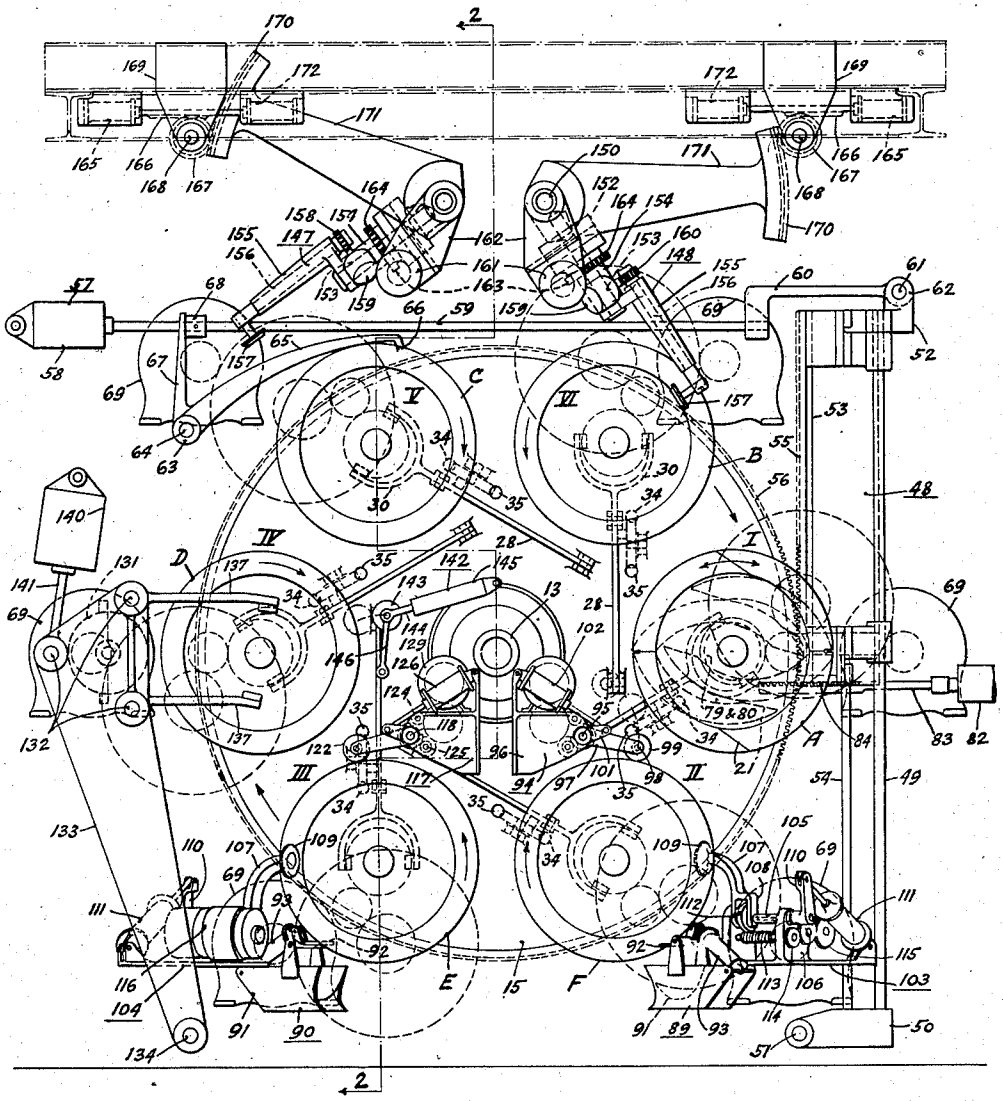
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APPARATUS FOR BUILDING TIRES

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Fig. 1.



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JORGEN I. HAASE

By

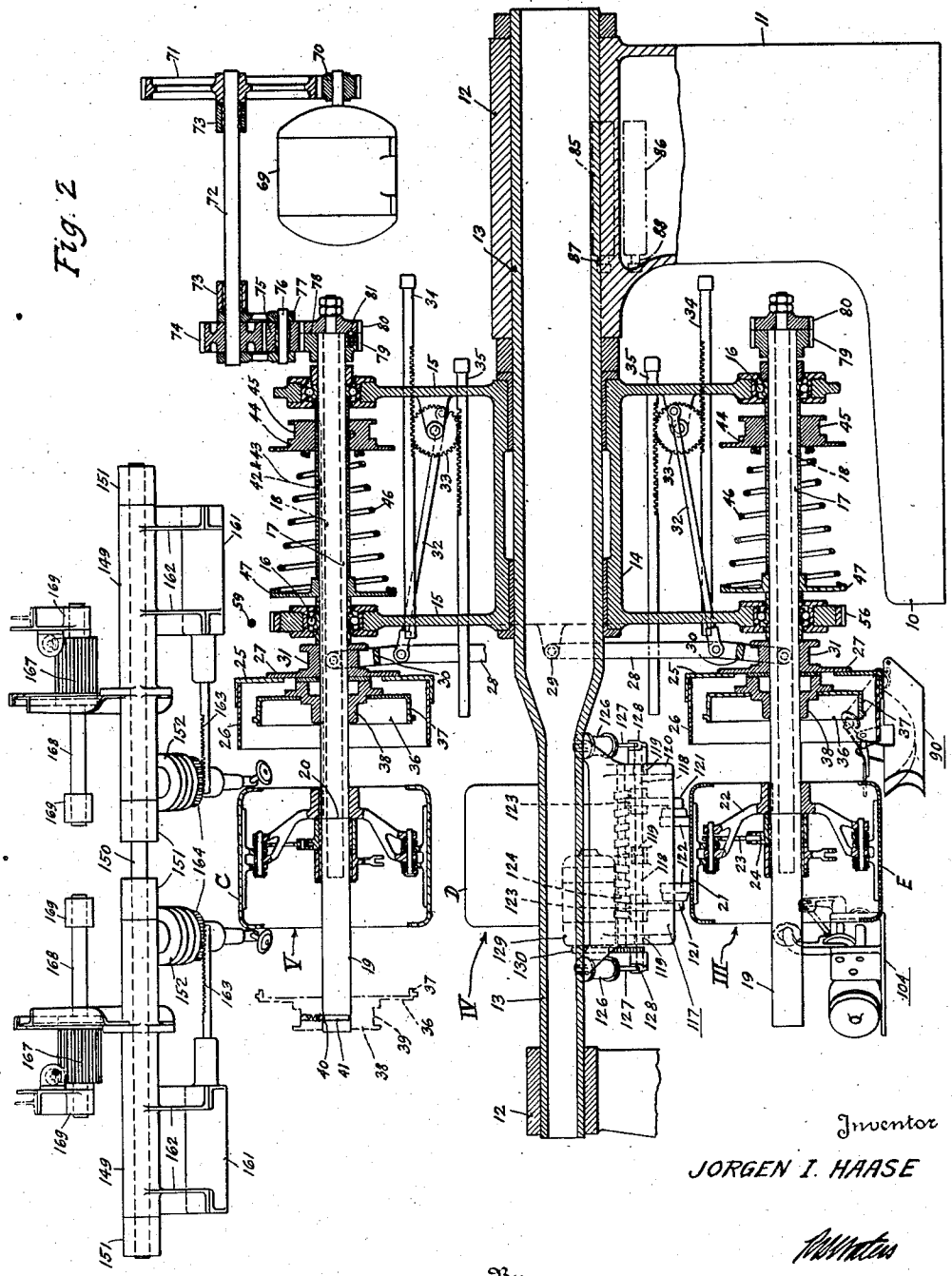
Attorney

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APPARATUS FOR BUILDING TIRES

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Fig. 2



Inventor

JORGEN I. HAASE

By

Attorney

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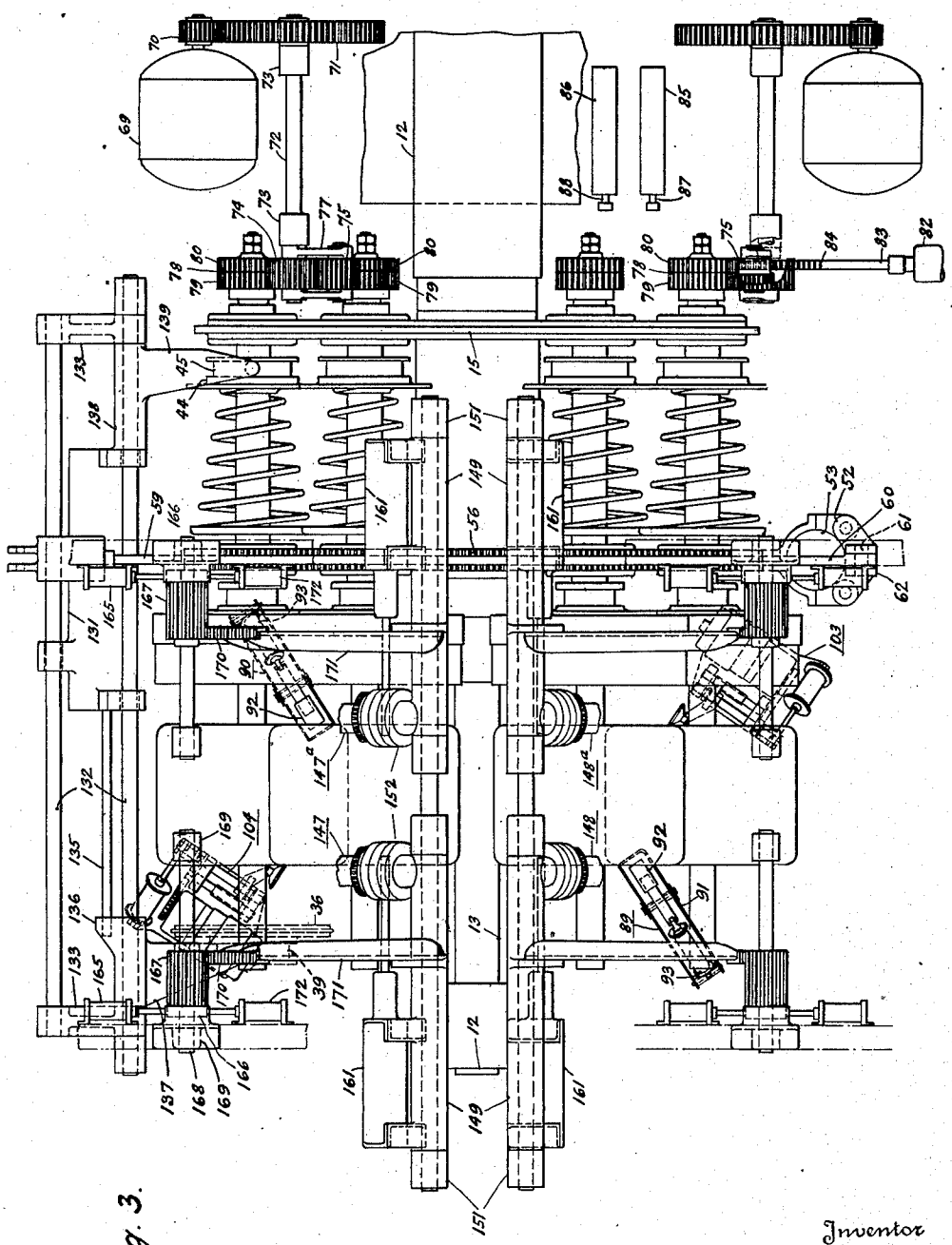


Fig. 3.

Inventor

JORGEN I. HAASE

By

Attorney

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Fig. 4

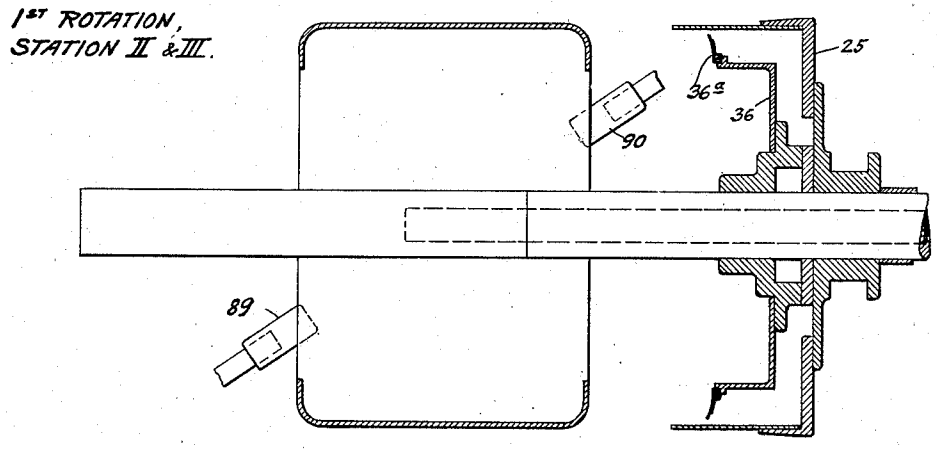
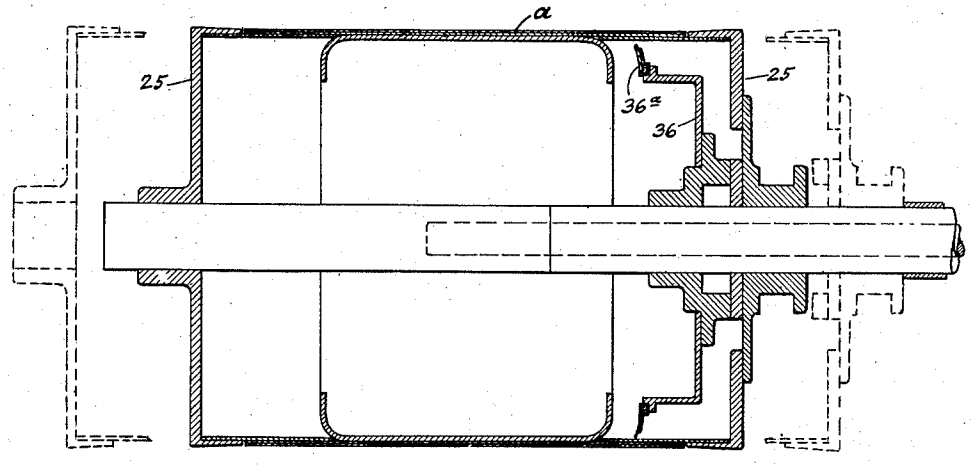


Fig. 5



Inventor

JORGEN I. HAASE

By

Attorney

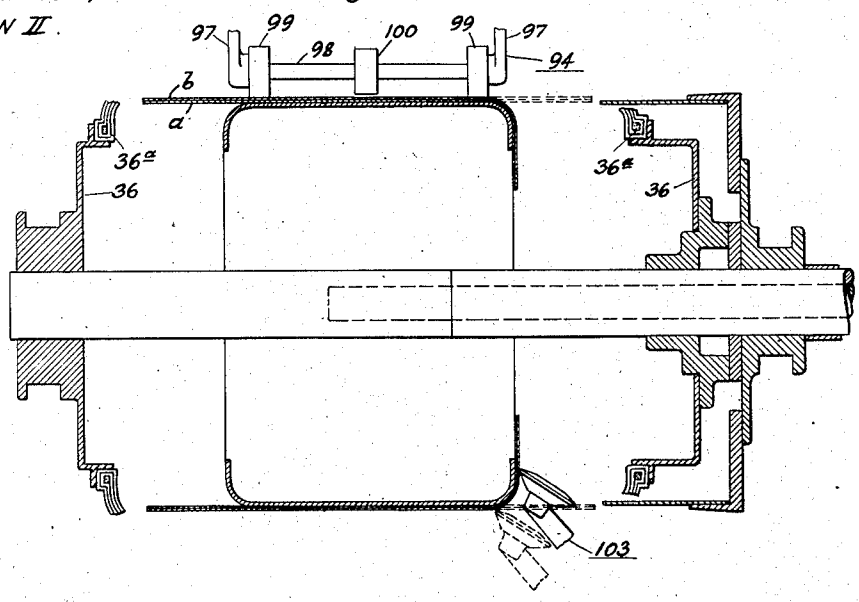
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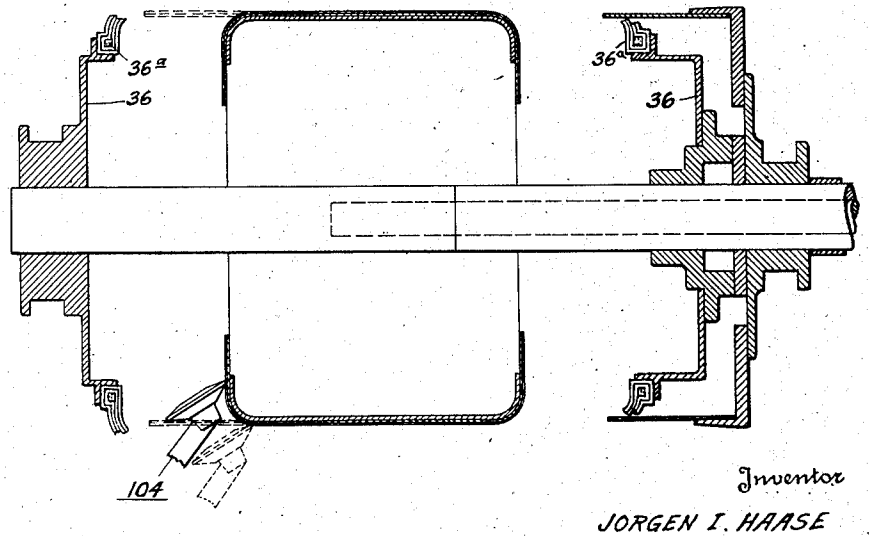
3RD ROTATION.
STATION II.

Fig. 6.



3RD ROTATION.
STATION III.

Fig. 7.



Inventor
JORGEN I. HAASE

By

Attorney

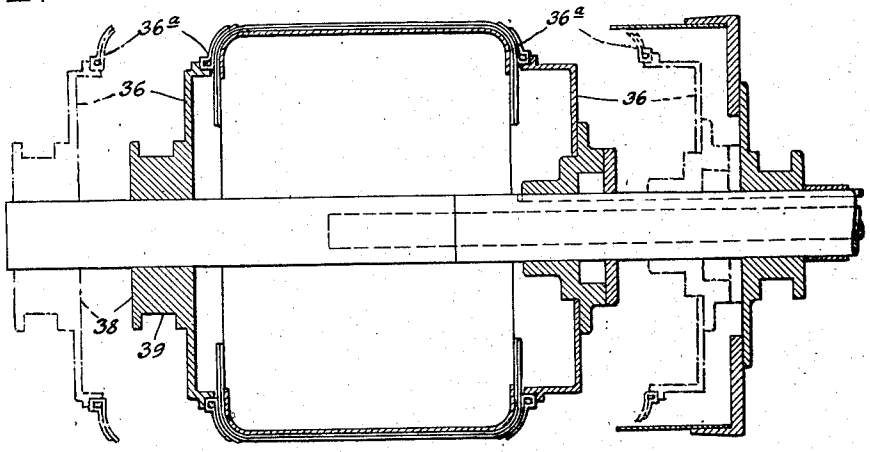
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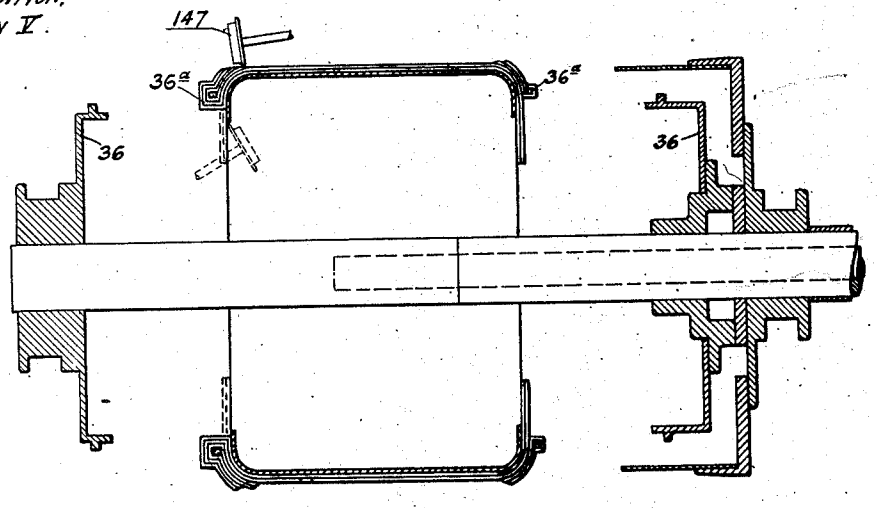
3RD ROTATION, STATION IV.

Fig. 8.



3RD ROTATION, STATION V.

Fig. 9.



Inventor

JORGEN I. HAASE

By

Attorney

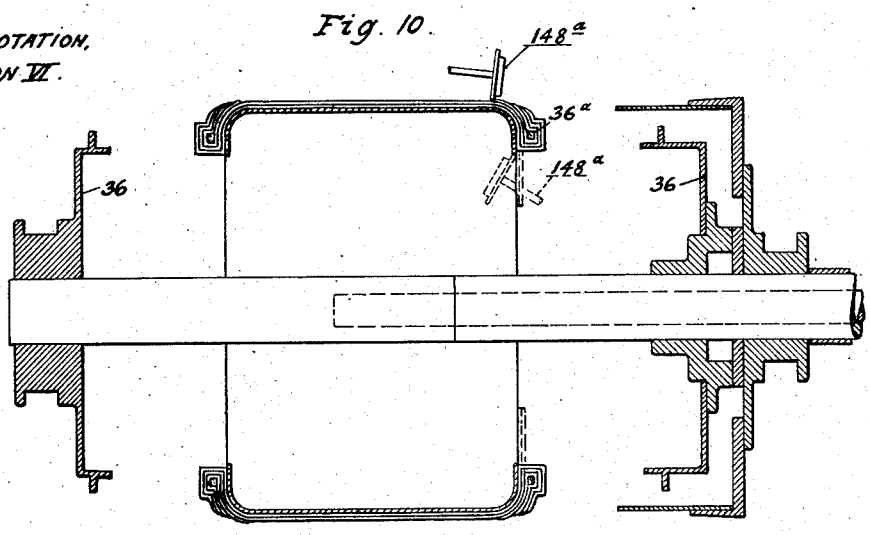
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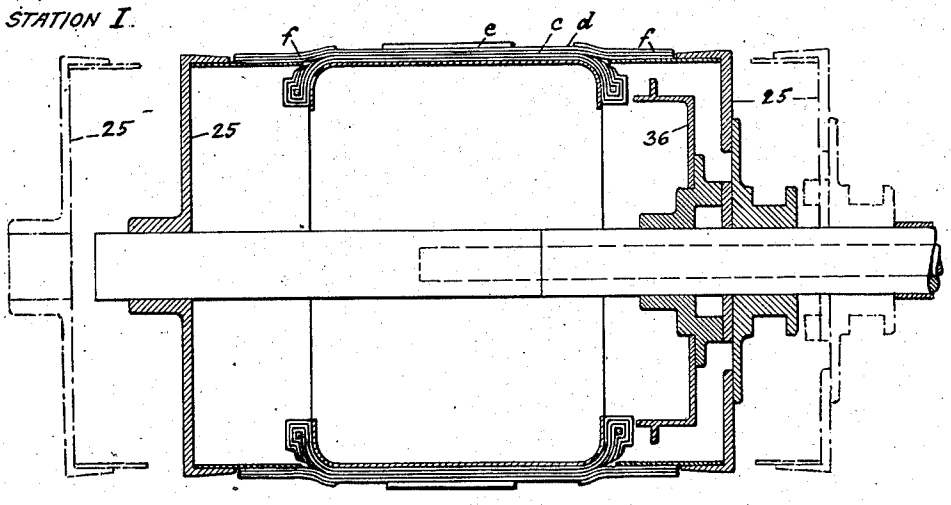
3RD ROTATION.
STATION VI.

Fig. 10.



4TH, 5TH & 6TH ROTATION.
STATION I.

Fig. 11.



Inventor
JORGEN I. HAASE

By

Attorney

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Fig. 12.

6TH ROTATION, STATION II.

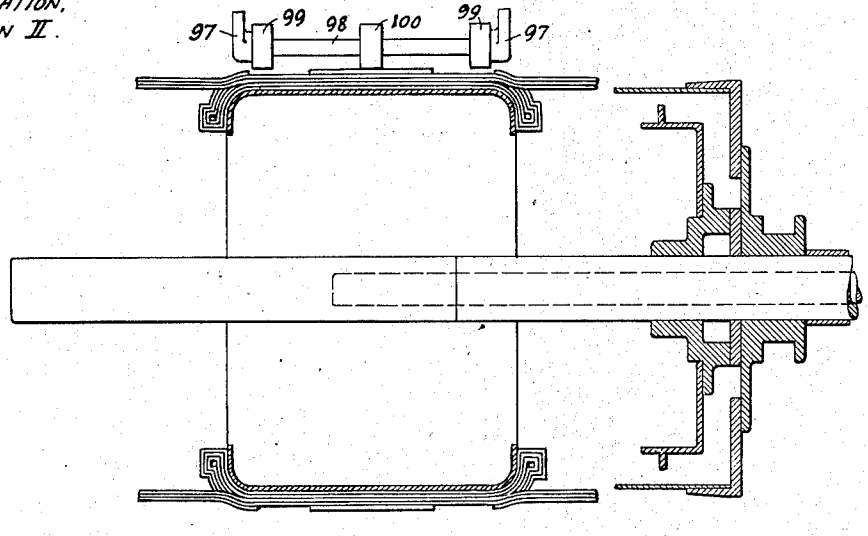
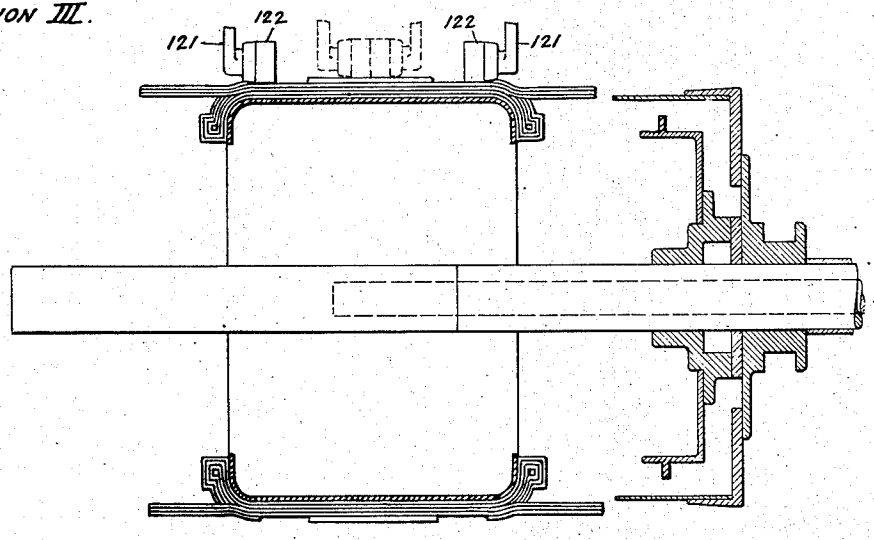


Fig. 13.

6TH ROTATION, STATION III.



Inventor

JORGEN I. HAASE

By

Attorney

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Fig. 14.

6TH ROTATION, STATION V.

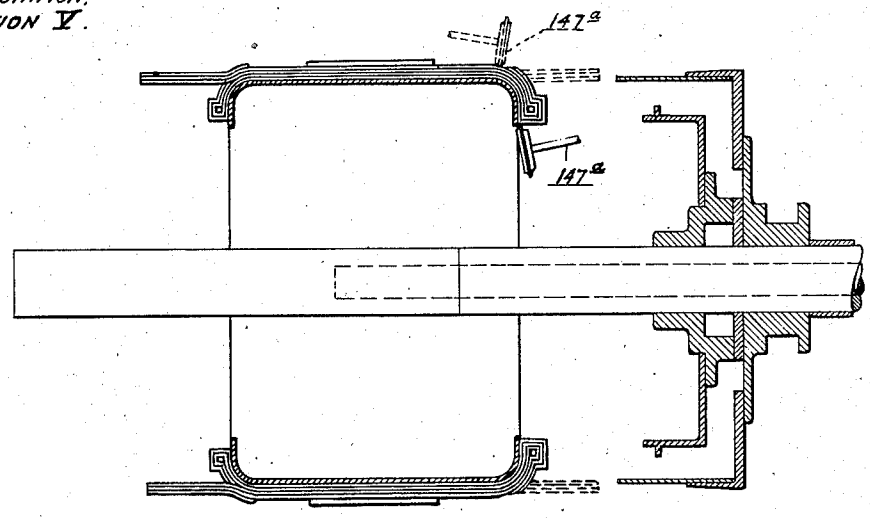
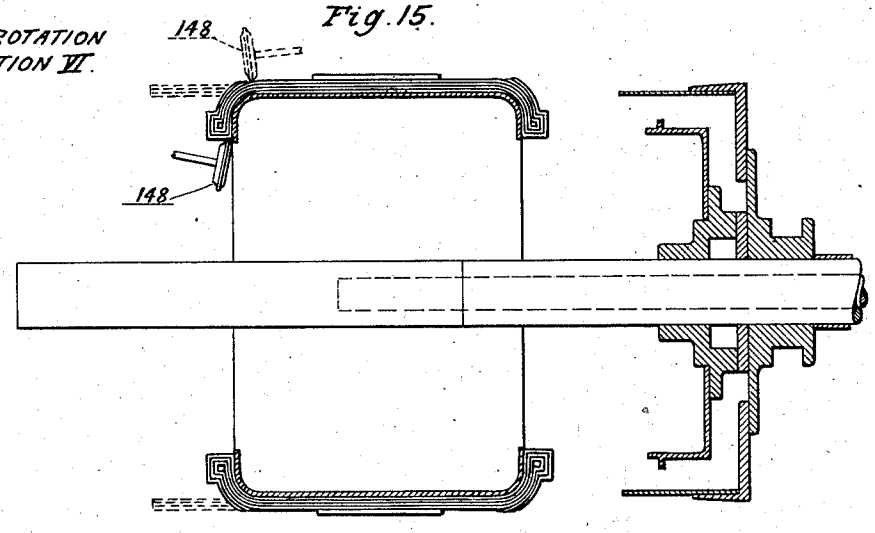


Fig. 15.

6TH ROTATION STATION VI.



Inventor
JORGEN I. HAASE

By

Attorney

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Fig. 16.

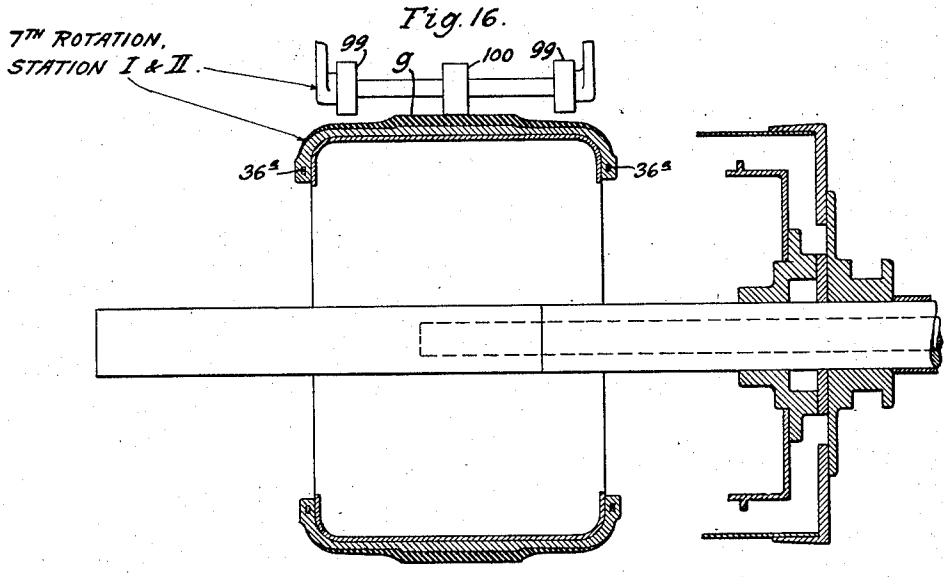
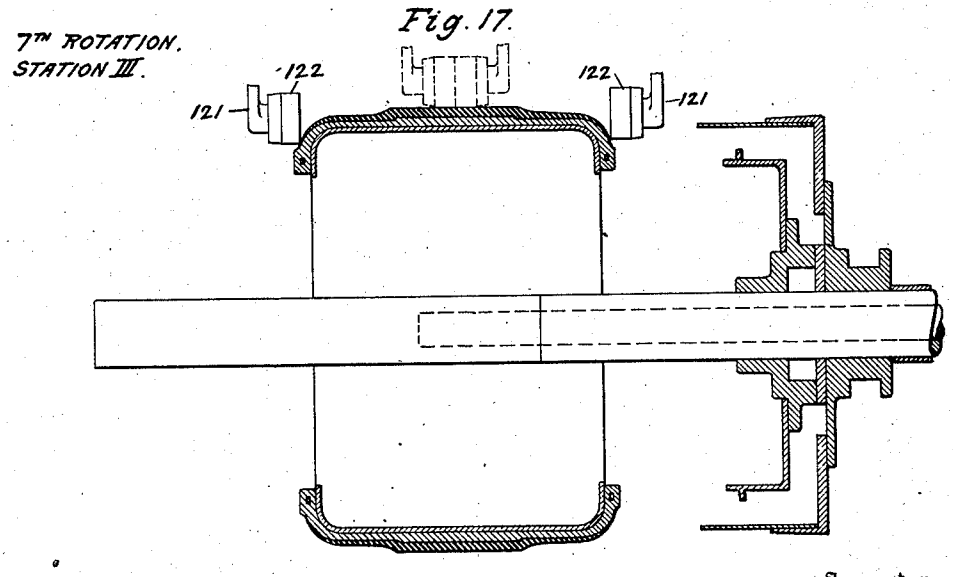


Fig. 17.



Inventor

JORGEN I. HAASE

By

Attorney

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Fig. 18.

7TH ROTATION, STATION IV.

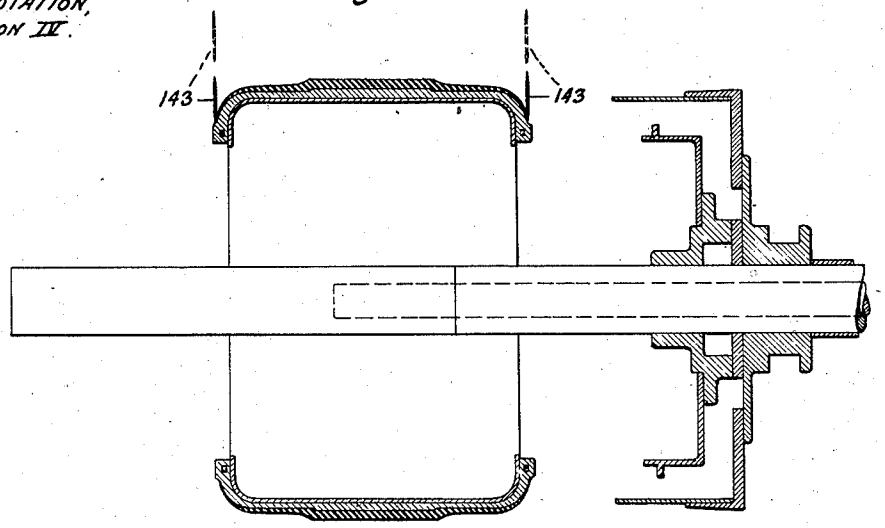
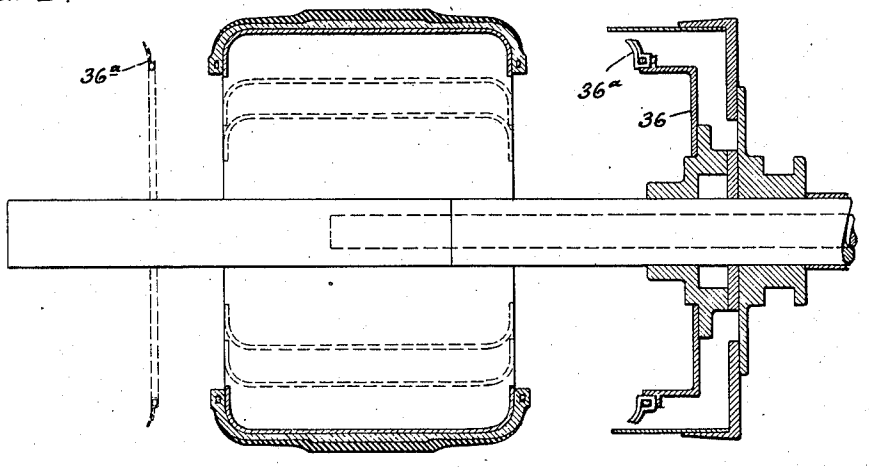


Fig. 19.

7TH ROTATION, STATION I.



Inventor

JORGEN I. HAASE

By

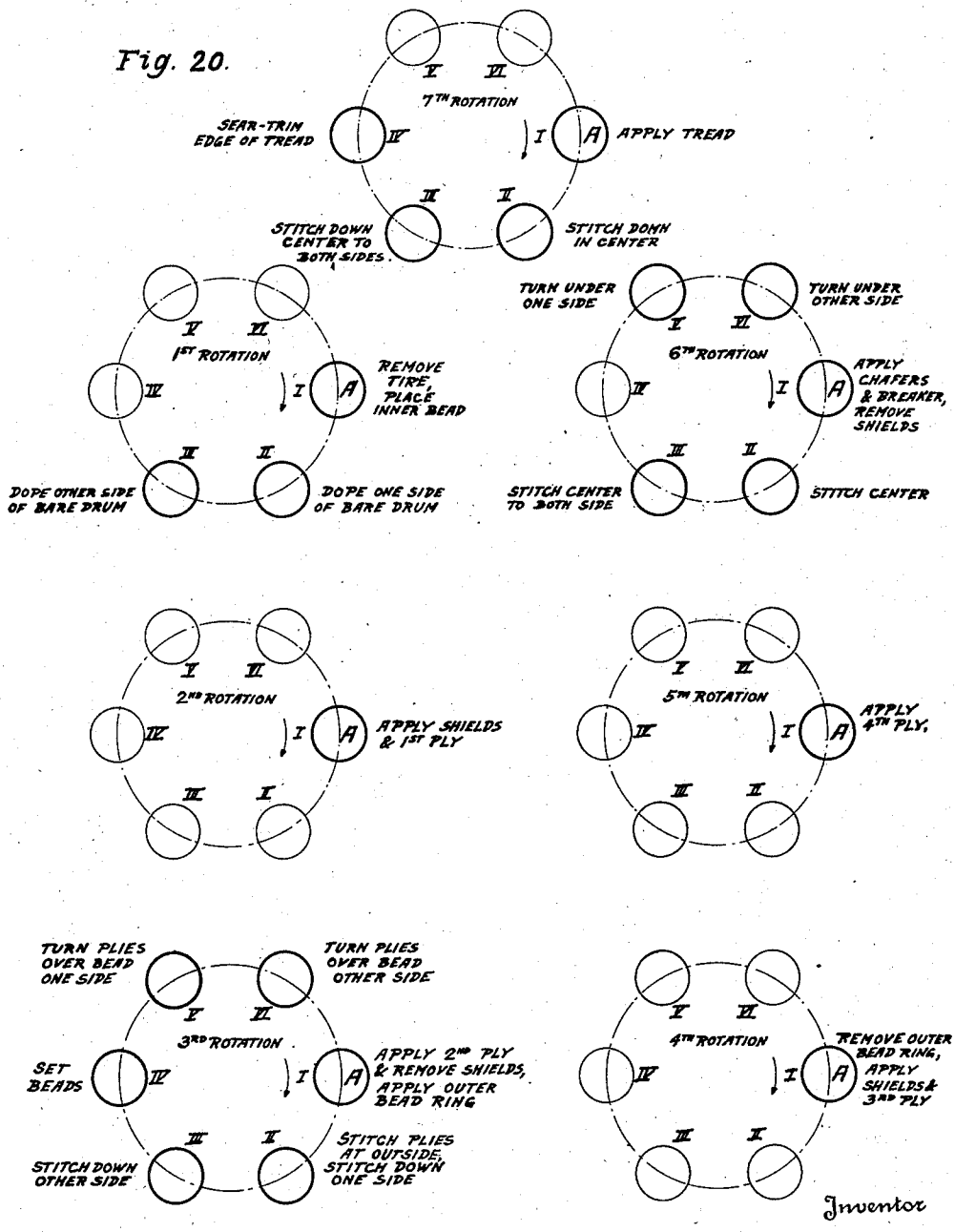
Attorney

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Fig. 20.



Inventor

JORGEN I. HAASE

By

Attorney

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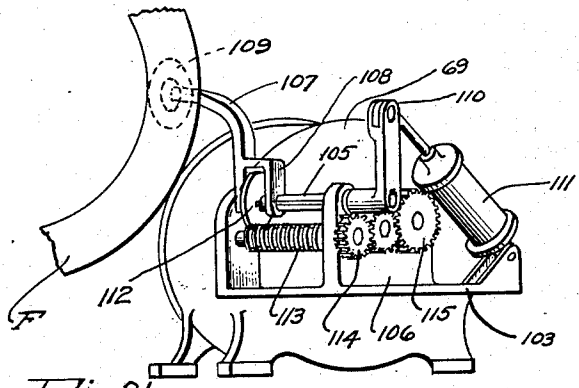


Fig. 21

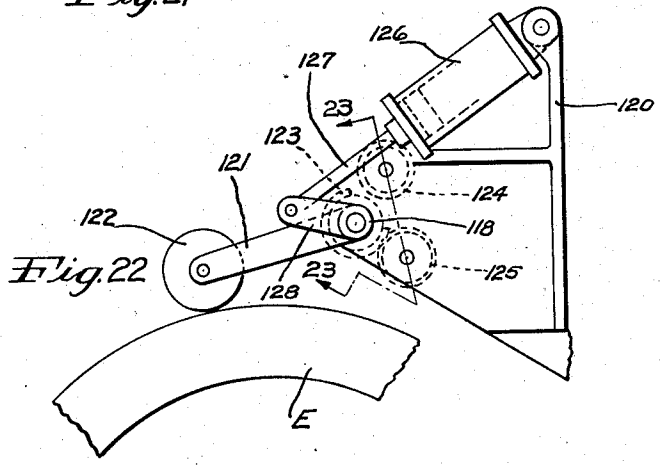


Fig. 22

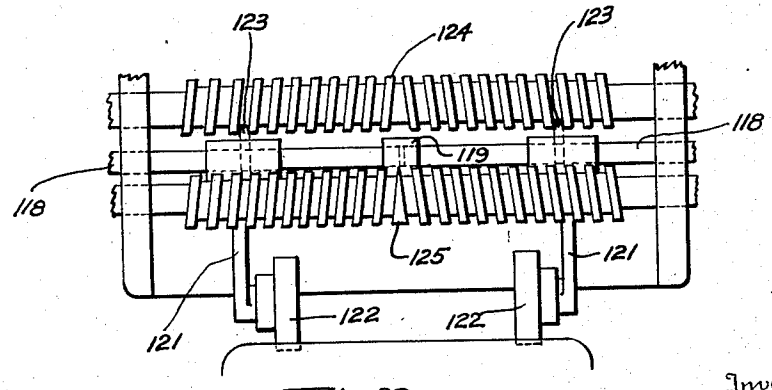


Fig. 23

Inventor
Jorgen I. Haase

By

Attorney

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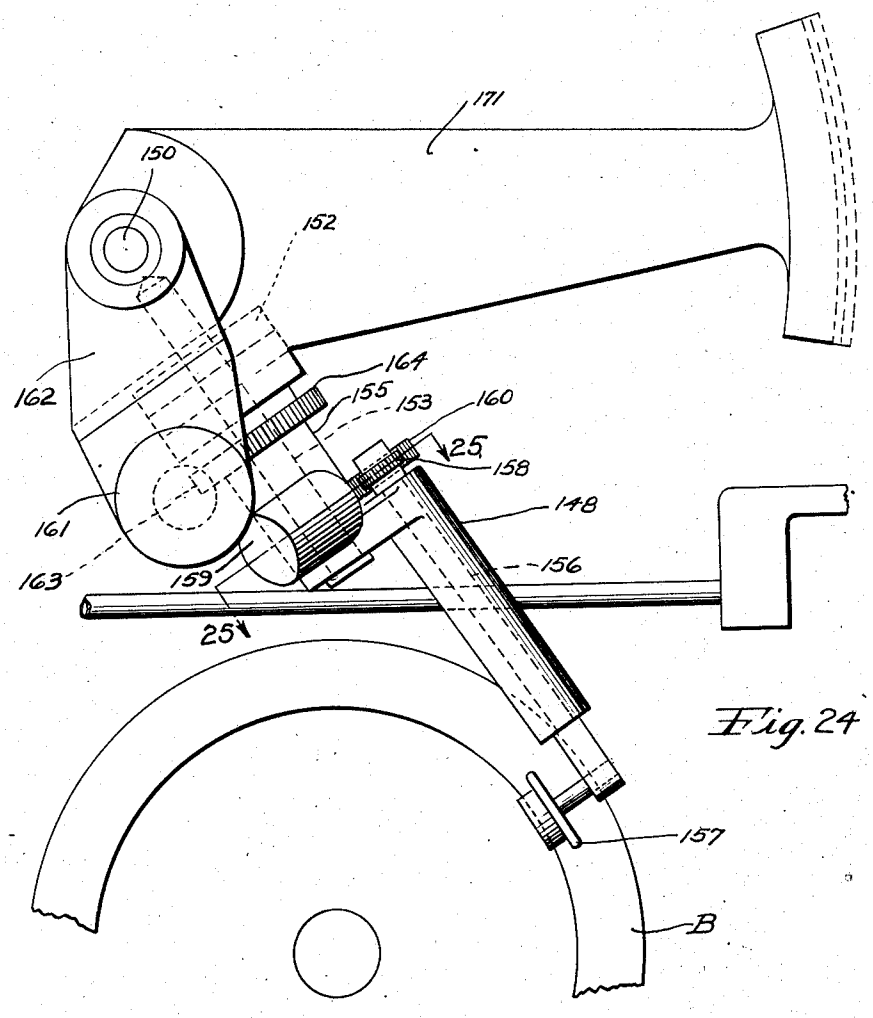


Fig. 24

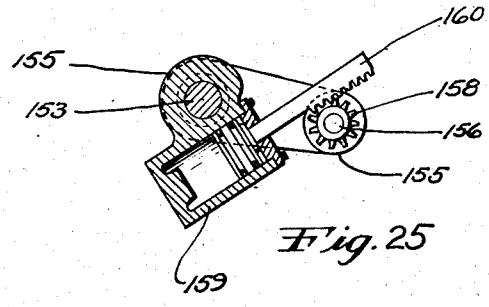


Fig. 25

Inventor
Jorgen I. Haase

By

Attorney

Patented July 16, 1940 2,208,324

UNITED STATES PATENT OFFICE

2,208,324

APPARATUS FOR BUILDING TIRES

Jorgen I. Haase, Akron, Ohio, assignor to Wingfoot Corporation, Wilmington Del., a corporation of Delaware

Application August 5, 1935, Serial No. 34,683

18 Claims. (Cl. 154—10)

This invention relates to the art of building pneumatic tires and it refers more particularly to a novel method and to novel steps in the method of building tires and to apparatus for practicing such method.

Prior to the present invention the commercial manufacture of pneumatic tires has involved a large amount of manual labor which, to a certain extent, is reflected in the uniformity or lack of uniformity of the product. As a result the labor cost is quite high and a large capital investment is necesary for apparatus and factory space to make possible production of tires in large quantities. Numerous attempts have heretofore been made to provide semi-automatic machinery for reducing the amount of manual labor required, but such prior suggestions have given rise to objections for various reasons. The principal objection has been that the suggested machines have performed certain operations automatically while an attendant stood by doing nothing, or else they involved multiple attendant stations wherein each attendant has been dependent upon a number of other attendants for his production schedule. In other words, if anything went wrong at one part of the machine or if one of the attendants was a slow worker all of the other attendants would be thrown out of work or correspondingly delayed.

One of the objects of this invention is the provision of a novel tire-building method and apparatus wherein a tire-building form and a fabricating station are relatively moved into and out of cooperative position with each other a plurality of times during the fabrication of a tire on said form.

Another object of the invention is the provision of a novel tire-building method and apparatus wherein a plurality of tire-building forms and a plurality of fabricating stations are relatively moved successively into and out of cooperative positions a plurality of times during the fabrication of tires on said forms.

Another object of the invention is the provision of a method of fabricating tires in a series of groups or batches and in which the tires of each group are delivered successively at the station where their construction was initiated.

Another object of the invention is the provision of a method wherein the tires in the course of construction are caused to traverse a definite path a plurality of times and to repeatedly be moved to different stations located in such path for various fabricating operations.

A further object of the invention is the provision of a method wherein a series of tire-building forms are moved in an orbital path toward and away from a plurality of stations located in such path for different fabricating operations, the construction and arrangement of the mechanism being such that the forms traverse such path and visit said stations a plurality of times before the tires built on said forms are completed.

A still further object of the invention is the provision of a compact apparatus in which certain tire-building operations are initiated manually at an attendant's station, but in which succeeding operations are performed automatically in a predetermined cyclic order and preferably in timed relation.

With these and other objects in view, as well as other advantages which may be incident to the use of the improvements, the invention consists in the several method steps and elements of the apparatus and combinations thereof, hereinafter set forth and claimed with the understanding that such steps and elements may be varied in order and in proportions and arrangement without departing from the nature and scope of the invention as defined in the appended claims.

In order to make the invention more clearly understood there are shown in the accompanying drawings, means for carrying the invention into practical effect, without limiting the improvements in their useful application to the particular constructions which, for the purpose of explanation, have been made the subject of illustration.

In the accompanying drawings:

Fig. 1 is a diagrammatic side elevation of a tire-building apparatus constructed in accordance with the invention, certain portions of the frame being omitted for the sake of clarity;

Fig. 2 is a diagrammatic vertical section taken approximately on line 2—2 of Fig. 1;

Fig. 3 is a diagrammatic plan of the structure shown in Fig. 1;

Figs. 4 to 19 inclusive are diagrammatic views illustrating the several tire-building operations in the order in which they are performed;

Fig. 20 is a diagrammatic view illustrating a complete cycle of operations necessary to complete a single tire on one of the several forms or drums;

Fig. 21 is a view on a larger scale of the stitching device located at station II;

Fig. 22 is a fragmentary end view on a larger scale of the tread-stitching device located at station III;

Fig. 23 is a fragmentary face view of the same showing more clearly the arrangements of the screws and stitching rolls;

Fig. 24 is an enlarged end view of one of the stitching devices for turning the ply material around the tire beads; and

Fig. 25 is a detail sectional view taken approximately on line 25—25 of Fig. 24.

Referring to the drawings and particularly to Figures 1, 2 and 3 thereof, one form of apparatus constructed in accordance with the present invention is shown as comprising a base 10 formed with pedestals 11 which are provided with bearings 12 in which a horizontally disposed supporting shaft 13 is fixed against rotation. Mounted for intermittent rotation on the shaft 13 is a main carrying structure embodying a hub 14 formed at each end with disks 15 provided with a plurality of bearings 16, herein shown as six pairs, in which tubular shafts 17 are journaled. A rock shaft 18 is journaled for independent rotation within each of the shafts 17 and is formed at its left hand or outer end as viewed in Fig. 2, with an enlargement 19 forming a shoulder 20 abutting the adjacent end of the shaft 17. These shafts together carry tire-building forms or drums A, B, C, D, E and F which may be of any standard or preferred construction, but which may be described as each comprising a plurality of collapsible sections 21 supported by arms 22 fixed to the tubular shafts 17, and links 23 pivotally connected to arms 24 fixed to the enlargement 19 of the inner rock shaft 18. The sections 21 of the drums may be collapsed to permit the removal of a tire and then expanded for a subsequent tire-fabricating operation, by mechanism hereinafter to be described.

Associated with each of the several drums is a pair of supplemental ply-supporting members or drum extensions 25, each comprising a cylindrical portion 26 carried by a hub 27. The member 25 at the left-hand or outer side of the apparatus is slidably mounted on the enlargement 19 of the inner shaft 18 and is removable and operated manually. The member 25 at the right-hand side of the drum is mounted permanently on the outer shaft 17 and is slidable into and out of operative position with respect to the drum by means of a lever 28 which is pivotally mounted on the left-hand disk 15, as at 29, and which is provided with a yoke 30 at its outer end for engagement with a groove 31 formed in the hub 27 of this member. The lever 28 is swung about its pivot by a link 32, one end of which is pivotally connected to the lever 28 and the other end of which is pivotally connected to a gear 33 eccentrically thereof. The gear 33 is journaled on the right-hand disk 15 and is rotated alternately in opposite directions by means of two rack bars 34 and 35 which are sildably mounted in the disks 15. These rack bars are actuated by mechanism hereinafter to be described.

Also associated with each of the several drums is a pair of bead-setting devices 36, each comprising a cylindrical portion 37 carried by a hub 38 and the left-hand one of which is formed with a circumferential groove 39. The device 36 at the left-hand side of the drum is also slidably mounted on the enlargement 19 and is also removable and replaceable manually.

A detent 40 is provided in the hub 38 of the removable device 36 for engagement with a circumferential groove 41 formed on the enlargement 19 so that the operator can determine when the device is in registry with the operating mechanism hereinafter to be described. The inner bead-setting device 36 is mounted permanently on the outer shaft 17 and is slidable into and out of operative position with respect to the drum by means of the following described mechanism. The hub 38 of this inner bead-setting device 36 is fixed to an elongated key 42 which is mounted for sliding movement in a keyway 43 formed in the shaft 17 and which extends along the shaft 17 within the outer circumference thereof and within the hub 27 of the adjacent member 25 and within the adjacent bearing 16. A collar 44 formed with a circumferential groove 45 is slidably mounted on the shaft 17 and is fixed to the extreme inner end of the key 42. A coiled spring 46 surrounds the shaft 17 between the collar 44 and a second collar 47 fixed to the shaft 17 and serves to normally maintain the inner bead-setting device 36 in the retracted position shown.

The main carrying structure is intermittently rotated about the shaft 13 in order to move the several drums successively to and from the different operating stations, by means of a fluid-pressure device indicated generally at 48 (Fig. 1). This device comprises a plurality of guide rods 49, the lower ends of which are fixed in a block 50 pivotally connected by a pin 51 to the main frame structure of the apparatus, and the upper ends of which are connected by a yoke 52. A fluid-pressure cylinder 53 is slidably mounted upon the guide rods 49 and has its piston rod 54 fixed to the block 50 so that when fluid pressure is admitted to either the upper or lower end of the cylinder the same will move downwardly or upwardly, as the case may be. The cylinder 53 is provided with a vertically extending rack 55 which meshes with a ring gear 56 fixed to the outer disk 15 of the carrying device so that downward movement of the cylinder will cause the drum-carrying device to revolve in a clockwise direction, as viewed in Fig. 1. The fluid-pressure device 48 is swung about its pivot pin 51 in order to engage the rack 55 with the ring gear 56 on the downward stroke of the cylinder 53 and to disengage the same therefrom on the upward stroke of the cylinder 53, by means of a fluid-pressure device 57. This device comprises a cylinder 58 pivotally mounted on the main frame of the apparatus and which is provided with a piston rod 59 secured at its forward end to a bar 60. This bar is pivotally connected by a pin 61 between ears 62 formed on the yoke 52. The carrying device is maintained against movement between its periods of rotation by means of a detent or latch device in the form of a bell crank lever 63 which is pivotally mounted on the frame by a pin 64. One arm 65 of this lever is provided with a hook portion 66 adapted to engage between the teeth of the ring gear 56 so as to positively lock the same against rotation. The other arm 67 of the lever 63 extends vertically and into the path of movement of a collar 68 fixed to the piston rod 59. When the cylinder 53 is swung to the position shown in Fig. 1, in which the rack 55 is in driving engagement with the ring gear 56, the collar 68 engages the arm 67 of the bell crank lever 63 and swings the same in a counterclockwise direction so as to lift the hook portion 66 of the arm 65 out of engagement with the teeth of the ring gear 56, thus permitting the carrying device to turn. When, however, the cylinder 53 is swung to the right in order to disengage the rack 55 from the ring

gear 56 at the end of its stroke, the collar 68 releases the arm 67, thus permitting the arm 65 and hook portion 66 to descend into engagement with the teeth of the ring gear 56 and lock it against rotation.

The several tire-forming drums A, B, C, D, E and F are rotated in the directions indicated by the arrows in Fig. 1 during their periods of dwell at the different fabricating stations by means of a plurality of variable speed, reversible electric motors 69 corresponding in number with the number of tire-forming drums and one of which is located at each of the fabricating stations. Each of these motors 69 is provided with a pinion 70 which meshes with and drives a gear wheel 71 fixed to one end of a shaft 72 journaled in bearings 73 carried by the main supporting frame. A pinion 74 is fixed to the opposite end of each of the shafts 72 for constant intermeshing engagement with a pinion 75 which is rotatably mounted upon a stub shaft 76 carried by links 77 swingingly mounted upon the shaft 72. The several pinions 75 are disposed in the path of travel of pinions 78, each of which is of multipart construction in that it embodies a portion 79 which is keyed to one of the shafts 17 and a portion 80 which is keyed to the inner shaft 18. A ball detent 81 yieldably maintains the parts 79 and 80 in positions wherein the teeth are in registry. Thus, it will be apparent that when the drums reach the several fabricating stations the pinions 78 engage the pinions 75, thus causing the drums to rotate at desired speed and in desired direction during the various tire-building operations only when current is supplied to motors 69. The pinion 75 located at station I is of less width than those at the other stations in that it is only as wide as the parts 79 of the pinions 78 (Fig. 3) for a purpose now to be explained.

When the drums A to F carrying the completed tire casings successively arrive at station I, the parts 79 of the pinions 78 engage the narrow pinion 75, the part 80 not so engaging. The motor 69, also located at station I, rotates at a relatively low speed for the reason that the plies are applied to the drums and the finished tire is removed therefrom at this point in their travel.

Located at station I is a device for successively collapsing the several drums to permit of the removal of a finished tire and for thereafter expanding the same for subsequent tire-fabricating operations. This device comprises a fluid-pressure cylinder 82 which is carried by the main frame and which actuates a piston rod 83 provided with a rack bar 84. When a drum carrying a finished tire arrives at this station fluid pressure is admitted into the rear of the cylinder 82 causing the piston rod 83 to be projected inwardly and the rack bar 84 to engage and rotate the relatively narrow portion 80 of the pinion 78 on the shaft 18 against the action of the ball detent 81, which it unlatches, while the shaft 17 is held against rotation by the closed gear train back to motor 69. This relative rotation of the shafts 17 and 18 actuates the linkage mechanism 22—24 in a well-known manner to collapse the sections 21 of the drum and to permit the finished tire casing to be removed. Fluid pressure is then admitted to the front end of the cylinder 82, thus causing the piston rod 83 and rack bar 84 to be retracted and the sections 21 of the drum to be expanded to their normal cylindrical shape.

Also located at station I are two fluid-pressure cylinders 85 and 86 provided with piston rods 87 and 88 respectively, the former being disposed in alignment with the path of travel of the rack bar 34 and the latter in alignment with the path of travel of the rack bar 35. These cylinders actuate the rack bars 34 and 35 in opposite directions in order to move the inner supplemental ply-supporting members 25 into and out of operative relation with the several drums at the proper times, as will hereinafter be explained.

Located at stations II and III are two cementing devices, 89 and 90 respectively, one for applying a coating of cement in a narrow band to one edge of the drums and the other one for applying a similar coating of cement to the opposite edge of the drums while they rotate at these stations. Each of these devices comprises a receptacle 91 for containing a supply of cement and having a brush 92 pivotally mounted thereon, which is periodically swung between the receptacle and the drum by means of a fluid-pressure device 93.

Also located at station II above the drum is a stitching device 94 for pressing down the first two plies of fabric along their edges to insure that they adhere to the cemented edges of the drum. This device comprises a rock shaft 95 which is journaled at its ends in a bracket 96 carried by the main frame and stationary shaft 13 and which carries arms 97 adjacent to its ends. A shaft 98 is journaled in the arms 97 and is provided with rolls 99, one at each end thereof and with a single intermediate roll 100. The rolls 99 are of a slightly larger diameter than the roll 100 so that when they are in engagement with the fabric at the ends of the drums, the intermediate roll 100 will be out of contact therewith, and so that when the intermediate roll 100 is in engagement with the breaker strip or tread the end rolls 100 will be out of engagement with the fabric. The rolls 99 and 100 are lowered and raised into and out of engagement with the fabric, breaker strip and tread by means of a lever 101 which is fixed to one end of the shaft 95 and which is pivotally connected with the piston rod of a fluid-pressure cylinder 102 having a pivotal connection with the bracket 96.

Also located at stations II and III below the drums are two stitching devices 103 and 104, the former being utilized for turning the plies of fabric under the beads down over the edge of the drum at one side thereof, and the latter for performing the same operation at the opposite side of the drum. Each of these devices comprises a rock shaft 105 journaled in bearing brackets 106 carried by the frame of the apparatus. An arm 107 having a yoke 108 at its lower end is keyed for axial sliding movement on the shaft 105 and is provided at its upper end with a stitching roller 109 for engagement with the plies at the edge of the drum. An arm 110 is fixed to the other end of the shaft 105 and is pivotally connected with a piston rod of a fluid-pressure cylinder 111 which is in turn pivotally connected to the main frame.

A traveler lug 112 is also keyed to the shaft 105 between the arms of the yoke 108 for intermeshing engagement with a worm 113 which is journaled in the bearing brackets 106 and is provided with a gear 114 at one end for driving engagement with a train of gears 115 driven by a reversible motor 116.

The operations of this motor and that of the fluid-pressure cylinder 111 are so timed that when, in the cycle of operations, a drum having the plies of rubberized fabric applied thereto suc-

cessively arrives at stations II and III, the worm 113 is rotated to move the stitching roller 109 inwardly to its initial position over the drum and then for combining the motions of the roller 109 both axially and radially inwardly by means of the motor 116 and fluid pressure cylinder 111.

Also located at station III is another tread stitching device 117 for stitching down both the fabric plies and the tread longitudinally of the drum. This particular device comprises two rock shafts 118 arranged in axial alignment and journaled in bearings 119 formed on a bracket 120 carried by the main frame and stationary shaft 13. Levers 121 are each splined adjacent to its middle to one of the shafts 118 for rocking movement therewith and also for sliding movement longitudinally thereof. One arm of each of the levers 121 is provided with a stitching roller 122 and the other arm thereof is formed with a threaded portion 123 for intermeshing engagement with worms 124 and 125 of opposite pitch, each worm having right- and left-hand pitch portions meeting at the center, the former being engaged by said threaded portion when the roller 122 is moved into engagement with the fabric and the latter being engaged by said threaded portion when the roller 122 is moved out of engagement with the fabric. The shafts 118 are independently rocked so as to move the rollers 122 into and out of engagement with the fabric by means of fluid-pressure cylinders 126 which are pivotally mounted on the bracket 120 and the piston rods 127 which are pivotally connected to arms 128 fixed to the outer ends of the shafts 118. The worms 124 and 125 are rotated in order to move the rollers 122 from a position central of the drum, outwardly therefrom when these rollers are in contact with the fabric, and to move the same inwardly to their initial position when out of contact with the fabric, by means of an electric motor 129 through the medium of gearing trains 130.

Located at station IV is the mechanism for operating the bead setting devices 36. This mechanism comprises a fluid-pressure cylinder 131 which is slidably mounted on guide rods 132 carried at their ends by levers 133 having a pivoted connection 134 with the frame. The cylinder 131 is provided with a piston rod 135 which is fixed in a bracket 136 slidably mounted on the rods 132 and which is provided with arms 137 for engagement with the groove 39 in the hub of the outer bead-setting device 38. The cylinder 131 is also formed with an extension 138 which is provided with arms 139 for engagement with the groove 45 in the collar 44. The arms 137 and 139 are periodically moved into and out of engagement with the grooves 39 and 45 by means of a fluid-pressure cylinder 140 which is pivotally mounted on the main frame and which is provided with a piston rod 141 having a pivoted connection with one of the rods 132. It will be apparent that when the arms 137 and 139 are swung into engagement with the grooves 39 and 45 and fluid pressure is applied to the cylinder 131, in front of its piston (not shown), the device as a whole will draw the arms 137 and 139 toward one another, thus moving the bead-setting devices 36 and bead 36a carried thereby, into operative engagement with the drum which is located at this station at this time. Also, it will be apparent that notwithstanding the fact that one of the devices 36 may contact with the drum before the other and comes to rest, the other device will continue to move until it also seats its bead 36a.

Also located at station IV are two devices 142 for trimming the edges of the side walls of the tread of the finished tire (Fig. 18). These devices each comprise a discoidal knife 143 which is mounted on the end of the piston rod 144 of a fluid-pressure cylinder 145 having a pivotal connection with the main frame of the apparatus. A link 146 is provided for steadying the knife 143 and for guiding it accurately toward that portion of the side-wall portion of the tread stock to be cut.

Located on opposite sides of the drum at station V are stitching devices 147 and 147a, the former for turning plies below the beads radially outwardly around the bead 36a (Fig. 9), and the latter for stitching the plies above the beads radially inwardly around the beads 36a (Fig. 14).

Located on opposite sides of the drum at station VI are stitching devices 148 and 148a, the former for turning plies above the beads radially inwardly around the bead 36a (Fig. 15), and the latter for stitching plies below the beads radially outwardly around the bead 36a (Fig. 10). The particular arrangement just described, permits the most advantageous stitching in bias-cut fabric.

Each of the devices 147, 147a, 148 and 148a comprises a bearing 149 which is mounted for swinging movement upon a shaft 150 fixed in bearings 151 carried by the main frame. The bearing 149 is formed with a hub 152 extending at right angles thereto in which a shaft 153 is fixed. Rotatably mounted on the shaft 153 is a bearing 154 formed with a tubular arm 155, the axis of which extends parallel with that of the bearing 154, but which is offset laterally thereto. Journaled in the arm 155 is a shaft 156 provided with a stitching roller 157 at its lower or outer end and with a gear 158 at its inner or upper end. This shaft is rotated in order to swing the roller 157 to and from its operative position and also during the stitching operation, by means of a fluid-pressure cylinder 159 which is fixed to the side of the bearing 154 and which actuates a rack 160 which meshes with the gear 158. The bearing 154, together with cylinder 159 is also rotated during the stitching operation by means of another fluid-pressure cylinder 161 which is mounted on brackets 162 carried by the bearing 149 and which actuates a rack 163 meshing with a gear 164 fixed to the bearing 154. The entire stitching device is rocked about the shaft 150 by means of a fluid-pressure cylinder 165 which is carried by the main frame and which is provided with a piston-actuated rack 166 for intermeshing engagement with an elongated gear 167 rotatably mounted on a shaft 168 fixed in bearings 169 carried by the main frame. The gear 167 meshes with a segmental rack 170 adjustably mounted on the end of an arm 171 fixed to the bearing 149. The movement of the rack 166 may be regulated by an oil-filled cylinder 172 in the manner of a dash pot. Thus, it will be seen that by properly regulating and timing the flow of fluid under pressure to and from the several cylinders 159, 161 and 165 a combination of movements is imparted to the stitching roller 157, such as not only will swing the same to and from its operative position but will cause the roller to move around the bead of the tire and stitch down the fabric uniformly and efficiently.

First rotation.—In operation, let it be assumed that the apparatus is being employed for the

first time and that no fabric has yet been placed on any of the drums. Let it also be assumed that during its dwell at station I the drum A has been collapsed, the inner bead 36ª positioned on the inner bead ring 36 and the drum again expanded. The next partial rotation of the drum carrier will move the drum A to station II where it will be rotated by motor 69 and where the cementing device 89 will apply a band of cement around the drum adjacent to one edge thereof (Fig. 4). The next partial rotation of the carrying device will move the drum A to station III where it is again rotated and where the cementing device 90 applies a band of cement around the drum adjacent to the other end thereof (Fig. 4). During the movement of the drum A from station III to station I, completing its first revolution, nothing happens, this time being employed to permit the cement to dry. It is, of course, to be understood that the cementing operations may be omitted in some cases.

Second rotation.—At station I members 25 are positioned at the ends of the drum and the first ply *a* of bias-cut fabric is applied to the drum manually by the operator (Fig. 5). No further operations are performed on drum A during this rotation.

Third rotation.—When the drum A comes to rest at station I upon the completion of its second rotation, the second ply *b* of fabric is applied to the drum, the supplemental ply-supporting members 25 are removed and the outer bead setting device 36 carrying a bead 36ª is mounted on the end of the enlargement 19. The next partial rotation of the carrying device moves the drum A to station II where the stitching devices 94 and 103 are located, the former stitching down the flat portion of the first two plies of fabric so that it will adhere to the cement and the latter for stitching the fabric around one end of the drum (Fig. 6). The succeeding partial rotation of the carrying device moves the drum A to station III where the second stitching device 104 stitches down the first two plies of fabric around the other end of the drum (Fig. 7). The next partial rotation of the carrying device moves the drum A to station IV where the arms 137 and 139 are swung into engagement with the grooves 39 and 45, respectively, in the hub 38 and collar 44 of the outer and inner bead-setting devices 36 and then moved axially inwardly, thus setting the beads 36ª. The bead-setting devices are then retracted by reversing these operations, leaving the beads 36ª securely affixed to the stitched-down portions of the first two plies of fabric (Fig. 8). The succeeding partial rotation of the carrying device moves the drum A to station V where the stitching device 147 stitches the edges of the first two plies *a* and *b* of fabric radially outwardly and over the bead 36ª at one end of the drum (Fig. 9). The next partial rotation of the carrying device moves the drum A to station VI where the stitching device 148ª stitches the edges of the first two plies *a* and *b* of fabric radially outwardly and over the bead 36ª at the other side of the drum (Fig. 10). The succeeding partial rotation of the carrying device returns the drum A to station I, completing its third revolution.

Fourth rotation.—During the period of dwell of drum A at station I the outer bead setting device 36 is removed, the supplemental ply-supporting members 25 again assembled adjacent to the ends of the drum and the third ply *c* of fabric applied upon the first two plies *a* and *b* (Fig. 11). No further operations are performed on drum A during its fourth revolution.

Fifth rotation.—During the period of dwell of drum A at station I after completing its fourth rotation the fourth ply *d* of fabric is applied upon the third ply (Fig. 11). No further operations are performed on drum A during its fifth rotation.

Sixth rotation.—During the period of dwell of drum A at station I after completing its fifth revolution, the chafer and breaker strips *e* and *f* respectively are applied to the fabric and the supplemental fabric-supporting members 25 are retracted, the outer member being removed completely (Fig. 11). The next partial rotation of the carrying device moves the drum A to station II where the intermediate roller 100 of the sitching device 94 stitches down the central portion of the breaker strip and thereby also the central portions of the last two plies of fabric (Fig. 12). The succeeding partial rotation of the carrying device moves the drum A to station III where the stitching devices 122 stitches down the remaining portions of the breaker and chafer strips and also the last two plies of fabric (Fig. 13). No operations are performed at station IV but at stations V and VI the stitching devices 147ª and 148 stitch the third and fourth plies of fabric and the chafer strips radially inwardly under the edges of the beads 36ª at each end of the drum. The next partial rotation of the drum carrier takes the drum A to station I, thus completing the sixth revolution thereof.

Seventh rotation.—During the period of dwell of drum A at station I, the tread *g* is applied over the breaker and chafer strips *e* and *f*. The drum is then moved to station II where the intermediate roller 100 of the stitching device 94 stitches down the central or crown portion of the tread *g* (Fig. 16). The next movement of the carrying device moves the drum A to station III where the rollers 122 of the stitching device 117 stitch down the remaining portions of the tread.

During the period of dwell of the drum A at station IV the knives 143 trim the edges of the tread (Fig. 18). The tire now being completed no further operations are performed at stations V and VI. When the drum carrying the finished tire arrives again at station I at the conclusion of its seventh revolution the drum is collapsed by mechanism previously described and the tire removed therefrom (Fig. 19). It will be noted that the drum revolves about the shaft 13 seven times for each six completed tires. While the fabrication of but a single tire upon only one of the drums has been described, it will be understood that tires are being built up simultaneously on all of the drums, the several operations occurring in predetermined relation at the different stations in sequence and in the order described.

One complete cycle of operation, as previously explained, is illustrated diagrammatically in Fig. 20 by way of giving a comprehensive view of the invention. From this it will be seen that the tire-building drums rotate seven times through their orbit in the production of a single group or batch of tires corresponding in number with the number of drums employed. The rotation of the drums through their orbit is intermittent, each drum stopping at each of six stations in the course of each revolution. As the drums thus pass from station to station, the tires are gradually built up, all of the operations being per-

formed automatically except those of placing or applying the component materials which are done manually by one operator or attendant. It is to be noted that while certain operations are performed at each station they are not repeated in each revolution of the drums. At some stations several different operations are performed in the successive rotations, yet during some of the rotations there are some stations where no operations are performed.

Thus, in Fig. 20 the seven large circles represent the seven successive rotations of the drums in their path of travel through one complete cycle. The small circles represent the drums (six in number) and the roman numerals I, II, III, IV, V, VI represent the stations at which the drums stop in the course of their intermittent rotation. Some of the small circles representing the drums are shown in light line and others in heavy line, and this is to indicate graphically the stations at which operations are performed. The heavy-line drum circles show that at the so-indicated stations certain operations are performed, the nature of the specific operations being given in the legends adjacent the drums or drum circles. The light-line drum circles indicate that at those particular points in the cycle no operations are performed. Thus, in the first rotation, operations are performed at stations I, II and III but none at stations IV, V and VI. In the second rotation an operation is performed at station I only. In the third rotation operations are performed at all six of the stations. In the fourth and fifth rotations operations are performed only at station I. In the sixth rotation operations are performed at stations I, II, III, V and VI while nothing transpires at station IV. In the seventh rotation operations are performed only at stations I, II, III and IV. The operations at station I are performed manually while those at the other five stations are carried out automatically without requiring any attention, selection or control by the operator.

The various automatic operations hereinabove described occur in a predetermined cyclic order, the same being controlled by suitable electrically operated valves not shown. The various component materials may be initially supplied and applied manually at station I, whereas all of the other operations referred to are performed entirely automatically, requiring neither selection nor attention by the attendant.

From the foregoing it will be evident that a novel method has been devised for constructing tires, and efficient apparatus has also been provided for practicing such novel method. The tires are built up in stages by automatic operations and with a minimum of hand labor, resulting in substantial savings, and they are built in groups or batches instead of one at a time. In the drawings the main frame structure has been omitted and certain parts illustrated diagrammatically for the sake of clarity. Of course, the invention is susceptible of numerous modifications in the steps of the method and in the arrangement of the apparatus. Thus, for example, there may be either more or less than six tire-building forms, and the specific number of operating stations may also be varied. The tire-building forms may be either flat drums, crown drums, cores or the like, and they may be oscillated, or otherwise moved if desired, instead of moved through an orbital path, the movement being in any preferred plane. Furthermore, the invention is not limited merely to movement of the building forms with reference to the various operating stations, but is intended to comprehend movement of either the forms or the stations or both. Other changes may also be made in the details of construction and in the order and arrangement of method steps, and the right is herein reserved to make such changes as fall within the scope of the appended claims without departing from the spirit of the invention.

Having thus described the invention, what is claimed is:

1. Tire-building apparatus comprising a support for a plurality of tire-building forms, a plurality of tire-building forms thereon, means for moving said support to present the forms successively and repeatedly to different operating stations, means to facilitate application of tire-building materials to the forms at one of the stations, and means for uniting such materials on the forms at other stations.

2. Tire-building apparatus comprising a support for a plurality of tire-building forms, a plurality of tire-building forms circumferentially spaced thereon, means for rotating said support intermittently through several revolutions to present the forms successively and repeatedly to different operating stations, means to facilitate manual application of tire-building materials in successive stages at only one of the stations, and means for uniting such materials progressively at other stations.

3. Tire-building apparatus comprising a support for a plurality of tire-building forms, a plurality of tire-building forms circumferentially spaced thereon, means for rotating said support intermittently through several revolutions to present the forms successively and repeatedly to different operating stations, means to facilitate application of ply fabric to the forms at only one of the stations, means for applying beads to the fabric at another station, and means for tying-in the beads with the fabric at still other stations.

4. Tire-building apparatus comprising a plurality of tire-building forms mounted for movement in an endless path, tire-fabricating instrumentalities of different kinds located at different stations along said path, and means for repeatedly moving said forms over said path during a complete cycle to repeatedly present each of said forms to the same station for different kinds of fabricating operations upon the same tire.

5. Tire-building apparatus comprising a plurality of tire-building forms mounted for intermittent movement in an endless path, tire-fabricating instrumentalities of different kinds located at different stations along said path, means for repeatedly moving said forms over said path during a complete cycle to repeatedly present each of said forms to the same station for different kinds of fabricating operations on the same tire, and means for rotating said forms during their periods of dwell at each of said stations.

6. Tire-building apparatus comprising a plurality of tire-building drums mounted for intermittent revolution in an endless path about a horizontal axis, tire-fabricating instrumentalities of different kinds located at different stations along said path, means for repeatedly revolving said drums several times about said axis to repeatedly present each of said drums to the same station for different fabricating operations on the same tire, and means for rotating said drums about their individual horizontal axes during their periods of dwell at each of said stations.

7. Tire-building apparatus comprising a plu-

first time and that no fabric has yet been placed on any of the drums. Let it also be assumed that during its dwell at station I the drum A has been collapsed, the inner bead 36ª positioned on the inner bead ring 36 and the drum again expanded. The next partial rotation of the drum carrier will move the drum A to station II where it will be rotated by motor 69 and where the cementing device 89 will apply a band of cement around the drum adjacent to one edge thereof (Fig. 4). The next partial rotation of the carrying device will move the drum A to station III where it is again rotated and where the cementing device 90 applies a band of cement around the drum adjacent to the other end thereof (Fig. 4). During the movement of the drum A from station III to station I, completing its first revolution, nothing happens, this time being employed to permit the cement to dry. It is, of course, to be understood that the cementing operations may be omitted in some cases.

Second rotation.—At station I members 25 are positioned at the ends of the drum and the first ply *a* of bias-cut fabric is applied to the drum manually by the operator (Fig. 5). No further operations are performed on drum A during this rotation.

Third rotation.—When the drum A comes to rest at station I upon the completion of its second rotation, the second ply *b* of fabric is applied to the drum, the supplemental ply-supporting members 25 are removed and the outer bead setting device 36 carrying a bead 36ª is mounted on the end of the enlargement 19. The next partial rotation of the carrying device moves the drum A to station II where the stitching devices 94 and 103 are located, the former stitching down the flat portion of the first two plies of fabric so that it will adhere to the cement and the latter for stitching the fabric around one end of the drum (Fig. 6). The succeeding partial rotation of the carrying device moves the drum A to station III where the second stitching device 104 stitches down the first two plies of fabric around the other end of the drum (Fig. 7). The next partial rotation of the carrying device moves the drum A to station IV where the arms 137 and 139 are swung into engagement with the grooves 39 and 45, respectively, in the hub 38 and collar 44 of the outer and inner bead-setting devices 36 and then moved axially inwardly, thus setting the beads 36ª. The bead-setting devices are then retracted by reversing these operations, leaving the beads 36ª securely affixed to the stitched-down portions of the first two plies of fabric (Fig. 8). The succeeding partial rotation of the carrying device moves the drum A to station V where the stitching device 147 stitches the edges of the first two plies *a* and *b* of fabric radially outwardly and over the bead 36ª at one end of the drum (Fig. 9). The next partial rotation of the carrying device moves the drum A to station VI where the stitching device 148ª stitches the edges of the first two plies *a* and *b* of fabric radially outwardly and over the bead 36ª at the other side of the drum (Fig. 10). The succeeding partial rotation of the carrying device returns the drum A to station I, completing its third revolution.

Fourth rotation.—During the period of dwell of drum A at station I the outer bead setting device 36 is removed, the supplemental ply-supporting members 25 again assembled adjacent to the ends of the drum and the third ply *c* of fabric applied upon the first two plies *a* and *b* (Fig. 11). No further operations are performed on drum A during its fourth revolution.

Fifth rotation.—During the period of dwell of drum A at station I after completing its fourth rotation the fourth ply *d* of fabric is applied upon the third ply (Fig. 11). No further operations are performed on drum A during its fifth rotation.

Sixth rotation.—During the period of dwell of drum A at station I after completing its fifth revolution, the chafer and breaker strips *e* and *f* respectively are applied to the fabric and the supplemental fabric-supporting members 25 are retracted, the outer member being removed completely (Fig. 11). The next partial rotation of the carrying device moves the drum A to station II where the intermediate roller 100 of the sitching device 94 stitches down the central portion of the breaker strip and thereby also the central portions of the last two plies of fabric (Fig. 12). The succeeding partial rotation of the carrying device moves the drum A to station III where the stitching devices 122 stitches down the remaining portions of the breaker and chafer strips and also the last two plies of fabric (Fig. 13). No operations are performed at station IV but at stations V and VI the stitching devices 147ª and 148 stitch the third and fourth plies of fabric and the chafer strips radially inwardly under the edges of the beads 36ª at each end of the drum. The next partial rotation of the drum carrier takes the drum A to station I, thus completing the sixth revolution thereof.

Seventh rotation.—During the period of dwell of drum A at station I, the tread *g* is applied over the breaker and chafer strips *e* and *f*. The drum is then moved to station II where the intermediate roller 100 of the stitching device 94 stitches down the central or crown portion of the tread *g* (Fig. 16). The next movement of the carrying device moves the drum A to station III where the rollers 122 of the stitching device 117 stitch down the remaining portions of the tread.

During the period of dwell of the drum A at station IV the knives 143 trim the edges of the tread (Fig. 18). The tire now being completed no further operations are performed at stations V and VI. When the drum carrying the finished tire arrives again at station I at the conclusion of its seventh revolution the drum is collapsed by mechanism previously described and the tire removed therefrom (Fig. 19). It will be noted that the drum revolves about the shaft 13 seven times for each six completed tires. While the fabrication of but a single tire upon only one of the drums has been described, it will be understood that tires are being built up simultaneously on all of the drums, the several operations occurring in predetermined relation at the different stations in sequence and in the order described.

One complete cycle of operation, as previously explained, is illustrated diagrammatically in Fig. 20 by way of giving a comprehensive view of the invention. From this it will be seen that the tire-building drums rotate seven times through their orbit in the production of a single group or batch of tires corresponding in number with the number of drums employed. The rotation of the drums through their orbit is intermittent, each drum stopping at each of six stations in the course of each revolution. As the drums thus pass from station to station, the tires are gradually built up, all of the operations being per-

formed automatically except those of placing or applying the component materials which are done manually by one operator or attendant. It is to be noted that while certain operations are performed at each station they are not repeated in each revolution of the drums. At some stations several different operations are performed in the successive rotations, yet during some of the rotations there are some stations where no operations are performed.

Thus, in Fig. 20 the seven large circles represent the seven successive rotations of the drums in their path of travel through one complete cycle. The small circles represent the drums (six in number) and the roman numerals I, II, III, IV, V, VI represent the stations at which the drums stop in the course of their intermittent rotation. Some of the small circles representing the drums are shown in light line and others in heavy line, and this is to indicate graphically the stations at which operations are performed. The heavy-line drum circles show that at the so-indicated stations certain operations are performed, the nature of the specific operations being given in the legends adjacent the drums or drum circles. The light-line drum circles indicate that at those particular points in the cycle no operations are performed. Thus, in the first rotation, operations are performed at stations I, II and III but none at stations IV, V and VI. In the second rotation an operation is performed at station I only. In the third rotation operations are performed at all six of the stations. In the fourth and fifth rotations operations are performed only at station I. In the sixth rotation operations are performed at stations I, II, III, V and VI while nothing transpires at station IV. In the seventh rotation operations are performed only at stations I, II, III and IV. The operations at station I are performed manually while those at the other five stations are carried out automatically without requiring any attention, selection or control by the operator.

The various automatic operations hereinabove described occur in a predetermined cyclic order, the same being controlled by suitable electrically operated valves not shown. The various component materials may be initially supplied and applied manually at station I, whereas all of the other operations referred to are performed entirely automatically, requiring neither selection nor attention by the attendant.

From the foregoing it will be evident that a novel method has been devised for constructing tires, and efficient apparatus has also been provided for practicing such novel method. The tires are built up in stages by automatic operations and with a minimum of hand labor, resulting in substantial savings, and they are built in groups or batches instead of one at a time. In the drawings the main frame structure has been omitted and certain parts illustrated diagrammatically for the sake of clarity. Of course, the invention is susceptible of numerous modifications in the steps of the method and in the arrangement of the apparatus. Thus, for example, there may be either more or less than six tire-building forms, and the specific number of operating stations may also be varied. The tire-building forms may be either flat drums, crown drums, cores or the like, and they may be oscillated, or otherwise moved if desired, instead of moved through an orbital path, the movement being in any preferred plane. Furthermore, the invention is not limited merely to movement of the building forms with reference to the various operating stations, but is intended to comprehend movement of either the forms or the stations or both. Other changes may also be made in the details of construction and in the order and arrangement of method steps, and the right is herein reserved to make such changes as fall within the scope of the appended claims without departing from the spirit of the invention.

Having thus described the invention, what is claimed is:

1. Tire-building apparatus comprising a support for a plurality of tire-building forms, a plurality of tire-building forms thereon, means for moving said support to present the forms successively and repeatedly to different operating stations, means to facilitate application of tire-building materials to the forms at one of the stations, and means for uniting such materials on the forms at other stations.

2. Tire-building apparatus comprising a support for a plurality of tire-building forms, a plurality of tire-building forms circumferentially spaced thereon, means for rotating said support intermittently through several revolutions to present the forms successively and repeatedly to different operating stations, means to facilitate manual application of tire-building materials in successive stages at only one of the stations, and means for uniting such materials progressively at other stations.

3. Tire-building apparatus comprising a support for a plurality of tire-building forms, a plurality of tire-building forms circumferentially spaced thereon, means for rotating said support intermittently through several revolutions to present the forms successively and repeatedly to different operating stations, means to facilitate application of ply fabric to the forms at only one of the stations, means for applying beads to the fabric at another station, and means for tying-in the beads with the fabric at still other stations.

4. Tire-building apparatus comprising a plurality of tire-building forms mounted for movement in an endless path, tire-fabricating instrumentalities of different kinds located at different stations along said path, and means for repeatedly moving said forms over said path during a complete cycle to repeatedly present each of said forms to the same station for different kinds of fabricating operations upon the same tire.

5. Tire-building apparatus comprising a plurality of tire-building forms mounted for intermittent movement in an endless path, tire-fabricating instrumentalities of different kinds located at different stations along said path, means for repeatedly moving said forms over said path during a complete cycle to repeatedly present each of said forms to the same station for different kinds of fabricating operations on the same tire, and means for rotating said forms during their periods of dwell at each of said stations.

6. Tire-building apparatus comprising a plurality of tire-building drums mounted for intermittent revolution in an endless path about a horizontal axis, tire-fabricating instrumentalities of different kinds located at different stations along said path, means for repeatedly revolving said drums several times about said axis to repeatedly present each of said drums to the same station for different fabricating operations on the same tire, and means for rotating said drums about their individual horizontal axes during their periods of dwell at each of said stations.

7. Tire-building apparatus comprising a plu-

rality of tire-building forms mounted for movement in an endless path, different kinds of tire-fabricating instrumentalities located at different stations along said path, the component tire materials being adapted to be applied to said forms successively at only one of said stations and to be operated upon by said instrumentalities at the other of said stations, and means for repeatedly moving said forms over said path to repeatedly present each of said forms to the same station several times for different fabricating operations on each tire being built.

8. Tire-building apparatus comprising a plurality of tire-building forms mounted for movement in an endless path, different kinds of tire-fabricating instrumentalities located at different stations along said path, the component tire materials being adapted to be applied to said forms successively at only one of said stations and to be operated upon by said instrumentalities at the others of said stations, and means for repeatedly moving said forms over said path to repeatedly present each of said forms to the same station several times for different fabricating operations on each tire being built, the completed tires being adapted to be removed from said forms at the station where said materials are applied thereto.

9. A bead-stitching or ply-turning device for tire-building apparatus comprising a primary carrying member mounted for swinging movement about an axis extending in a predetermined direction, a secondary carrying member mounted on said primary carrying member for swinging movement about an axis extending transversely to that of said primary carrying member, a tertiary carrying member mounted on said secondary carrying member for swinging movement about an axis extending parallel to that of said secondary carrying member, a stitching roller mounted on said tertiary carrying member for rotation about an axis extending transversely to that of said tertiary carrying member, and independent means for swinging said members relative to one another to move said stitching roller into and out of operative position with respect to a tire-building form, and for controlling the bodily movement thereof during its stitching operation.

10. A ply-turning device for tire-building apparatus comprising a primary carrying member mounted for swinging movement about an axis extending in a predetermined direction, a secondary carrying member mounted on said primary carrying member for swinging movement about an axis extending transversely to that of said primary carrying member, a tertiary carrying member mounted on said secondary carrying member for swinging movement about an axis extending parallel to that of said secondary carrying member, a stitching roller mounted on said tertiary carrying member for rotation about an axis extending transversely to that of said tertiary carrying member, and fluid-pressure means for swinging said members relative to one another to move said stitching roller into and out of operative position with respect to a tire-building form, and for controlling the bodily movement thereof during its stitching operation.

11. A ply-turning device for tire-building apparatus comprising a first bearing mounted for swinging movement about a horizontal axis, a second bearing mounted on said first-mentioned bearing for swinging movement about an axis extending transversely to that of said first bearing, a third bearing mounted on said second bearing for swinging movement about an axis extending parallel to that of said second bearing, a shaft in said third bearing, a stitching roller mounted on said shaft for rotation about an axis extending transversely to that of said shaft, fluid-pressure means for swinging said bearings relative to one another to move said stitching roller into and out of operative position with respect to a tire-building form, and for controlling the bodily movement thereof during its stitching operation.

12. A ply-turning device for tire-building apparatus comprising a primary carrying member mounted for swinging movement about an axis extending in a predetermined direction, a secondary carrying member mounted on said primary carrying member for swinging movement about an axis extending transversely to that of said primary carrying member, a tertiary carrying member mounted on said secondary carrying member for swinging movement about an axis extending parallel to that of said secondary carrying member, a stitching roller mounted on said tertiary carrying member for rotation about an axis extending transversely to that of said tertiary carrying member, means for swinging said primary carrying member about its axis, means for swinging said secondary carrying member about its axis, and means for swinging said tertiary carrying member about its axis.

13. A ply-turning device for tire-building apparatus comprising a primary carrying member mounted for swinging movement about an axis extending in a predetermined direction, a secondary carrying member mounted on said primary carrying member for swinging movement about an axis extending transversely to that of said primary carrying member, a tertiary carrying member mounted on said secondary carrying member for swinging movement about an axis extending parallel to that of said secondary carrying member, a stitching roller mounted on said tertiary carrying member for rotation about an axis extending transversely to that of said tertiary carrying member, means for swinging said primary carrying member about its axis, means mounted on said primary carrying member for swinging said secondary carrying member about its axis, and means mounted on said secondary carrying member for swinging said tertiary carrying means about its axis.

14. A ply-turning device for tire-building apparatus comprising a primary carrying member mounted for swinging movement about an axis extending in a predetermined direction, a secondary carrying member mounted on said primary carrying member for swinging movement about an axis extending transversely to that of said primary carrying member, a tertiary carrying member mounted on said secondary carrying member for swinging movement about an axis extending parallel to that of said secondary carrying member, a stitching roller mounted on said tertiary carrying member for rotation about an axis extending transversely to that of said tertiary carrying member, fluid-pressure for swinging said primary carrying member about its axis, fluid-pressure means mounted on said primary carrying member for swinging said secondary carrying member about its axis, and fluid-pressure means mounted on said secondary carrying member for swinging said tertiary carrying means about its axis.

15. A tread-stitching device for tire-building

apparatus comprising carrying means mounted for swinging movement about an axis extending in a predetermined direction, a tread-stitching roller mounted on said carrying means, means for swinging said carrying means about its axis to move said roller into and out of engagement with a tire tread carried by a tire-building form, positively-driven means for moving said carrying means and roller to an initial stitching position when said roller is out of engagement with said tread, and additional positively-driven means for moving said carrying means and roller across said tread in an opposite direction when said roller is in engagement therewith.

16. A tread-stitching device for tire-building apparatus comprising carrying means mounted for swinging movement about an axis extending in a predetermined direction, a tread-stitching roller mounted on said carrying means, means for swinging said carrying means about its axis to move said roller into and out of engagement with a tire tread carried by a tire-building form, a worm for moving said carrying means and roller to an initial stitching position when said roller is out of engagement with said tread, and an additional worm for moving said carrying means and roller across said tread in an opposite direction when said roller is in engagement therewith.

17. A tread-stitching device for tire-building apparatus comprising a pair of carrying means mounted for swinging movement about an axis extending in a predetermined direction, a tread-stitching roller mounted on each of said carrying means, means for swinging said carrying means in unison about their axes to move said rollers into and out of engagement with a tire tread carried by a tire-building form, means including a positively-driven worm for moving said carrying means and rollers simultaneously to an initial stitching position intermediate of said form when said roller is out of contact with said tread, and means including another positively-driven worm for moving said carrying means and rollers simultaneously across said tread in opposite directions when said roller is in engagement therewith.

18. A tread-stitching device for tire-building apparatus comprising carrying means mounted for swinging movement about an axis extending in a predetermined direction, outer stitching rolls mounted on said carrying means for engagement with the edges of the fabric, and an intermediate roll of less diameter than said outer stitching rolls, for engagement with the tread of a tire being fabricated on said form, said outer stitching rolls being maintained out of engagement with the edges of said tread during such time as said intermediate roll is in engagement with the central portion thereof.

JORGEN I. HAASE.