide the necessary loosening of the fibers torn from the logs by the grinding wheel.

Although one piece, or monolithic, pulp wheels have been described in the prior art and attempts have been made to reinforce such wheels in order to enable them to stand up under severe operating conditions, pulp wheels which are now almost universally in use consist of abrasive segments anchored to a drum. In order to compensate for the thermal expansion of individual segments and to seal the abrasive structure against the influx of water, thin packing members are generally employed between segments, such packings being in the nature of rubber or rubber-like materials employing fillers and the like. The use of large segmental type wheels has long been recognized as presenting numerous disadvantages. Their construction involves the assembly of a large number of parts, all of which must be very carefully put in place if the structure is to be safe. The packings employed between segments frequently give trouble by wearing away much faster than the abrasive and by being attacked by the hot water. Because the abrading surface of the wheels is not continuous, but is broken up into a large number of segments, the grinding action, whether upon wood or any other material, is uneven, since a different type of product is produced every time a joint passes the material being ground from what is produced when other portions of the abrasive rim traverse the work. In the case of pulp wheels such joints cause the production of a relatively large amount of coarse waste pulp. In spite of these disadvantages of segmental wheels, which are well-known, and in spite of the fact that the grinding action of a one-piece abrasive annulus has long been recognized as the ideal one, pulp wheels of segmental abrasive construction were almost universally employed before the present invention. This was due to the impossibility of producing large wheels with one piece abrasive rims which would stand up under the grinding conditions imposed, particularly those encountered in wood pulp grinding.

The present invention makes feasible the use of a one piece abrasive annulus of the diameter desired, which may be in the order of 5 feet, and may reach 72 inches or above. The abrasive annulus, which is relatively thin in a radial direction compared to its total diameter, is provided with a supporting and driving means, such means being so constructed that it subjects the abrasive annulus to a predetermined compressive or inwardly directed force so that the abrasive is under a large yet permissible compressive stress circumferentially when the wheel is at room temperature and not rotating, said force being substantially uniform at least at the periphery of the annulus. The amount of such force is calculated, in the case of a pulp wheel, by taking into account among other factors, the mass of the abrasive rim, the normal speed of rotation of the wheel, and the average temperature of the wet pulp bath in which it operates under normal conditions, so that during normal operation the abrasive rim will be in its normal, relatively unstressed condition or under a relatively small compressive force and able to stand up under operating grinding loads and local and over-all temperature changes.

The invention will be more readily understood by reference to the accompanying drawings in which,

Figure 1 is a side elevation of a partially constructed wheel made in accordance with the present invention,

Figure 2 is a view in cross section taken along the line 2—2 in Figure 1,

Figure 3 is a perspective view of a completed wheel employing a single unitary abrasive annulus, and,

Figure 4 is a perspective view of a completed wheel employing two abrasive annuli mounted side by side.

In Figure 1, the abrasive portion of the wheel consists of a unitary abrasive annulus 1 of known pulp wheel composition. The annulus is made by pressing a mixture of abrasive grain and ceramic bond, drying the structure, and firing to vitrify the bond. A softer grade abrasive may be employed in the wheel of this invention than is feasible where the abrasive is in segments, since in the latter construction if the segments were too soft the entering edge of each segment, being adjacent a relatively soft separator layer, would be worn down much more rapidly than the remainder of the segment. Abrasive annulus 1 is provided with a plurality of radial slots 2 which extend from the inner surface of the annulus to points a substantial distance from the outer periphery. In Figure 1 such distance is roughly between ⅓ and ½ the radial thickness of the annulus. Slots 2 connect with bores 3 (Fig. 2), which may be approximately cylindrical and which extend a substantial distance into the abrasive rim in an angular direction toward the axis of the annulus. Slots 2 and bores 3 may be formed by suitably shaped core members on the top and bottom plates of the mold during pressing of the annulus, such core members being withdrawn either manually or mechanically after molding in such direction as not to deform or break out the molded structure around them. The abrasive rim may be solid throughout its extent with the exception of slots 2 and bores 3, or may be provided, at locations substantially intermediate bores 3, with shallow radially directed slots 4 to allow the inner periphery of the annulus to assume more readily a smaller diameter when the annulus is subjected to inwardly directed tension. Slots 4 may, in the finished annulus, be filled with a resilient material such as soft rubber or the like.

The rim supporting and driving means is now assembled with the abrasive annulus. This is done by inserting the short end 5 of a hook shaped spoke 6 into each bore 3 in the rim, locating it axially and in a radial direction with reference to the adjacent side of the abrasive rim by means of a suitable jig, and then pouring about the inserted short end of the spoke a suitable, hardenable seating material 7. One such suitable seating material is Babbitt metal, which is fusible at such temperatures that it may be poured into the abrasive without cracking it, and which, when it hardens, becomes suitably rigid and resistant to flow to provide an unyielding seat for the short end of the spoke. Spoke 6 may be made in one piece of a suitable high strength but elastic metal, such as high strength iron-nickel alloy having a coefficient of expansion approximating that of the abrasive rim. Alternatively, the spokes may be made with the portion containing short end 5 and a suitable length of the shank of one metal or alloy and the remainder of the shank of another metal or alloy, the two portions being connected as by a screw threaded coupling or being integrally joined as by welding. Such composite spoke structure may be made more accurately to conform to the thermal coefficient of expansion of the assembled wheel structure as a whole.

After the spokes have been assembled in the abrasive rim and seating material 7 has been poured about the short end of each, a metal ring or annulus 8 of metal having such depth of section that it has sufficient strength in a radial direction to withstand the force imposed, is placed between the shanks of opposite spokes 6, in a position coaxial with the axis of the rim. Metal straps 9, having a length approximately equal to the width of the rim, and having a hole 10 at each end so spaced as to receive the shanks of the opposed pairs of spokes, are then assembled and are held in place by means of nuts 11 screwed onto the threaded ends 12 of the long shanks of the spokes. Various nuts 11 are tightened progressively in a predetermined order and to a gradually increasing tension so that metal ring 8 is coaxial of the rim at all times. The final predetermined tension to be given to each spoke may then be applied by means of a calibrated wrench with which nuts 11 are finally tightened. Such final tension, as has been explained above, is substantially one such that centrifugal force and normal heat expansion forces will approximately balance such tension when the wheel is in operation. It may be preferred, however, to impose a slightly higher initial tension in spokes 6 so that under normal operating conditions the abrasive rim will always be subjected to circumferential compression. The tension is such that it and any higher tension in spokes 6 arising from operation of the wheel will lie well within the elastic limit of the material of which the hooks are made.

The pre-stressing of the abrasive rim above set out may be accomplished while all parts of the wheel are at room temperature. Alternatively, metal rim 8 may be heated to a predetermined temperature before assembly, in which case nuts 11 are tightened to a somewhat lower degree, additional pre-stressing being furnished by ring 8 upon its cooling to room temperature. A converse of this method, which may also be used, leaves metal ring 8 at room temperature and cools the abrasive rim section as by being placed in contact with dry ice.

Although hook shaped spokes have been shown as the means connecting the wheel supporting and driving means with the abrasive rim, it is to be understood that other types of tensioning members firmly secured to the abrasive annulus may be employed. One such means consists of nuts embedded in radial bores in the abrasive and secured therein by cast metal or cement, and radially directed bolts screwed into the nuts to act as spokes in the finished wheel. In wheels having annuli of narrow widths, only one row of spokes acting as tensioning means need be employed if such means are located centrally of the rim and are such as to exert a force on the rim in a purely radial direction. However, it is usually preferred to use at least two rows of such members, located adjacent opposite sides of the rim, as shown in Figures 1 and 2. It is convenient although not necessary, to have members of opposite rows form opposed pairs. The construction should, however, be such that it effectively balances the forces applied to the abrasive portion and yields a balanced, stable, wheel construction. It is obvious, in either construction described above, to employ a central spoke securing means other than annular in shape and to use means other than the straps described for securing the spokes to such member.

After the structure shown in Figure 1 has been completely assembled, and the abrasive rim subjected to the predetermined degree of inward force exerted by spokes **6** or the equivalent means above described, the space between the abrasive rim **1** and the metal ring **8** and the space inwardly of ring **8** up to the central arbor hole in the wheel is filled with concrete to produce the structure shown in Figure 3. The location of the arbor hole is indicated by a dotted circle **13** in Figure 1 and by dotted lines **14** in Figure 2. Slots **2** are likewise filled with concrete and the finished structure is, in the modification shown, brought to a final thickness equal to that of the abrasive rim. In order to produce the central arbor hole in the wheel, a removable form is employed which is positioned coaxially of the wheel, during pouring and hardening of the concrete, such form having a configuration on its outer surface corresponding to the shape of the arbor hole desired. Reinforcing metal ring members **15**, of which one is shown in Figure 3, are located in the center of the wheel by the arbor hole forming means and become incorporated in the wheel as a permanent part thereof after the concrete has hardened and the arbor hole forming means is removed. A wheel supporting and driving arbor **16** extends through the arbor hole in the wheel and interfits with the members **15** in the wheel by means of bushings **17**, of which one is partially shown in Figure 3, which fit in between arbor **16** and metal reinforcing rings **15** within close tolerances. The wheel is held against movement axially of the arbor and is driven by means of flanges (not shown) which are screwed onto threaded portions **18** of the arbor, one on each side of the wheel. The threads on each of the portions **18** are made of such hand that the flanges on both sides of the wheel tend to tighten against the wheel as the wheel is driven.

Although the structure shown in Figure 3 is suitable for many applications, it is preferable in some cases, particularly where wider wheels are desired than are feasible to make in one piece, to use a composite wheel such as that constructed in Figure 4. Such wheel is made by forming two similar abrasive annuli, similar to those shown as **1** in Figures 1 and 2, mounting spokes or equivalent means in each annulus for exerting tension inwardly of the annulus, placing the annuli together in a coaxial position with the anchor hooks aligned, and positioning a metal ring such as ring **8** shown in Figures 1 and 2 within each of the abrasive annuli. Strap members designated **19** are employed in this case, such members being of substantially the same width as the two assembled annuli so that the inner ends of four aligned spokes, two for each annulus, project through each one. The annuli are subjected to a predetermined amount of stress directed inwardly by the same methods or combinations of methods disclosed in connection with the modifications shown in Figures 1 and 2.

It is preferable, in making a wheel such as shown in Figure 4, to employ biased joints between adjacent annuli. This may be accomplished by dressing the adjacent sides of the two or more annuli so that they interfit but so that the joint does not lie in a radial plane, that is, a plane at right angles to the axis of the wheel. In a pulp wheel it is sufficient that the joint or joints lie in a plane but that at one point on the circumference of the wheel it lies from ½" to 1" on one side of a radial plane and at a point 180° removed from the first named point it lies from ½" to 1" on the other side of the same radial plane. Such a biased joint prevents the production of the coarse waste pulp which would result at the joint if it lay in a radial plane.

It is possible, in thus making a composite wheel, to place the abrasive annuli directly in contact with each other, but it is preferred, in order to minimize stresses arising from thermal expansion and also in order to seal the joint between annuli, to employ a packing material **20** between them. Such packing is shown, for ease of illustration, greatly exaggerated in thickness in Figure 4. Actually it need not be more than $\frac{1}{32}$ to $\frac{1}{16}$" in thickness when the wheel is assembled and the parts compressed against each other. A suitable packing can be made by impregnating two sheets of fabric with reactive synthetic resin and forming a composite packing layer of the desired thickness and consisting of two resin impregnated sheets separated by means of a vulcanizable rubber composition. The layered sheet thus formed is heated to harden the synthetic resin in the outer layers of fabric and to vulcanize the intermediate rubber composition. A sufficient number of layered sheets made in a manner similar to that just described are placed between the abrasive annuli to produce packing layer **20**. Instead of having the layered sheets contact with the surfaces of the abrasive annuli, a self-hardening resinous cement can be used in direct contact with the annuli, and one or more of the layered sheets of the kind described above used to complete the joint between the abrasive annuli.

The wheel in Figure 4 has concrete poured into its center portion both between the abrasive annuli and the inner metal rings, and between the metal rings and the central arbor hole. The wheel likewise is provided with reinforcing metal rings **15** permanently incorporated into the arbor hole, and is mounted on an arbor **16** by means of bushings **17** between the arbor and rings **15** and by means of suitable flanges (not shown) screwed onto threaded portions of the arbor. Although the wheel shown in Figure 4 has but two annuli **1** involved in its make-up, it is obvious that wider abrasive wheels can be made employing as many annuli as desired placed side by side and connected together in the same manner as in Figure 4.

Although the invention has been described in connection with the specific structures shown and it has been discussed in connection with its use as a pulp wheel, it is to be understood that the invention may be used in structures equivalent to those described, and that it displays advantages in other applications where large diameter wheels are employed in rigorous grinding operations. Other advantages of the invention besides those above pointed out will be apparent to those skilled in the art from the foregoing description taken in connection with the drawings. The invention is therefore defined within the compass of the following claims:

We claim:

1. A reinforced abrasive wheel comprising an integral abrasive annulus of relatively large diameter, said annulus being relatively thin in a radial direction as compared to its total radius, said annulus being provided with a plurality of pairs of opposed radial slots on the sides thereof extending from the inner circumference of the abrasive annulus for a substantial distance toward the outer circumference thereof, said slots being spaced equally about the abrasive annulus, there being an inwardly directed bore connecting to the outermost portion of each slot, said bore being of substantial depth and being directed angularly toward the axis of the annulus, said annulus being provided with a plurality of spokes having long and short portions directed at an acute angle to each other, the short end of each of said spokes being each inserted into one of the angularly directed bores in the annulus and being fitted and held therein by means of a hardened cast metal seat, the long ends of the spokes being threaded and being directed radially of the abrasive rim, the outer parts of the long ends being received in the radial slots in the abrasive annulus, a strong metal annulus of substantially smaller diameter than that of the abrasive annulus and of such width as to fit snugly between the long portions of opposed pairs of spokes, said metal annulus being located coaxially of the abrasive rim, a plurality of strap members, each having a hole at each end thereof and so spaced as to fit over the long ends of two opposed spoke members, said straps being positioned parallel to the axis of the metal annulus and in contact with the inner face thereof, and a nut on the threaded end of each long portion of the spokes, each nut being tightened to such an extent that all spokes are under substantially the same heavy tensile stress, the combined stresses in all spokes being such as to subject the annular abrasive rim to heavy compressive forces in a circumferential direction when the wheel is at rest and at room temperature, the space between the abrasive annulus and the inner metal annulus and between the inner metal annulus and the arbor hole of the wheel being filled with solidified concrete.

2. A reinforced abrasive wheel comprising an integral abrasive annulus of relatively large diameter, said annulus being relatively thin in a radial direction as compared to its total radius, said annulus being provided with a plurality of pairs of opposed inwardly directed bores, said bores being spaced equally about the abrasive annulus, each of said bores being of substantial depth and being directed angularly toward the axis of the annulus, said annulus being provided with a plurality of spokes having long and short portions directed at an acute angle toward each other, the short end of each of said spokes being each inserted into one of the angularly directed bores in the annulus and being fitted and held therein by means of a hardened cast metal seat, the long ends of the spokes being threaded and being directed radially of the abrasive rim, a strong metal annulus of such diameter and width as to fit between the long portions of opposed pairs of spokes, said metal annulus being located coaxially of the abrasive rim, a plurality of strap members, each having a hole at each end thereof and so spaced as to fit over the long ends of two opposed spoke members, said straps being positioned parallel to the axis of the metal annulus and in contact with the inner face thereof, and a nut on the threaded end of each long portion of the spokes, each nut being tightened to such an extent that all spokes are under substantially the same heavy tensile stress, the combined stresses in all spokes being such as to subject the annular abrasive rim to compressive forces in a circumferential direction when the wheel is at rest and at room temperature, the space between the abrasive annulus and the inner metal annulus and between the inner metal annulus and the arbor hole of the wheel being filled with solidified concrete.

3. A reinforced abrasive wheel comprising an integral abrasive annulus of relatively large diameter, said annulus being relatively thin in a radial direction as compared to its total radius, said annulus being provided with a plurality of pairs of opposed inwardly directed bores of substantial depth and directed angularly toward the axis of the annulus, said bores being spaced substantially equally about the abrasive annulus, said annulus being provided with a plurality of spokes having long and short portions directed at an acute angle to each other, the short end of each of said spokes being inserted into one of the angularly directed bores in the annulus, the long ends of the spokes being threaded and being directed radially of the abrasive rim, a strong metal annulus of such diameter and width as to fit between the long portions of opposed pairs of spokes, said metal annulus being located coaxially of the abrasive rim, a plurality of strap members each having a hole at each end thereof so spaced as to fit over the long ends of two opposed spoke members, said straps being in contact with the inner face of the metal annulus and a nut on the threaded end of each long portion of the spokes, each nut being tightened to such an extent that all spokes are under substantially the same heavy tensile stress, whereby the spokes subject the annular abrasive rim to compressive forces in a circumferential direction when the wheel is at rest and at room temperature.

4. A reinforced abrasive wheel comprising an integral abrasive annulus of relatively large diameter, said annulus being relatively thin in a radial direction as compared to its total radius, said annulus being provided on each side thereof with a plurality of inwardly directed bores, the bores on each side of the annulus being spaced substantially equally about the annulus, the bores being of substantial depth and being directed angularly toward the axis of the annulus, said annulus being provided with a plurality of spokes having long and short portions directed at an acute angle to each other, the short end of each of said spokes being inserted in one of the angularly directed bores in the annulus, the long ends of the spokes being threaded and being directed radially of the abrasive rim, a strong metal annulus of such diameter and width as to fit between the long portions of the spokes on opposite sides of the annulus, said metal annulus being located coaxially of the abrasive rim and means attaching

the long ends of the spokes to the metal annulus, said means comprising a nut on the long end of each spoke, each nut being tightened to such an extent that all spokes are under substantially the same heavy tensile stress, said spokes subjecting the annular abrasive him to heavy compressive forces in a circumferential direction when the wheel is at rest and at room temperature.

5. A reinforced abrasive wheel comprising an integral abrasive annulus of relatively large diameter, said annulus being provided adjacent each side thereof with a plurality of radially directed spokes firmly engaging the abrasive rim, the spokes on each side of the annulus being spaced substantially equally about the abrasive annulus, a strong metal annulus of such diameter and width as to fit between the spokes of opposite sides of the abrasive rim, said metal annulus being located coaxially of the abrasive rim, and means comprising a nut on the inner threaded end of each spoke connecting each spoke to the metal annulus, each nut being tightened to such an extent that all spokes are under the same tensile stress, said spokes subjecting the annular abrasive rim to heavy compressive forces in a circumferential direction when the wheel is at rest and at room temperature.

6. A reinforced abrasive wheel comprising an integral abrasive annulus of relatively large diameter, said annulus being provided with at least one set of radially directed spokes which lie substantially in a plane, said spokes being distributed substantially equally about the abrasive annulus, spoke holding means within the abrasive annulus substantially coaxial with the abrasive annulus and means connecting each of the spokes to such spoke holding means, the means connecting each spoke to the spoke holding means being adjustable so that each spoke may be subjected to a predetermined amount of tension, each spoke in the wheel being subjected to substantially the same heavy tensile stress, the spokes subjecting the annular abrasive rim to heavy compressive forces in a circumferential direction when the wheel is at rest and at room temperature.

7. A reinforced abrasive wheel comprising an integral abrasive annulus of relatively large diameter, said annulus being provided with at least one set of spokes which lie substantially in a plane, said spokes being distributed substantially equally about the abrasive annulus, spoke holding means within the abrasive annulus substantially coaxial with the abrasive annulus and means connecting each of the spokes to such spoke holding means, the means connecting each spoke to the spoke holding means being adjustable so that each spoke may be subjected to a predetermined amount of tension, each spoke in the wheel being subjected to substantially the same heavy tensile stress, the spokes subjecting the annular abrasive rim to heavy compressive forces in a circumferential direction when the wheel is at rest or at room temperature.

8. A reinforced abrasive wheel comprising an integral abrasive annulus, said annulus being provided with at least one set of spokes which lie substantially in a plane, said spokes being firmly attached to the abrasive annulus and being distributed substantially equally about the annulus, spoke holding means within the annulus, and means connecting each of the spokes to such spoke holding means, the means connecting each spoke to the spoke holding means being adjustable so that each spoke may be subjected to a predetermined amount of tension, each spoke in the wheel being subjected to substantially the same heavy tensile stress, the spokes subjecting the abrasive annulus to heavy compressive forces in a circumferential direction when the wheel is at rest and at room temperature.

9. A reinforced abrasive wheel comprising an integral abrasive annulus, said annulus being provided with at least one set of spokes, said spokes being firmly attached to the abrasive annulus and being distributed substantially equally about the annulus, spoke holding means within the annulus, each of said spokes being connected to the spoke holding means in such manner as to be subjected to a heavy tensile stress, the spokes subjecting the abrasive annulus to heavy compressive forces in a circumferential direction.

10. A reinforced abrasive wheel comprising an integral abrasive annulus, said annulus being provided with at least one set of spokes, said spokes being firmly attached to the abrasive annulus and being distributed substantially equally about the annulus, spoke holding means within the annulus, each of said spokes being connected to the said spoke holding means in such manner as to be subjected to a heavy tensile stress, the spokes subjecting the abrasive annulus to heavy compressive forces in a circumferential direction, said abrasive annulus having stress relieving slots of appreciable depth in the inner circumferential surface thereof.

11. A reinforced abrasive wheel comprising at least two integral abrasive annuli of substantially the same diameter positioned coaxially, each annulus being provided with at least one set of spokes, spokes of adjacent annuli forming opposed pairs, said spokes being firmly attached to the abrasive annuli and being distributed substantially equally about the annuli, spoke holding means within each annulus, each of the spokes being connected to a spoke holding means so as to be subjected to a heavy tensile stress, opposed pairs of spokes being held by a common means holding the annuli together, the spokes subjecting each abrasive annulus to heavy compressive forces in a circumferential direction.

12. A reinforced abrasive wheel comprising at least two integral abrasive annuli of relatively large diameters, said annuli being of substantially the same diameter and being positioned substantially coaxially, each annulus being provided with at least one set of spokes which lie substantially in a plane, spokes of adjacent annuli forming opposed pairs, said spokes being firmly attached to the abrasive annuli and being distributed substantially equally about the annuli, spoke holding means within the annuli substantially coaxial thereof, and means common to opposed pairs of spokes of adjacent annuli connecting each of the spokes to the spoke holding means, the last named means connecting adjacent annuli together, and adjustable means for subjecting each spoke to tension, each spoke being subjected to a heavy tensile stress, the spokes subjecting the abrasive annuli to a heavy substantially uniform compressive force in a circumferential direction.

13. A reinforced abrasive wheel comprising at least two substantially similar integral abrasive annuli of relatively large diameter, said annuli being positioned coaxially, each annulus being provided adjacent each side thereof with a plurality of radially directed spokes firmly engaging the annulus, the spokes on each side of the

annulus being spaced substantially equally about the abrasive annulus, the spokes in each annulus forming opposed pairs, said pairs being aligned with similar pairs in the adjacent annulus, a strong metal annulus in each abrasive annulus, said metal annuli being of such diameter and width as to fit between the spokes on opposite sides of the abrasive rim, each metal annulus being located coaxially of its abrasive annulus, elongated metal members having holes therein for the reception of aligned spokes within the metal annuli and fitting over the inner ends of aligned spokes, and means holding the elongated metal member on each spoke, said means being adjustable whereby the spokes may be tightened, each spoke being tightened to substantially the same amount, said spokes subjecting the abrasive annuli to heavy substantially uniform compressive forces in a circumferential direction.

14. A reinforced abrasive wheel comprising, in combination an integral abrasive annulus, at least one pair of spokes for the annulus, means firmly attaching the spokes to the annulus in substantially even distribution around the annulus, spoke holding means within, and spaced from, the inner face of the annulus, and means detachably connecting each spoke to the spoke holding means.

15. A reinforced abrasive wheel comprising, in combination at least two integral abrasive annuli, at least one pair of spokes for each of the annuli, means firmly attaching the spokes to their respective annuli in substantially even distribution around the annuli, spoke holding means within, and spaced from, the inner face of each of the annuli, and common means detachably connecting each spoke to its spoke holding means and interconnecting the spoke holding means.

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