J. S. WILLIAMS.

WHEEL EQUIPMENT AND METHOD OF CONSTRUCTING THE SAME.

APPLICATION FILED APR. 15, 1913.

1,417,008. Patented May 23, 1922.

5 SHEETS—SHEET 1.

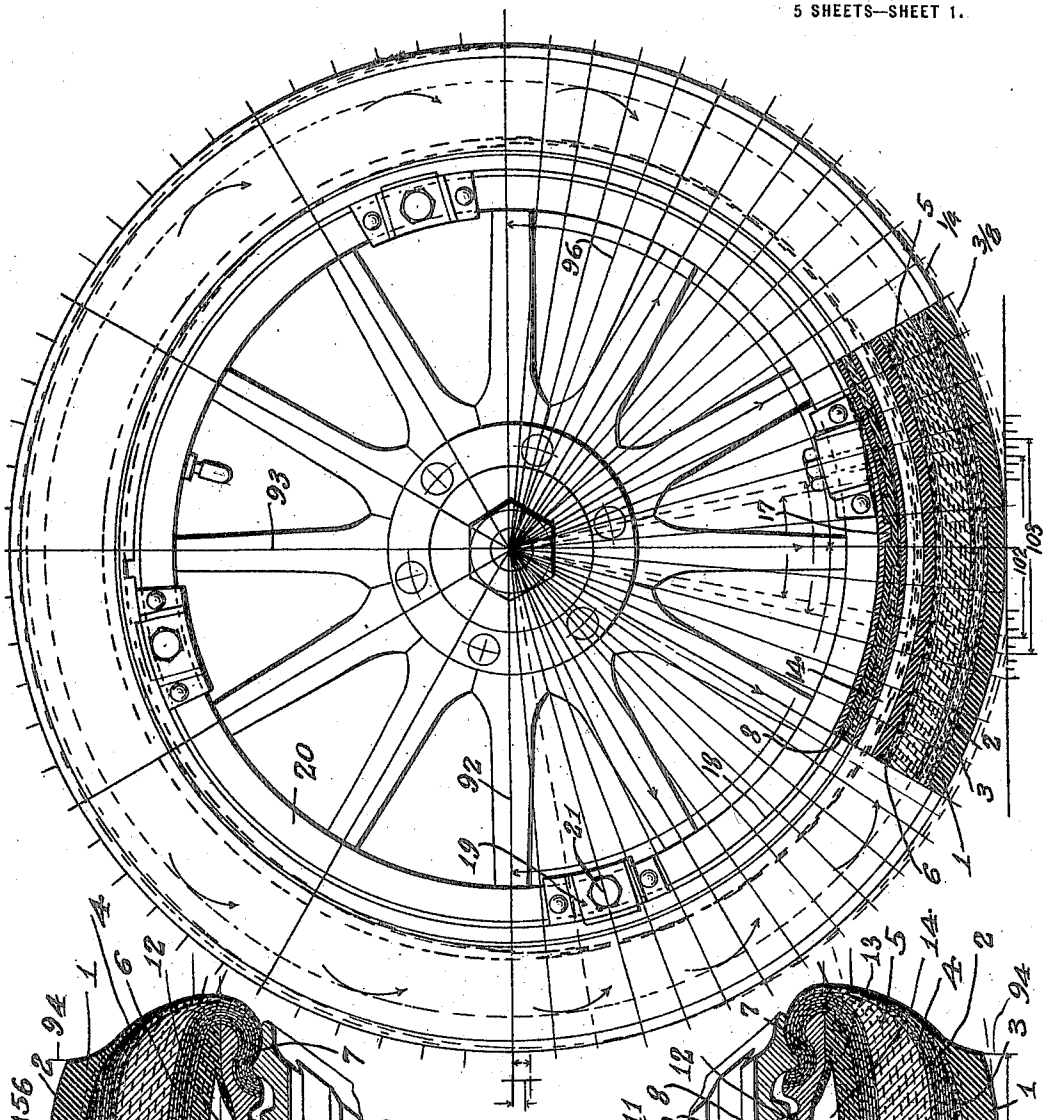


Fig. 1.

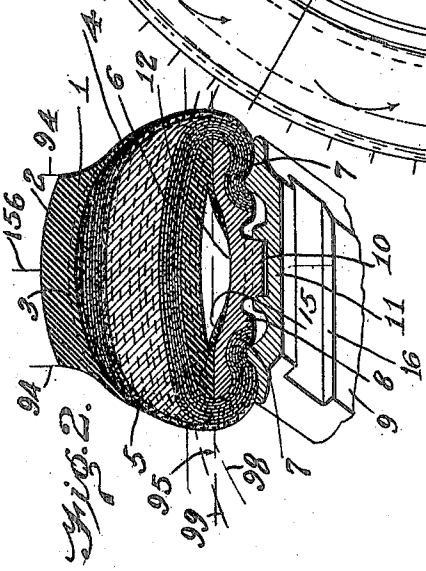


Fig. 2.

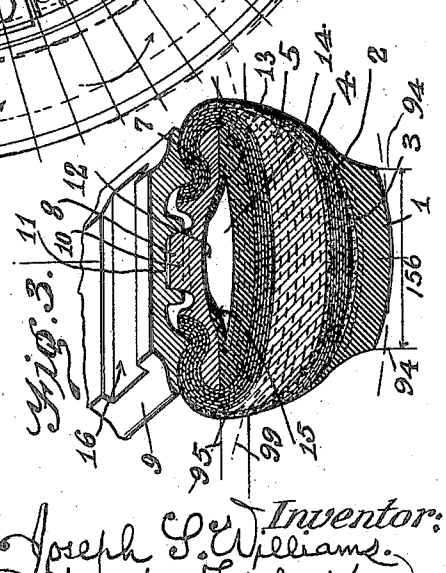


Fig. 3.

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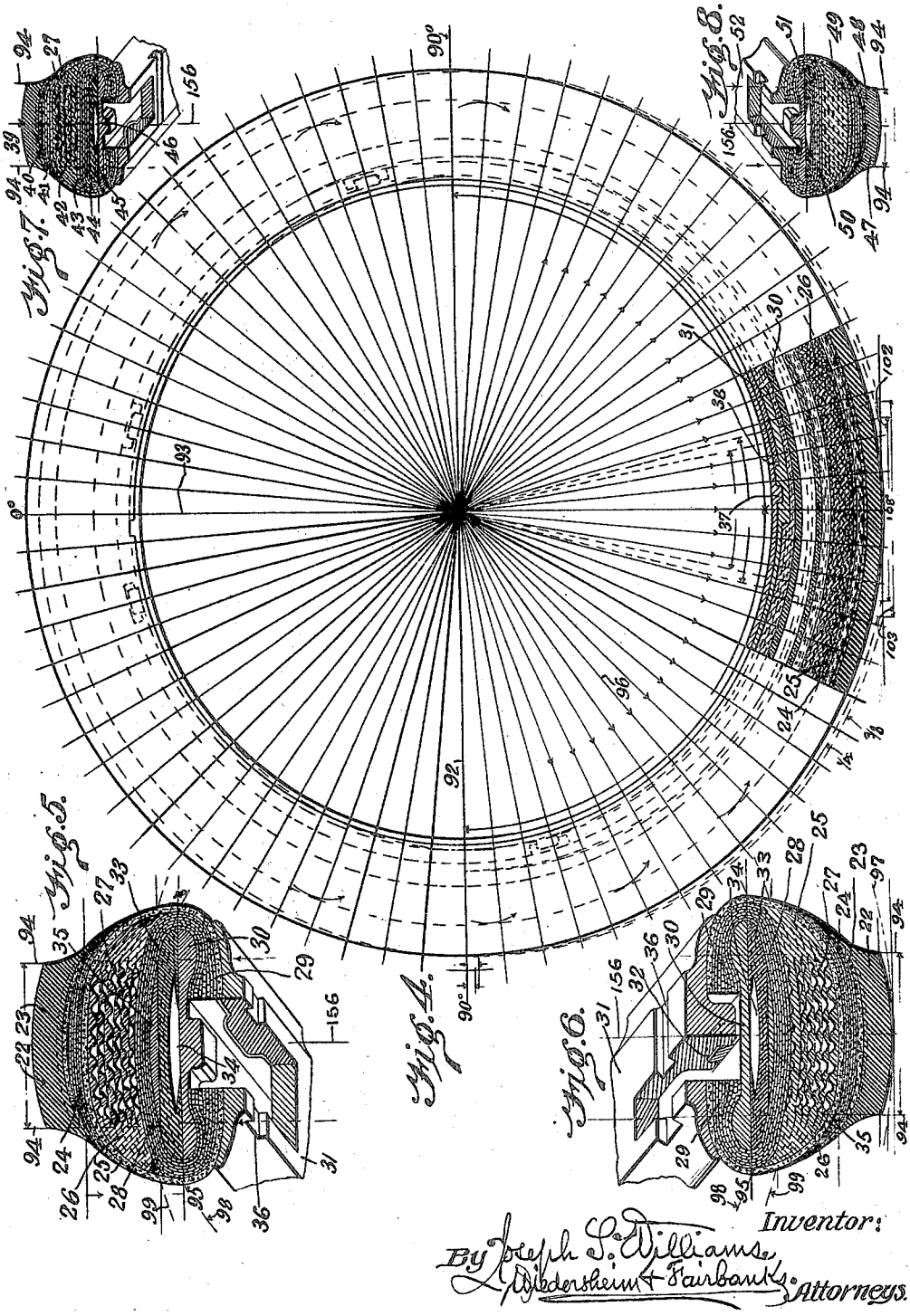
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5 SHEETS—SHEET 2.



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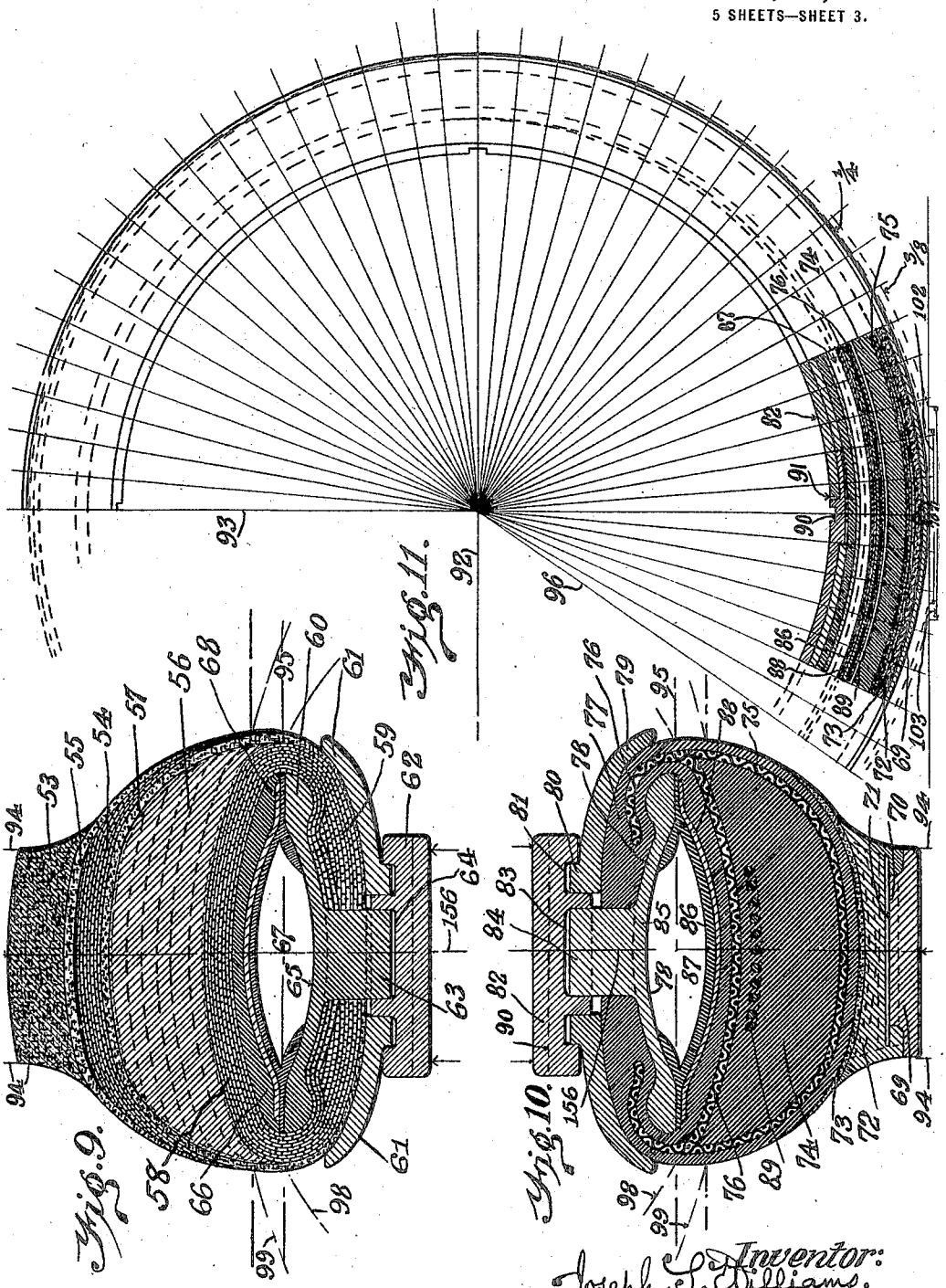
WHEEL EQUIPMENT AND METHOD OF CONSTRUCTING THE SAME.

APPLICATION FILED APR. 15, 1913.

1,417,008.

Patented May 23, 1922.

5 SHEETS—SHEET 3.



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WHEEL EQUIPMENT AND METHOD OF CONSTRUCTING THE SAME.

APPLICATION FILED APR. 15, 1913.

1,417,008.

Patented May 23, 1922.

5 SHEETS—SHEET 4.

Fig. 16.

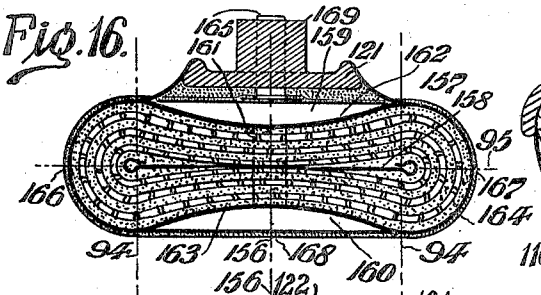
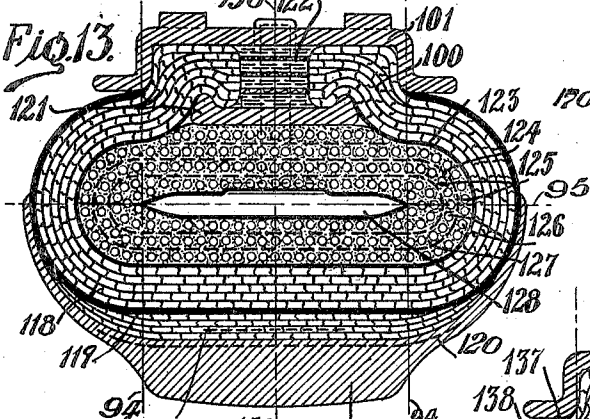


Fig. 13.



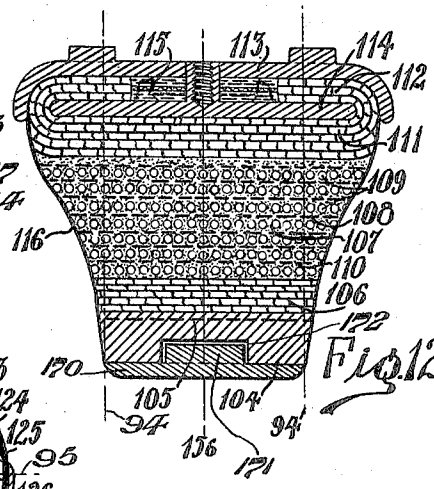
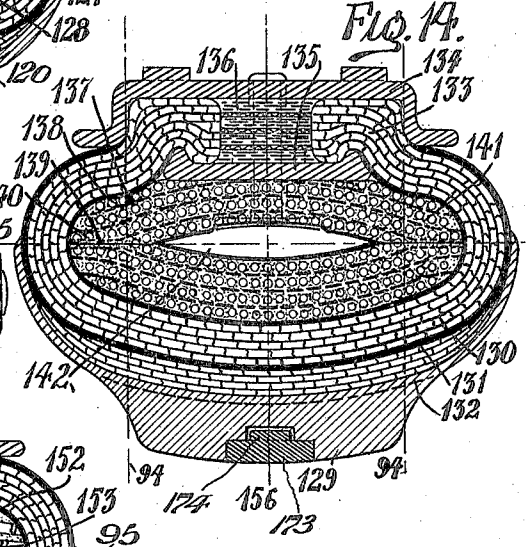


Fig. 12.

Fig. 14.



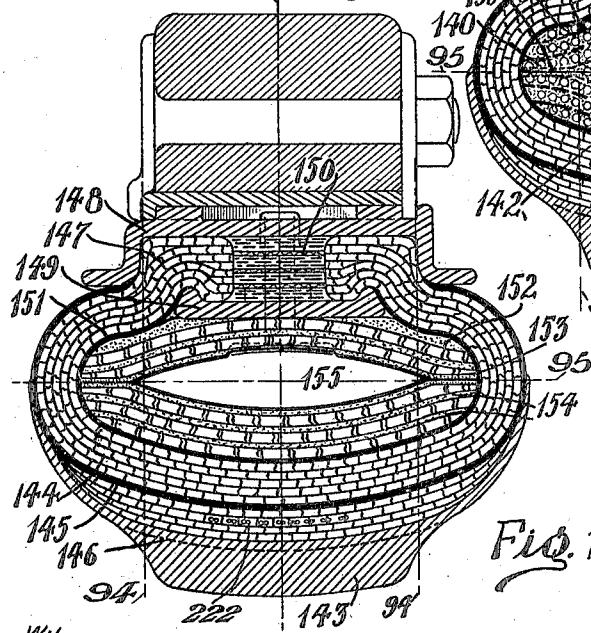


Fig. 15.

Witnesses

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WHEEL EQUIPMENT AND METHOD OF CONSTRUCTING THE SAME.

APPLICATION FILED APR. 15, 1913.

1,417,008. Patented May 23, 1922.

5 SHEETS—SHEET 5.

Fig. 17.

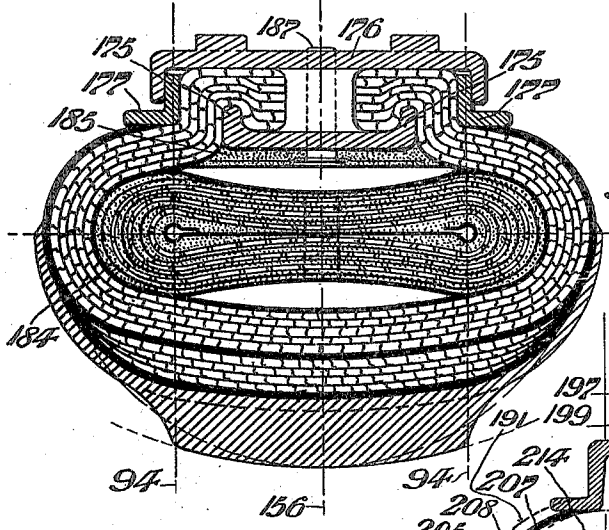


Fig. 18.

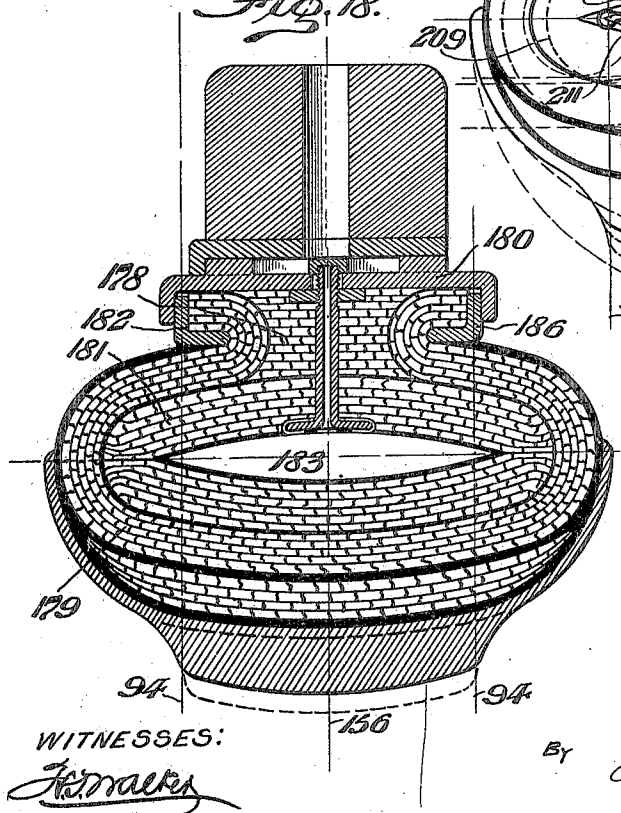
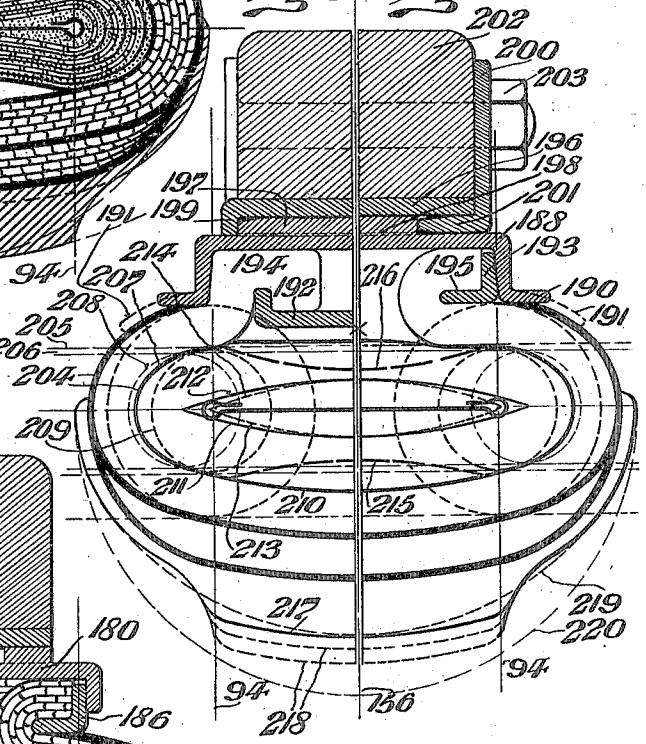


Fig. 19.

Fig. 20.



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WHEEL EQUIPMENT AND METHOD OF CONSTRUCTING THE SAME.

1,417,008. Specification of Letters Patent. Patented May 23, 1922.

Application filed April 15, 1913. Serial No. 761,193.

To all whom it may concern:

Be it known that I, JOSEPH S. WILLIAMS, a citizen of the United States, residing at Riverton, in the county of Burlington, State of New Jersey, have invented a new and useful Wheel Equipment and Method of Constructing the Same, of which the following is a specification.

My invention in its broad and generic scope consists of a novel wheel equipment and method of constructing it, in order that the stresses and strains in the construction due to load, road thrusts, and reactions will be resiliently supported and balanced within definite ranges of resilient movements.

Other novel features of construction and advantage will hereinafter clearly appear in the detailed description of the invention.

For the purpose of illustrating my invention, I have shown in the accompanying drawings preferred embodiments which are at present preferred by me, since the same will give in practice satisfactory and reliable results, although it is to be understood that the various instrumentalities of which my invention consists can be variously arranged and organized and that my invention is not limited to the precise arrangement and organization of these instrumentalities as herein shown and described.

Figure 1 represents a side elevation partly in section of a resilient wheel equipment embodying my invention, the same being shown in assembled condition with respect to a vehicle wheel.

Figure 2 represents a transverse section of a portion of Figure 1, taken through the upper part of the construction.

Figure 3 represents a transverse section of a portion of Figure 1 showing the lower portion of the construction.

Figure 4 represents a side elevation partly in section of a portion of a wheel equipment embodying my invention.

Figure 5 represents, in perspective, a transverse section of Figure 4, the section being taken through the upper portion of the construction.

Figure 6 represents, in perspective, a transverse section of a portion of Figure 4, showing the lower portion of the construction.

Figures 7 and 8 represent, in perspective and transverse sections, other embodiments of my invention certain of the elements having a flattened formation.

Figures 9 and 10 represent transverse sections of other embodiments of my invention.

Figure 11 represents a side elevation partly in section of the construction seen in Figure 10.

Figures 12 to 15 inclusive represent transverse sections of other embodiments of my invention.

Figure 16 represents a transverse section of an insert adapted to be used in Figure 13 and with slight modification in curvatures with other figures of the drawings.

Figures 17 and 18 represent transverse sections of other embodiments of my invention.

Figures 19 and 20 represent diagrammatical views showing lines of formation of different embodiments.

Similar numerals of reference indicate corresponding parts in the figures.

Referring to the drawings:—

In a copending application, Serial No. 761,192, filed April 15th, 1913, I have described and generically claimed a novel method and organism for balancing thrusts and reactions, wherein the flexures in the resilient construction take place inwardly and outwardly of the major transverse axis of such resilient construction.

Referring first to Figures 1 to 3 inclusive, 1 designates a tread, having its inner periphery circumferentially and transversely disposed, with a radially projecting tread wearing part extending therefrom to the tread surface, which latter may have any desired contour, although in practice the same is preferably made substantially concentric with the resilient and tensile element of the annular body of the construction. The sides of the tread are radially deflected with curvature towards the side of the construction, and the tread is carried by and secured to an outer tensile belt 2, by means of a breaker strip 3 of resilient rubber and tensile material in order to provide the proper resilient waterproofing, bonding, and frictioning between the tread 1 and the outer tensile belt 2.

The tensile belt 2 is inwardly supported upon the outer periphery of a resilient waterproof layer 4 the sides of which en-

close a transversely disposed resilient cushion belt 5, consisting of layers of fabric and rubber vulcanized together and supported on an inner tensile belt 6, transversely disposed in the annular planes of the construction and having its sides extended inwardly and laterally to form terminals or seating parts 7, it being noted that the waterproofing layer 4 preferably extends around the sides of the inner tensile belt 6, so that the resilient cushion 5, is rendered impervious to moisture. The terminals 7 are in compressive engagement between an annular band 8, and a transversely divided annulus 9, said band being provided with lugs 10, which interlock with recesses 11 to prevent relative circumferential movement of such parts. The outer periphery of the band 8 is incavated or inwardly curved as at 12, in order to form with a resilient belt 13 a clearance space 14, which latter may be provided, if desired, with elastic, mobile or fluid content, although the same may be dispensed with in many cases arising in practice. The resilient belt 13 is preferably formed of fabric and rubber, and is provided with the inwardly extending flanges 15, in order to form the fluid tight spacement 14. The sides of the inner tensile belt 6 are in close coinage around the sides of the tube forming belt 13 and the sides of the band 8. The annulus 9 is provided with a transversely arranged recess 16, with which is adapted to interlock a lug 17 on the felly band 18, in order to prevent relative circumferential movement. The lateral movement is prevented by means of clips 19 secured to the felly 20 by means of fastening devices 21. The outer tensile belt 2 is substantially concentric with the inner tensile belt 6 and with the resilient construction 5 therebetween. The sides of the annular body of the resilient construction thus formed extend laterally beyond the width of road contact of the tread and the sides are deflected inwardly with curvature or angularity from the major transverse axis of the outer periphery of the resilient and tensile belt which extends across the body of the resilient construction in close relationship to the transverse planes on the inner periphery of the tread belt from which the tread belt is projected radially with a desired depth and width of road contact, and the sides of the tread are radially directed to provide approximately constant width of tread as the same wears away.

Referring now to the embodiment seen in Figures 4 to 6 inclusive, the results attainable are substantially the same as in the construction just described with reference to Figures 1 to 3 inclusive, but in this embodiment, seen in Figures 4 to 6 inclusive, the resilient cushion between the inner and outer tensile belts is provided with pores or cells. A different manner of rendering the terminals circumferentially inextensible is shown, and the resilient belt which forms a spacement is encircled by a flexible annular band.

22 designates a tread secured by means of a breaker strip 23 to the outer tensile belt 24. The inner periphery of the tensile belt 24 is faced with a waterproof layer of rubber 25 which extends to the terminal seatings of the construction, and encloses a transversely disposed resilient cushioning belt 26 constructed of fabric and rubber, and provided throughout the width of the tread belt with cells or pores 27 to provide a clearance space for definite ranges of resilient action.

28 designates an inner tensile belt, transversely disposed and having its sides inwardly and laterally extended to form terminals 29 which are in compressive engagement between a band 30 and an annulus 31, provided with interlocking means 32, in order to prevent relative circumferential movement of such parts. The outer periphery of the band 30 is substantially flat and forms with a resilient belt 33 a spacement 34, which is adapted to be filled with any suitable elastic, fluid or mobile content. The outer periphery of the central portion of the belt 33, is encircled by a flexible metallic band 35. The waterproofing 25 enclosed the sides of the resilient cushioning belt 26 and forms a waterproofing on the inner face of the terminals 29. The tread belt 22, the outer tensile belt 24, the resilient cushioning belt 26 and the inner tensile belt 28 are substantially concentric in the transverse planes of the construction. The annulus 29 is transversely recessed as at 36, in order to interlock with a lug 37, carried by a felly band 38, it being understood that clips are employed in connection with the felly band and annulus in a similar manner to that already described with reference to Figures 1 to 3 inclusive, in order to prevent relative lateral movement of the felly band and annulus. The flexible band 35 imparts load capacity and support to the resilient construction outwardly thereof.

In the embodiment seen in Figure 7, the construction is substantially the same as that shown in Figures 5 and 6, except that the flexible metallic band 35 in said figures is omitted, and the elements in the transverse planes have substantially flattened formation. The tread belt 39, the breaker strip 40, the outer tensile belt 41, the resilient cushion 42, and the inner tensile belt 43 correspond in construction to similar parts seen in Figure 6, except for the flattened formation given thereto in the transverse planes of the construction.

The resilient belt 44 forms with the band 45 a clearance space 46 of less area than that seen in Figures 5 and 6. The construction

of the band and annulus is similar to that already described in connection with Figures 5 and 6.

In the embodiment seen in Figure 8, the construction corresponds to that seen in Figure 7, except that the cellularity or porosity is omitted in the resilient cushion between the inner and outer tensile belt. The tread belt 47 and breaker strip 48, correspond in construction to that seen in Figure 7, while the resilient cushion 49 is composed of layers of fabric and rubber, and throughout the width of the tread zone the fabric in such cushion extends transversely to lie substantially in the transverse planes of the construction.

The inner tensile belt 50, the band 51, and the annulus 52 correspond in construction and are arranged in a similar manner to the corresponding parts seen in Figure 7.

In the embodiment seen in Figure 8, the resiliency in the cushion belt 49 is obtained by the compressibility of the fabric and rubber and the flexures circumferentially and at sides of the construction.

Referring now to the embodiment seen in Figure 9, 53 designates a tread belt of relatively hard material, the rubber having embedded therein relatively hard material, such as for example, carborundum, pulp, or fibrous material, in suitable relative proportions with rubber to provide a tread of high resistance to wear and slip, and one capable of carrying heavy load. The sides of the tread are radially directed as in the other embodiments of my invention herein shown. Between the tread 53 and the outer tensile belt 54 is a layer of resilient material 55, which extends around the sides of the construction to the terminals or seating parts thereof and encloses a resilient field 56 consisting of fabric and rubber, and between which and the tensile belt 54 is preferably employed a resilient layer or breaker strip 57.

58 designates the inner tensile belt, the terminals 59 of which are in compressive engagement between the band 60 and the annuli 61, which latter interlock with an annulus 62 by forcing said annuli laterally towards each other to permit the annulus 62 to be interlocked thereon. The band 60 and the annulus 62 are interlocked to prevent relative circumferential movement and in the present instance the band 60 is shown as having a lug 63 which interlocks in a recess 64 of the annulus 62.

The outer periphery of the band 60 is inwardly deflected or curved as at 65, in order to form, with a resilient band 66, a clearance space 67, which may be filled with elastic, mobile or fluid content, of any desired nature, and with any desired degree of pressure preferably in the ratio of one pound per degree of length circumferential to ninety pounds of load and otherwise to higher pressures which will not limit the range of resilient altitude to less than one-quarter to three-eighths of an inch in the local lines of radii of twenty to twenty-five degrees along the length of the road contact. The resilient belt 66 is reinforced by transversely divided metal bands 68, embedded in the construction and providing increased resilient support to secure the desired resilient load capacity and altitude.

In the construction seen in Figure 10, instead of employing a fabric tension belt, I employ inner and outer tension belts of woven, interlaced, or other metal of flexible construction, it being understood that the formation of these tension belts in such manner is within the broad and generic scope of my invention.

69 designates the tread which is formed of a flexible metallic band, which provides a circumferentially inextensible portion at the outer periphery of the construction and which is provided with preferably inwardly extending lugs 70, which interlock with recesses 71, in an outer belt 72, constructed of fabric and rubber and having its inner periphery joined to a breaker strip 73, which in turn is bonded with a resilient belt 74, having at its outer portion a tensile belt 75, of woven or apertured metal or wire gauze, transversely disposed throughout the tread zone and embedded in the construction, and having its sides extended into the terminal or seating parts of the construction.

76 designates an inner tensile belt of metal transversely disposed throughout the tread zone, and having its sides extended inwardly and laterally to form with the sides of the belt 74 terminal or seating parts 77, which are rendered inextensible circumferentially by the band 78 and the annuli 79, which latter are provided with flanges 80 which interlock in the grooves 81 of a transversely divided annulus 82, which corresponds in construction to that seen in Figure 9. In order to prevent relative circumferential movement of the band 78 and the transversely divided annulus 82, the latter is provided with a recess 83, with which interlocks a lug 84, carried by the band 78. The outer face of the band 78 is inwardly deflected as at 85 throughout the width of the tread zone to form with a resilient belt 86 a spacement 87, which is transversely disposed in annular transverse planes of the construction.

88 designates transversely disposed reinforcements encircling the resilient belt 86, outwardly thereof.

89 designates annular reinforcing members outwardly of the inner tensile belt 76 which renders the construction circumferentially inextensible. The transversely divided annulus 82 is transversely recessed as at 90, in order to interlock with the felly

band in a similar manner to that already described with respect to other figures of the drawings. The line of division of the annulus 82 is shown at 91, in Figure 11.

In all the embodiments of my invention herein shown, 92 designates the horizontal axis of the wheel or the axis of thrust, and 93 designates the vertical axis of the wheel.

94 designates vertical lines which indicate the width of the tread belt. 95 designates the major transverse axis of the construction.

In the embodiment seen in Figure 12, the materials forming the resilient organism are transversely disposed in the areas of the fields of planes of the construction. In this embodiment 104 designates a tread of any desired depth which is illustrated as of uniform depth throughout its width with slight curvature at the sides on the tread surface, but any suitable form of tread and with any degree of hardness may be used.

105 designates a breaker strip by means of which the tread 104 is resiliently bonded with the tensile belt 106, which provides tensile capacities resisting circumferential inextensibility in multifold ratio to load, preferably in proportions of six to ten of load. This belt is shown composed of layers of open weave fabric and rubber, the rubber being bonded through the fabric but any suitable construction may be employed. The outer tensile belt 106 is transversely disposed in the areas of the annular fields of planes, and is bonded with a resilient belt 107. The construction 107 is formed of layers of open weave fabric 108, and rubber coated yarns 109, which are spaced from each other by and bonded with suitable rubber filling 110, which also passes through the weaves of the fabric 108. Such composite body of material is vulcanized together along with the inner tensile belt 111, and the outer tensile belt 106. The rubber coated yarns and open weave fabric are in suitable proportions with resilient and relatively pliable rubber to provide for the uniform distribution and equalization of the stresses and strains, in such body, and for obtaining definite ranges of resilient movements in the construction.

The inner periphery of the resilient belt 107 encircles and is bonded with an inner tensile belt 111, constructed of layers of fabric and rubber, the rubber being bonded through the fabric, said tensile belt, having its sides inwardly curved to form terminals 112, which are in compressive engagement between a transversely divided annulus 113 and an annular band 114, which are secured together by co-fitting parts 115 to maintain proper co-relationships.

116 designates a layer of rubber on the sides of the resilient body extending from the tread to the annulus 113 and beneath the deflected sides thereof in order to render the resilient body water repellant.

In the embodiment seen in Figure 13, the material of the resilient belt which provides definite ranges of resilient movements and for equalization of stresses and strains in the under load is formed of fabric and rubber coated yarns spaced from each other and bonded together under conditions to provide resiliency in the areas of the fields as well as definite ranges of resilient movements as described with reference to Figure 20, the materials of such resilient belt being arranged in a different manner from that seen in Figure 20, with clearance space providing for a definite part of resilient movement approximating one-quarter of an inch.

117 designates a tread having any desired depth and having its formation in transverse section with the sides radially projected with curvature partly around a tensile belt 118, which is resiliently bonded with the inner periphery of the tread 117, by means of a layer of rubber 119 and a breaker strip 120. The inner periphery of the tread 117 is transversely disposed throughout the width of the tread, and the tensile belt 118 is disposed in a similar manner and has its sides forming a tensile support, about the cooperative inner stable resilient support in the sides and on the inner and outer peripheral parts thereof with the terminals 100 thereof in firm retention in the rim field. These terminals 100 are retained in compressive engagement between a transversely divided annulus 101 and an inner band 121 interlocked therewith to prevent relative circumferential movement of such parts.

122 designates a filling between the terminals 100. The tensile belt 118 has an inner facing of rubber 123, which extends into engagement with the band 121 in order to form a water tight bond therewith.

124 designates a resilient belt encompassed by the tensile belt 118 and in definite cooperative relationship providing for constancy of retroactively resilient support and definite ranges of movements in the construction between the rim seating and tread fields.

This resilient belt 124 consists of layers of fabric 125, interposed between transversely spaced and annularly extending rubber coated yarns 126, which are bonded with rubber 127, extending through the weave of the fabric, with proportions, and under conditions as described. A clearance space 128 is formed to provide definite ranges of movements in the resilient belt to represent any desired part of the total movement, any part of which may be provided in the proportionment of the compressible fabric and yarn cooperating with the rubber, in combination therewith as described with reference to other figures.

The clearance space 128 provides for re-

silient movements and other definite conditions as described in proportion to its capacity. The sides of the resilient belt are supported by the sides of the tensile belt. The layer of waterproofing 119 extends around the sides of the tensile belt with the terminals thereof so that the resilient body is coated with water repellant material.

In the embodiment seen in Figure 14, the construction is substantially the same as that seen in Figure 13, except that the layers of fabric and rubber and rubber coated yarn are arranged in flattened arch formation with the altitudes of these arches providing for three-eighths to one-half inch ranges of resilient movements and the abutments being resilient outwardly and inwardly.

129 designates a tread, the inner and outer peripheries of which are in flattened arch formation, and the inner periphery thereof is concentric with a tensile belt 130, to which it is resiliently bonded by means of a facing of rubber 131 and a breaker strip 132. The sides of the tensile belt 130 are curved about the resilient supports and abutments in the sides to form terminals 133, which are in compressive engagement between a transversely divided annulus 134 and an annular band 135 interlocked therewith to prevent relative circumferential movement of such parts.

136 designates a filling between the side terminals 133. The layer of waterproofing 131 extends around the sides of the tensile belt to the terminals in order to render water repellant the resilient body. The inner face of the tensile belt 130 is coated with a layer of rubber 137, which extends to the terminals and into engagement with the annular band 135 in order to form a water tight seal at such place.

138 designates a resilient member formed of layers of fabric 139 and rubber coated yarns 140, which are arranged in arch formation on opposite sides of the major transverse axis of the construction, and elastic material 141, such as rubber, surrounds the rubber coated yarn and is bonded through the layers of fabric 139, providing for resiliency and definite ranges of movements and stability as described. A clearance space 142 is formed within the resilient cushion 138 which is shown as preferably of elliptical formation in order to provide a definite part of resilient movement and clearance for the flexures of the material, it being understood that the tensile belt and the resilient belt cooperatively have stable supporting capacities and provide definite ranges of resilient movements, in the construction, to resiliently equalize thrusts and reactions.

In the embodiment seen in Figure 15, 143 designates a radially projected tread resiliently bonded with a tensile belt 144 by means of a layer of rubber 145, and a breaker strip 146. The inner periphery of the tread 143 is in arch formation throughout the width of the tread zone, and concentric with the outer periphery of the tensile belt 144 which is also arranged in arch formation in the fields of the planes of the construction and has its sides curved inwardly forming annular tensile and resilient abutments and truss formation in the sides between the outer tensile fields of support and the rim seating and terminating in terminals 147, which are maintained in compressive engagement between the transversely divided annulus 148 and an annular band 149 interlocked therewith in any desired manner to prevent relative circumferential movement with respect thereto.

150 designates a filling between the terminals 147. The layer of rubber 145 extends around the sides of the tensile belts 144 to the terminal seatings to render the resilient construction water repellant. The inner face of the tensile belt 144 is provided with a coating of rubber 151 which extends to the terminals 147 to form a waterproof union with the annular band 149.

152 designates a resilient belt which instead of being formed of rubber coated yarn is shown as being formed of layers of fabric 153 and layers of rubber 154 which latter is bonded through the fabric. The layers of fabric and rubber on the opposite sides of the major transverse axis are disposed in flattened arch formation, and inclose a clearance space 155, preferably of elliptical formation and extending transversely throughout the greater width of the tread zone with adequate capacity in clearance to provide for the equalization of stress and strain of movements for resilient equalization of thrusts and reactions.

It will be evident that the area capacities of the fields of planes of construction can be increased to any desired extent by increasing the width in transverse section or by increase of circumferential length or in both such ways or by using a multiplicity of units of such construction for providing increase of capacities.

It will be further evident from all the embodiments shown herein, that the definite ranges of resilient movements and equalization of stress and strain in the areas of the fields of planes, will hereunder be effectually provided for by suitably formed proportions and disposed clearance or areal disposed cellularity in proper proportions or by equivalent porosity in stable elastic material or by using uniformly distributed relatively compressible material in proper proportions with elastic rubber.

In Figure 16 a transversely elongated annular resilient cushion 157 is shown in transverse section formed of open weave fabric and rubber with an annular tensile reinforcement 158 approximately in the ma-

jor transverse axis and with semi-elliptical clearance spaces 159 and 160 on the inner and outer peripheral parts of the resilient cushion extending across such portions and the vertical axis 156 thereof, with curvatures to the inner and outer peripheral portions thereof into support with the inner peripheral portions of transverse planes of the tension member 121 towards or in proximity to the vertical axis of the curvatures at the sides inwardly and outwardly of the major transverse axis 95. The tensile reinforcement may be of suitable flexible metal or other material and be inextensible circumferentially so that fluid pressure may be used in the spacement 159 against the inner periphery of the resilient cushion with any desired degree of pressure in such part without developing resistance to resiliency outwardly of the major transverse axis 95 or fluid pressure may be employed in the clearance spaces 159 and 160 both inwardly and outwardly of the major transverse axis by providing radial passageways 161 between the same.

Such clearance spaces are inclosed and made fluid tight in any preferred manner and this can be readily effected by facing the resilient cushion on its inner and outer peripheries with rubber 162 and 163, and by securing thereon a fluid tight annular belt of fabric and rubber 164, which may be as a unit member secured to and fluid tight with the annulus 121 or detachable therefrom with a valve 165 secured thereto and passing therethrough.

The fabric and rubber construction may be dividid on one or both sides at 166 or 167 on the line of the major transverse axis 95 so as to be readily constructed and applied to or removed from the resilient cushion. Furthermore it may be divided on the outer periphery part at 168 so as to be slipped over the resilient cushion. Such construction will make the inner clearance space 159 fluid tight and as this spacement will be immune from puncture or injuries, fluid means can always be maintained in such clearance space in case the outer clearance space shall not contain fluid under pressure and passageways 161 shall not be employed. In case they shall be used the meeting ends can lap each other, with or without sealing or even be left free to form a fluid tight seal against the rubber facing 123, see Figure 13, on the inner periphery of the tension belt.

The valve organism as shown provides for connecting the fluid tight spacement on the inner periphery through the inner field of support to pumping organism, and 169 represents a cofitting locking part to engage in a suitable recess or part of the transversely divided annulus 101, as shown in Figure 13, and as otherwise represented in Figures 14 and 15 and others of the drawings.

Such annular resilient cushion and cooperative parts as shown in Figure 16 are adapted for use in an annular body of resilient tension construction, having an annular tension belt with formation as shown in Figure 13, or, if desired, with annular tension belt formation as shown in Figures 14 and 15 with or without slight differences in curvature in the outer peripheral parts to better conform to the curvature from across the body to the curvatures in the sides in proximity to 94, as shown in Figures 14 and 15, whereby the curvatures in proximity to the vertical axis 94 of the curvatures in the sides and therefrom towards and across the vertical axis of the construction can be constantly supported to the lines 94 and to any desired degree inwardly therefrom along the line of curvature of the tension member towards the vertical axis of the construction.

The tread in all the embodiments is adapted to have its road contacting surface provided with relatively incompressible material and in Figures 9, 10, 12 and 14 such construction is illustrated. In Figure 12 the tread 104 is provided with a flexible metal band 170 having lugs 171 interlocking with the body portion of the tread 104 or seating or aligning members 172 therein, whereby such metal band is relatively incompressible in contact with the road, resiliency being obtained inwardly thereof with definite ranges of resilient movements of one-quarter to three-eighths of an inch in the annular portions of the construction between the inner and outer inextensible parts. In Figure 14 a belt 173 of metal is shown which is flexible and provided with lugs 174 interlocking with the body portion of the tread 129. This belt is disposed across the vertical axis 156 to a desired extent laterally towards the lines 94, whereby such portion of the tread possesses great resistance to wear and great capacity for load without interfering with the resiliency of the construction, and also provides for maintaining greater wearing capacity in the material lying in the vertical axis and maintaining the contour of tread surface substantially constant during the life of the tread, and thereby a greater constancy of resilient action on both sides of the vertical axis of construction.

In Figures 17 and 18, the curvatures in the sides of the construction are shown of greater depth laterally from lines 94 than the distance between the major transverse axis and the transverse planes of such curvatures in their greatest depth or in proximity to lines 94. The curvatures of the tension belt across the body outwardly of the major

transverse axis between the curvatures at the sides has an altitude of approximately three-sixteenths of an inch relatively to the transverse planes tangent to the arcs of the curvatures at the sides. The curvatures at the sides are shown extending inwardly to the inner portion lying tangent to the arcs of such curvatures with terminal parts inwardly of lines 94 in Figure 17 secured between an inextensible annulus 175 and a transversely divided extensible annulus 176 cooperating with annular locking rings 177 over the lines 94 with flanges disposed outwardly substantially tangent to the arcs of the curvatures at the sides.

In Figure 17 the flanges are disposed outwardly while in Figure 18 the corresponding flanges or rings 177 are disposed inwardly forming clincher rings 186. The tension terminals 178 of the belt 179 curve inwardly about the ends and into seating on the inner portion of such clincher rings where they are firmly held in compression by the transversely divided annulus 180, which provides the requisite width of support and compression of the inner portions of the terminals against the clincher rings providing inextensibility. The terminals of the tension belt are further secured in position by the resilient belt 181 extending across the body into resilient support with the curvatures at the sides of the tension belt and to or inwardly of lines 94 towards the vertical axis 156, and otherwise by the annular support 182 between the terminals and in compressive and locking engagement with the extensible annulus 180.

The resilient belt 181, in Figure 18, corresponds substantially to that seen in Figure 15 except that the clearance space 183 extends outwardly of lines 94 and the outer contour is adapted to conform to the inner periphery of the chamber formed by the tension belt 179 and the annular support 182. Means are shown in Figure 18 providing for the insertion, if desired, of fluid or mobile content under any desired degree of pressure. The tread may have the depth thereof increased as desired as shown by the dotted line. The width of the tread in all the figures is indicated approximately by lines 94 which also approximately indicate the vertical axis of the curvatures at the sides. The tread between lines 94 is substantially of uniform width and depth between such lines 94 whereby constancy of tread wearing surface is obtained throughout the depth of tread wear.

The resilient belt 184 in Figure 17 conforms to the inner periphery of the chamber formed by the inner periphery of the tension belt and the inner seating member 185 on the transverse lines. Otherwise the resilient belt in Figure 17 corresponds substantially to that seen in Figure 16, the curvatures in formation in the outer part being carried inwardly of lines 94 to balance up with the curvature in the tension belt and provide definite ranges of resilient movements in such part of the construction. The curvatures across the field have an altitude to the plane of approximately three-sixteenths of an inch and provide a range of resilient movement of approximately three-sixteenths of an inch to the plane, and resiliency of greater range inwardly thereof under excessive strains. The portion of the construction inwardly of the major transverse axis provides approximately the same range of resilient movement and a total range of three-eights of an inch altitude may be obtained on the vertical axis of the construction.

In Figure 17 the resilient belt 184 corresponds substantially to that seen in Figure 16, except that the curvatures at the sides exceed one hundred and eighty degrees and the curvatures correspond to the inner periphery of the tension belt. In Figure 16 the curvatures are balanced to the plane while in Figure 17 curvatures on transverse lines are shown.

In the embodiment seen in Figures 19 and 20, I have shown lines of formation which indicate more clearly the construction and operation of my invention. In Figure 19 the tension belt and the terminals as shown in full lines correspond substantially to that seen in Figure 17, except that a preferred form of transversely divided annulus is shown in compressive engagement with an annular band corresponding to the band 175 seen in Figure 17. In Figure 20 the full lines indicate a construction of tread, tension belt and terminals, corresponding substantially to that seen in Figure 18, in which a clincher ring is employed, but the transversely divided annulus 188 in Figures 19 and 20 is provided at each side with an outwardly extending flange 189 and laterally extending flange 190. The inner face of the outwardly extending flange lies substantially on the line of the vertical axis 94, and with the flange extending laterally in the plane or, if desired, with curvature as indicated by dotted line 191 to any desired extent towards the major transverse axis. It will be seen that by such construction of transversely divided annulus the same may be employed with straight side terminals as shown in Figure 19 or with a straight side clincher as seen in Figure 20.

In Figure 19 the terminal is rendered inextensible by the annular band 192 and in Figure 20 the terminal is rendered inextensible by the clincher ring 193, it being understood that the transversely divided annulus 188 is brought into compression with the terminal seatings 194 and 195. The annular band 192 preferably interlocks with the transversely divided annulus as herein set forth in connection with the other figures.

The transversely divided annulus is in alignment on the felly band 196 and interlocks therewith transversely, by means of a lug 197 interlocking with a recess 198 on the inner periphery of the transversely divided annulus. The felly band is provided with a flange 199 engaging the transversely divided annulus to prevent lateral movement in one direction, the lateral movement in the opposite direction being prevented by a ring or clip 200, having a laterally extending flange 201 adapted to be driven between the felly band and the transversely divided annulus, said ring 200 being secured in position with respect to the felly 202, by means of a fastening device 203. By securing the transversely divided annulus in position in this manner the same is expanded to a slight degree and the compression on the terminals is increased. The parts are thus interlocked so as to positively prevent any relative lateral or circumferential movement. The curvatures in the sides of the construction from the vertical lines 94 outwardly therefrom, are indicated by the full lines 204, which define the inner and outer peripheries of the curvatures of the tension belt at the sides. These curvatures at the sides outwardly of the lines 94 exceed one hundred and eighty degrees as shown in full lines, and these curvatures extend inwardly of the major transverse axis and inwardly of the lines 94 towards the vertical axis 156 in close relationship to the transverse plane, and through the terminals 194 and 195 into support with the transversely divided annulus 188 and the inextensible member or support cooperating therewith such as the band 192 or the clincher ring 193. With the curvatures as shown in full lines a range of resilient movement to the transverse plane is provided representing a range of resilient movement approximating three-sixteenths to one-quarter of an inch or more, if desired, in the construction outwardly of the major transverse axis. The lines 205 and 206 indicate transverse planes tangent to the arcs 207 and 208 respectively, showing the difference in altitude which takes place between the planes tangent to the arcs. The curvatures from such arcs across the body provide the additional range of resilient movement desired in accordance with the standard set. It will be evident that the movement in the portion of the construction tangent to the arcs at the sides may be varied to provide any additional range of resilient movements up to the required standards by variation of the arcs of the curvatures at the sides, so that the curvatures across the body may be relatively small and eliminated if desired, so that the tension belt across the body may have a curvature between lines 94 providing for a minimum amount of resilient movement or in any balancing ratio to the range of movement relatively to the transverse plane between lines 94. The dotted lines 209 indicate the curvature of one hundred and eighty degrees outwardly of lines 94 with the vertical axis of the curvature on such lines 94, and with the curvature across the body approximately as shown in full lines 210 as indicating the full lines of the tension belt, as clearly indicated also in Figures 13, 14 and 15, except that in Figure 13 the tension belt is disposed in the fields of transverse planes between the lines 94. The full lines 211 and 212 indicate clearance space in the resilient belt on each side of the major transverse axis, as also seen in Figure 18, it being seen that the clearance space is extended laterally to a slight extent beyond the lines 94. The dotted lines 213 and 214 indicate the clearance space terminating approximately on lines 94 whereby an increased field of support for the curvatures of the tension belt at the sides is provided, as also clearly indicated in Figure 14.

This clearance space provides for the equalization of the stresses and strains and definite ranges of resilient movements in the transversely disposed parts of the construction and the curvatures in construction at the sides in balancing ratios to resilient movements in annular portions of the construction. With the clearance space as indicated by lines 211 to 214 inclusive, the resilient support at the sides and across the body and at the inner and outer periphery of the tension belt and the rim field, is universal and universally resilient, as will be clearly understood by reference also to Figures 14, 15 and 18. The dotted lines 215 and 216 define the annular belt of resilient support extending across the body into resilient support with the curvatures of the tension belt at the sides and to the inner and outer peripheries thereof to the lines 94 and to the desired extent inwardly thereof towards the vertical axis, the curvatures in the construction being slightly different from those shown in Figure 17, and conforming to the arcs in the curvatures in the sides as already described. The clearance spaces provide for relative free movement of the tension belt between lines 94 and the fields of planes to the supports at the sides. The construction as defined by the dotted lines conforms to that seen in Figures 16 and 17 except as to a slight variation in the curvatures. The tension belt between lines 94 provides stable support for the construction in annular portions, and for the distribution and equalization of stresses and strains inwardly thereof and about the annular portions whereby stable support for the movements inwardly thereof is provided, and the tensile strength in the tension belt between lines 94 is in excess of load preferably in the ratio of six or ten to one of load. The tread is supported on the outer periph-

eral field of the tension belt which is transversely disposed in or in close relationship to the transverse lines, and radially projected as shown, so that any desired depth of tread wear may be obtained as indicated by the full and dotted lines 217 and 218 respectively. The dotted line 219 indicates the contour of a round tread which indicate the same as employed, the vertical axis of which is well within the circle shown by dotted line 220 representing the dimension of the construction. By such construction I am enabled to reinforce the same to any desired extent without setting up any counter-strains in the construction, for example, the reinforcements may be on or in proximity to the major transverse axis as shown in Figures 1 to 11 inclusive, or as indicated in Figures 16 and 17 or the reinforcement may be in or in connection with the tension belt as seen in Figures 13 and 15 or the reinforcements may be in the outer field of tread as shown in Figures 9, 10, 12 and 14.

The tensile strength of the tension belt may be increased by metal or other bands 221, as shown in Figure 13, or by wires or cables 222, as shown in Figure 15, such parts 221 and 222 being preferably inextensible.

For the purpose of more clearly setting forth the operation of my invention under load, the same may be considered as consisting of one or more resilient parts of relatively low internal resistance or load capacities per degree of length and width and transversely disposed between inner and outer annular parts, likewise transversely disposed, the construction of which is such that the inner parts are substantially inextensible circumferentially.

The cushioning part may be provided with fluid content under any desired degree of pressure, and all of such parts are transversely disposed and firmly secured in a unit of structure with the rim equipments, the outer part being transversely disposed in the planes and forming or having secured thereto a tread wearing surface of any desired construction, but preferably with a radially extending or projected body.

The resilient or cushioning part or parts in a unit of structure with the cooperating elements provide a constant resilient load capacity and a determined range of altitude for resiliency. The standards of such load capacities per degree of length and width of the construction may be in the ratios of one-twentieth to one-twenty-fifth to one-ninetieth of any determined load, with altitude of radial movement of resiliency of approximately one-quarter to three-eighths of an inch. Such range of radial movement is equivalent to the difference between the altitude of the chord and arc lines of twenty to twenty-five degrees in length annularly of the tread surface, or in other words in the field of impact in contact with the road, which is equivalent to a drop substantially one-quarter to three-eighths of an inch between the axis of thrust which is the horizontal axis of the wheel and the field of impact which is the road surface.

This drop in the construction of one-quarter to three-eighths of an inch is indicated in dotted lines on the drawings in Figures 1, 4, and 11, by reference characters 1/4 and 3/8. The degrees of the construction are shown by radial dotted lines 96 spaced five degrees apart. The movement of one-quarter of an inch in such construction is indicated by the dotted line 97. The range of relative movement of the parts representing one-quarter of an inch resilient altitude is indicated by the lines 98 and 99, the normal position of the parts being indicated by full lines.

The length of road contact, under a resilient altitude of one-quarter of an inch, is indicated by the arrows 102, and the length of road contact circumferentially under a resilient altitude of three-eighths of an inch is indicated by the arrows 103. The altitude of the curvatures in transverse section are substantially in balancing ratio to the resilient altitude and to the flexures in the annular planes.

The flexures in the outer portion of the resilient wheel equipment will be towards the transverse planes of the construction, along the planes of road contact, between the lines 94, which denote the width of the tread and otherwise across the width and annularly with suitable standards of resilient internal resistance and tensile support in the construction to support and balance load with ranges of altitude or resilient movements of approximately one-quarter to three-eighths of an inch. These flexures will be in balancing ratio to the altitude and will be mainly towards the planes of road contact, and these flexures will extend annularly toward the horizontal axis of thrust 92 and thereby provide an annular resilient support in approximate ratio to the angularity of the radii 96. The load and opposing thrust are resiliently supported and balanced by the cooperative action of the inextensible tensile belt or belts and the cushion belt or belts, which provide a constant resilient support about the rim portion of the construction. The inextensible tensile belt or belts supporting the tread is thrown in tension by the load thrusts on the rim and seating, and as the tensile belt or belts provide requisite standards of tensile strength with requisite width transversely to support the cushion belt and the load, with large factors of safety, the load is resiliently supported and balanced on a large supporting surface and in a large measure by the tensile belt operating upon the outer and upper portion of

the resilient cushion, whereby excessive tread deflection or variation in altitude is prevented and great resiliency in the construction is provided.

The load on the vertical axis 93 of the wheel may be suspended to any desired degree by insertion of fluid content, under any desired pressure in the transversely disposed clearance space or any suitable elastic, pliable or mobile content can be employed to provide additional resilient supporting capacity or to vary the capacity or standard of resilient resistant capacities in the annular clearance space therefor, which also provides capacity for definite standard ranges of resilient movements or altitude of resiliency.

The internal resistance of the cushioning portion may be increased by the insertion of fluid content or by the employment in said cushioning portion of tensile, flexible, or resilient material such as fabric or spring metal, or a combination of such materials may be employed to provide the desired standards of resilient load balance in construction.

In order to avoid confusion, the range of resilient altitude corresponding to three-eighths of an inch has not been indicated in the transverse sectional views of the different embodiments, but has been indicated in Figures 1, 4, and 11, by the reference character 3/8 which indicates a length of road contact under three-eighths of an inch of resilient altitude as approximating twenty-five degrees in length as shown by the lines 103.

Owing to the flexures of the tread surface toward the transverse planes, such tread surface will be in road contact substantially throughout its width, thus giving a firm grip on the road and thus effectively resisting the side thrust and skidding of the resilient wheel equipment. I am also enabled to employ in the tread relatively hard material, since owing to the manner in which the tread is supported and the standard of resilient altitude which is provided, the enormous counter strains and kneading of the tread material, such as occur in all other types of resilient wheel equipment is eliminated.

The tensile belt encircling the resilient cushioning field, serves resiliently to limit the lateral extension of the sides of the cushioning part proportionately from the portion lying on the vertical radius towards the plane of the axis of thrust.

Owing to the provision of the tensile belt of a definite standard encircling and enclosing a resilient cushioning belt of a definite standard to provide a constancy of range of resilient altitude, the stresses and strains on the construction are uniformly distributed throughout the annular part so that an absolute balance of the load is provided.

The cushioning part may be located inwardly of the tensile part, or both inwardly and outwardly thereof and a plurality of tensile parts and a plurality of cushioning parts may be employed as herein set forth.

It will now be apparent that I have devised a novel and useful construction of a resilient wheel equipment and method of constructing the same, which embodies the features of advantage enumerated as desirable in the statement of the invention and the above description, and while I have in the present instance, shown and described preferred embodiments thereof which will give in practice satisfactory and reliable results, it is to be understood that the same are susceptible of modification in various particulars without departing from the spirit or scope of the invention or sacrificing any of its advantages.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. A resilient wheel equipment comprising an inner annular support, a tension belt having its outer portion transversely disposed substantially on transverse section lines parallel with the major transverse axis of the belt, with curvatures at the sides of approximately one hundred and eighty degrees, and with seating parts secured to said support, a resilient belt within said tension belt and extending into resilient support with the curvatures at the sides, and a tread encircling said tension belt.

2. A resilient wheel equipment comprising an inner annular support, a tension belt having its outer portion transversely disposed substantially on transverse section lines parallel with the major transverse axis of the belt, with curvatures at the sides of approximately one hundred and eighty degrees, and with seating parts secured to said support, a resilient belt within said tension belt and extending into resilient support with the curvatures at the sides, and a tread encircling said tension belt, and having its width approximately the same as the distance between the vertical axes of said curvatures.

3. A resilient wheel equipment comprising an inner annular support, a tension belt having its outer portion transversely disposed substantially on transverse section lines parallel with the major transverse axis of the belt, with curvatures at the sides of approximately one hundred and eighty degrees, and with seating parts secured to said support, a resilient belt within said tension belt and extending into resilient support with the curvatures at the sides and having a clearing space approximately equalling in width the distance between the vertical axes of said curvatures, and a tread encircling said tension belt.

4. A resilient wheel equipment comprising an inner annular support, a tension belt having its outer portion transversely disposed substantially on transverse section lines parallel with the major transverse axis of the belt, with curvatures at the sides of approximately one hundred and eighty degrees, and with seating parts secured to said support, at points within the vertical axes of said curvatures, a resilient belt within said tension belt and extending into resilient support with the curvatures at the sides, and a tread encircling said tension belt.

JOSEPH S. WILLIAMS.

Witnesses:
H. S. FAIRBANKS,
F. G. WALTERS.