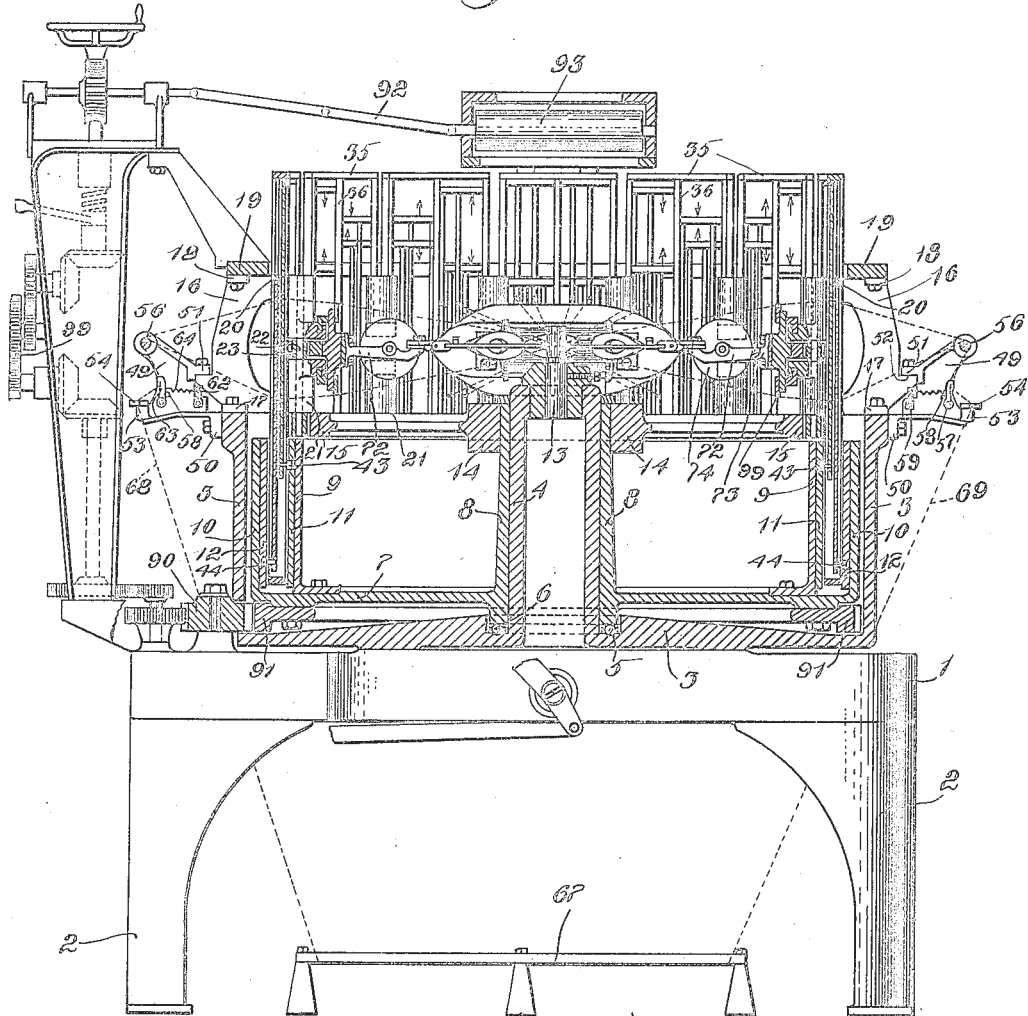


J. HIRST.
CIRCULAR LOOM.
APPLICATION FILED JULY 17, 1918.

1,426,641.

Patented Aug. 22, 1922.
6 SHEETS—SHEET 1.

Fig. 1

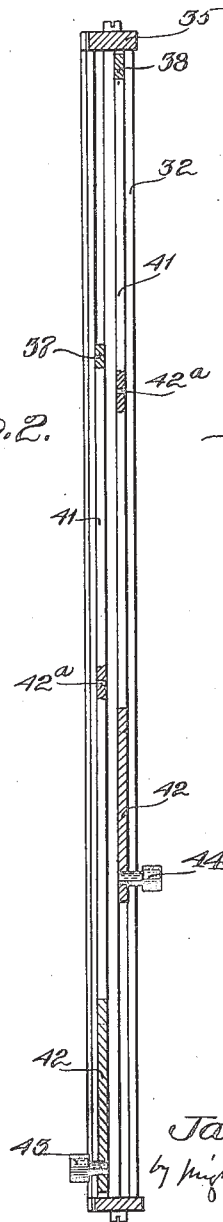
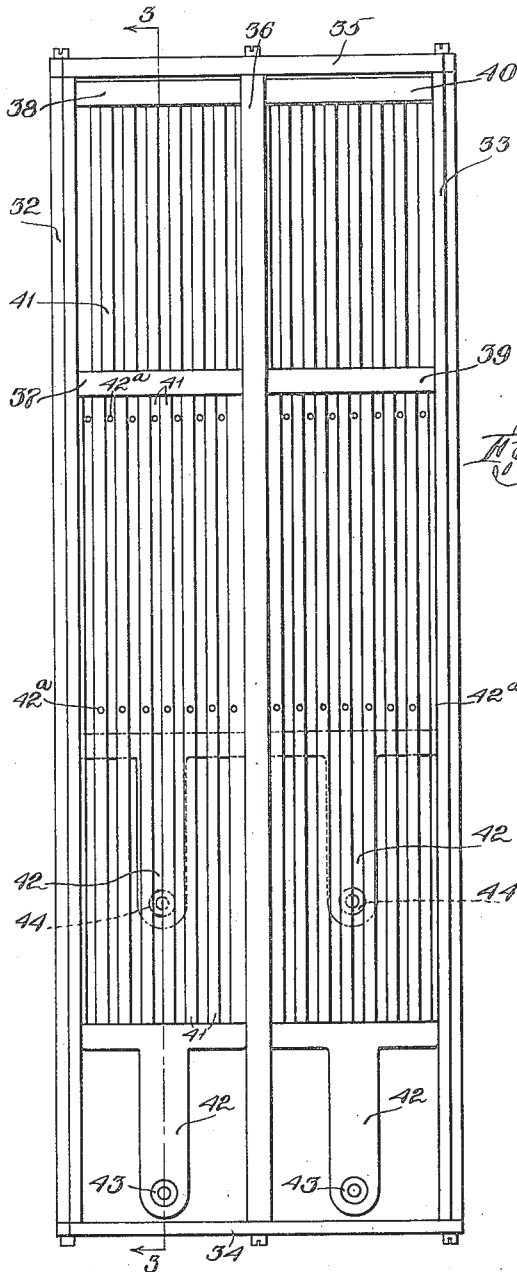
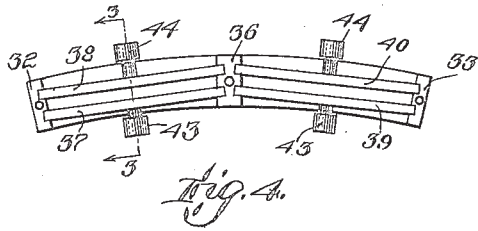


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6 SHEETS—SHEET 2.



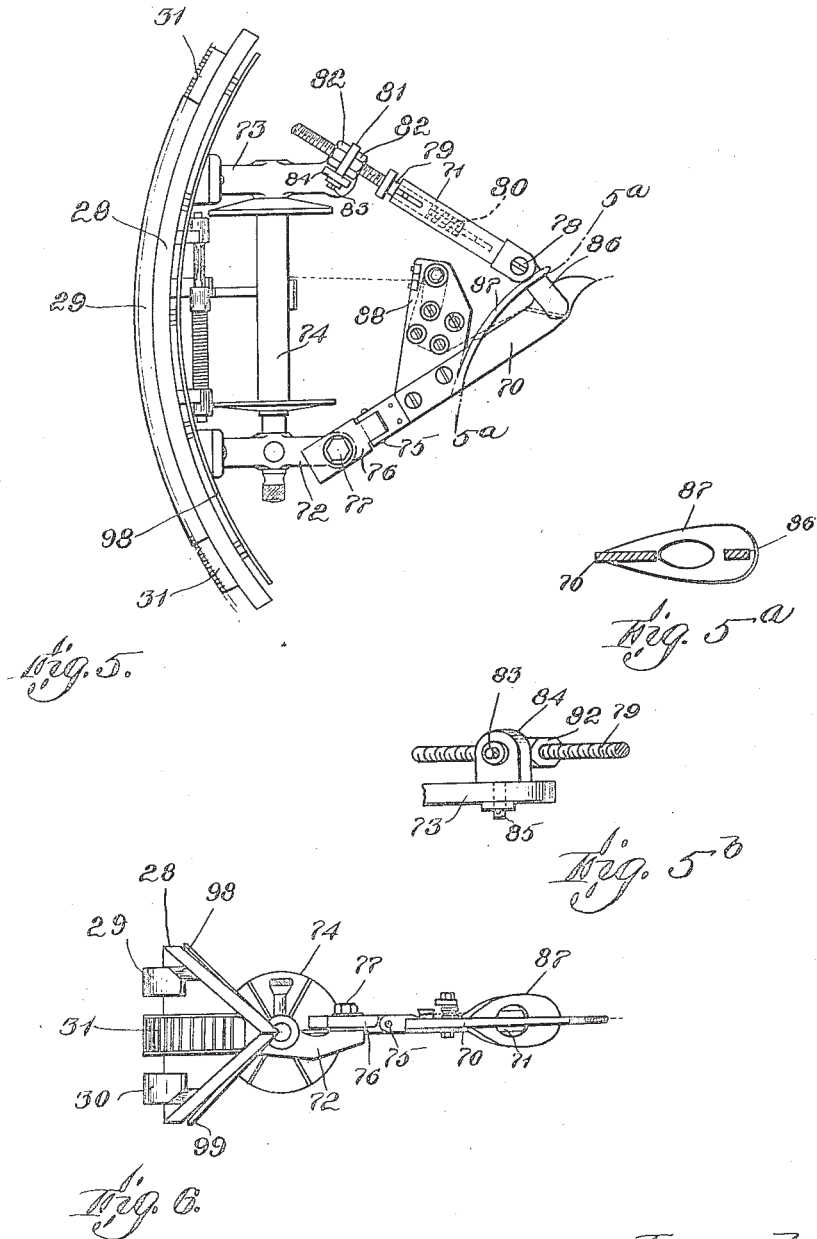
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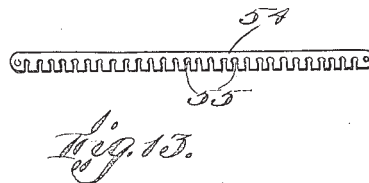
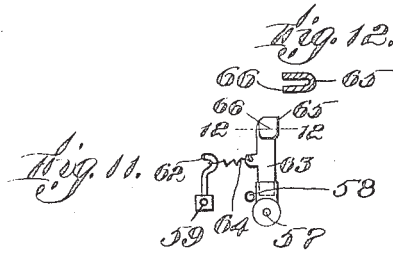
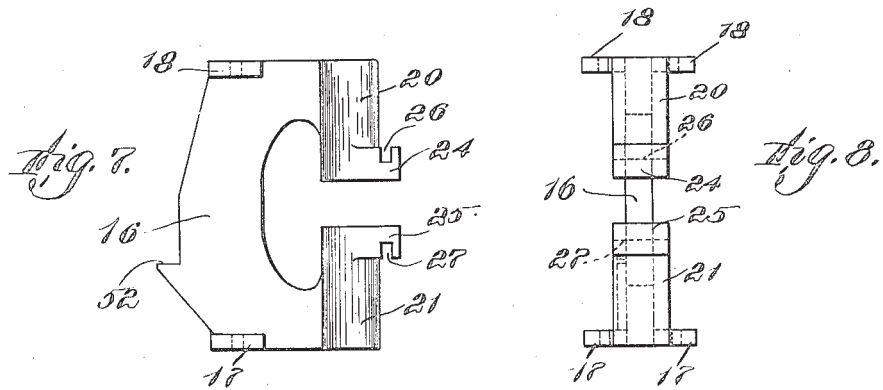
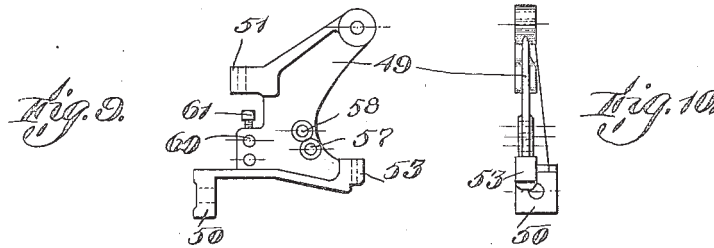
6 SHEETS—SHEET 3.



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6 SHEETS—SHEET 5.

Fig. 15.

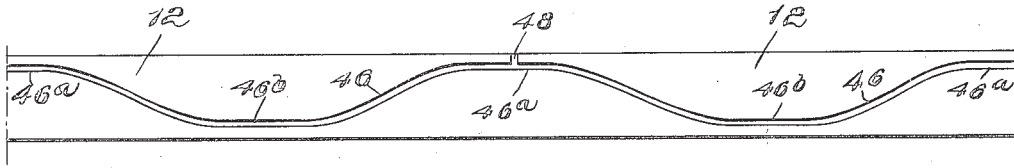


Fig. 14.

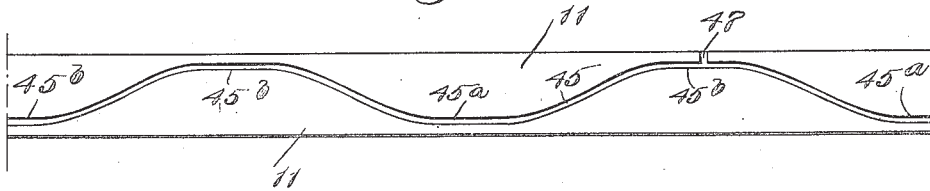
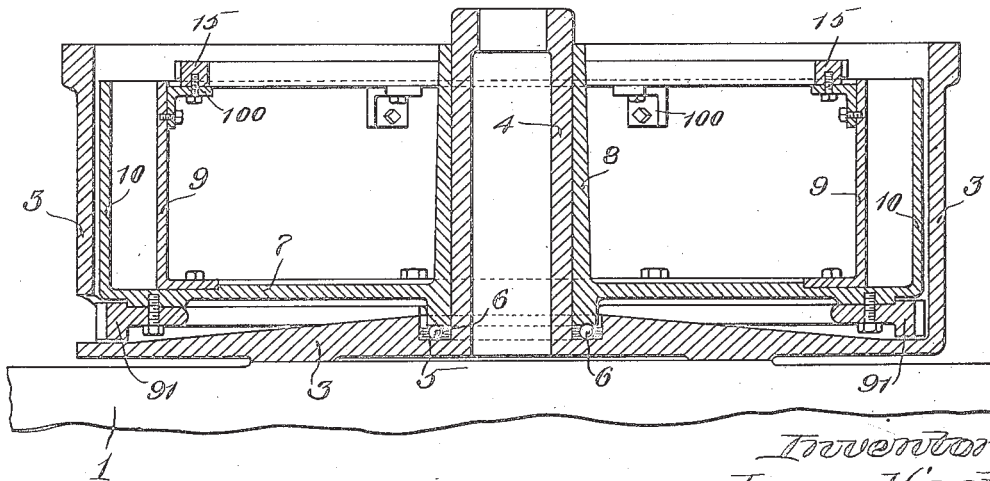


Fig. 10.



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6 SHEETS—SHEET 6.

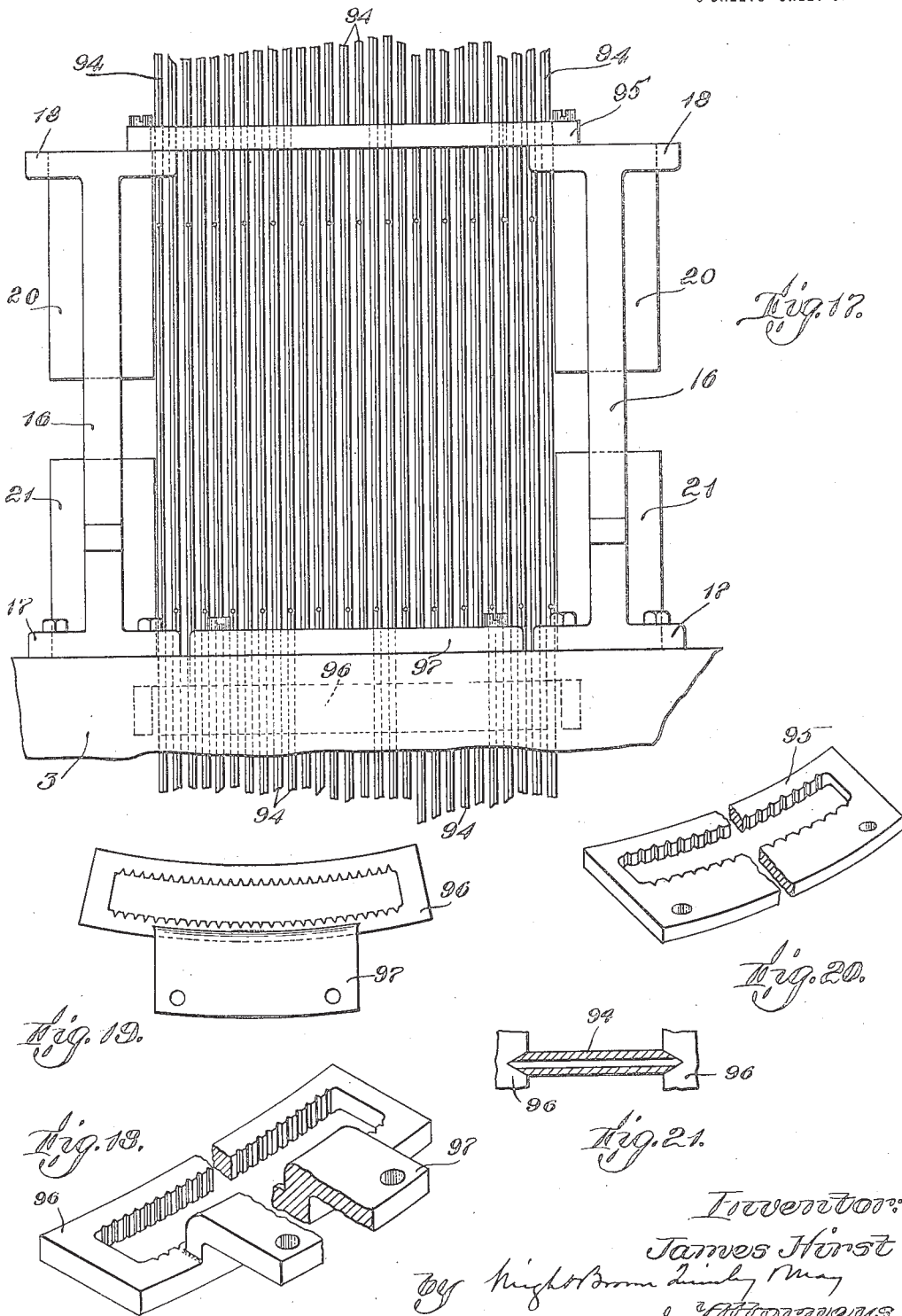


Fig. 17.

Fig. 20.

Fig. 18.

Fig. 21.

Fig. 19.

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UNITED STATES PATENT OFFICE.

JAMES HIRST, OF MELROSE, MASSACHUSETTS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO TUBULAR WOVEN FABRIC COMPANY, OF PAWTUCKET, RHODE ISLAND, A CORPORATION OF RHODE ISLAND.

CIRCULAR LOOM.

1,426,641.

Specification of Letters Patent. Patented Aug. 22, 1922.

Application filed July 17, 1918. Serial No. 245,362.

To all whom it may concern:

Be it known that I, JAMES HIRST, a subject of the King of Great Britain, residing at Melrose, in the county of Middlesex and State of Massachusetts, have invented new and useful Improvements in Circular Looms, of which the following is a specification.

The present invention relates to looms adapted for circular weaving and adapted to make tubes of various diameters having a filling thread, or a number of filling threads, passing in a continuous helix of uniform pitch around the axis of the tube.

The objects of the invention are principally, first, to provide a loom having capacity for introducing a greater number of warp threads into the fabric, having regard to the diameter of the tube produced, than has been possible heretofore in looms of the same general type as these; second, to combine in the same loom the principle of a gear driven shuttle or shuttles with cam driven heddles; third, to provide an improved means or mode of detachably mounting the heddles; fourth, to provide in connection with the shuttle a weft packing device which is adjustable as to the pressure which it applies, and is self-accommodating to differences in the level or plane of the shuttle path and the weaving point; and in general to provide improvements resulting in a more compact and simplified construction of looms, embodying the features described in the following specification and pointed out in the claims.

The invention consists in means and constructions adapted to accomplish the foregoing objects which are hereinafter described in detail and are pointed out in the claims.

Referring to the drawings, Figure 1 is a sectional view of a loom embodying the principles of my invention. Figure 2 is an elevation of one of the detachable heddle guides with the heddles assembled therewith. Figure 3 is a longitudinal section of the same on line 3—3 of Figure 2. Figure 4 is a plan view of the heddle frame with the top member thereof removed and the heddles shown in place therein. Figure 5 is a plan view of a shuttle having a spreader and weft packer embodying my invention applied thereto. Figures 5^a and 5^b are detail views respectively of the spreader and the adjuster for the spreader and weft packer. Figure 6 is an elevation of the shuttle and spreader as seen from the under side of Figure 5. Fig-

ures 7 and 8 are elevations at right angles to each other of one of the brackets which support the shuttle driving pinions and the heddle frames. Figures 9 and 10 are similar views of one of the brackets which support the adjustable warp tension devices. Figure 11 is an elevation of one of the warp tension devices. Figure 12 is a detail section on line 12—12 of Figure 11 of the tension device. Figure 13 is a plan view of one of the warp thread guiding eyes. Figures 14 and 15 are views showing developments of the cam tracks by which the heddles are driven. Figure 16 is a sectional view showing a modification which consists in a different mode of mounting the main shuttle driving gear from that shown in Figure 1. Figure 17 is an elevation showing a modified form of heddle and guiding means therefor. Figures 18 and 19 are respectively a perspective view and a plan view of the lower guide for the modified heddle construction. Figure 20 is a perspective view of the top guide forming part of such construction. Figure 21 is a horizontal section through the eye of one of the heddles shown in Figure 17.

Like reference characters designate the same parts in all the figures.

In the drawings 1 represents a table mounted on legs 2 which may rest on the floor of the mill, and on the table is secured, in any suitable manner so that it will be stationary, a cup shaped base 3 having a central tubular bearing post 4. The outer wall of this base member surrounds and protects the rotating cams which drive the heddles. Preferably such wall, the bottom of the cup, and the post 4 are all made as integral parts of one casting in the bottom of which adjacent to the post is a raceway 5 adapted to support a ball bearing 6.

Within the cup shaped base is a spider or frame 7 having a hub sleeve 8 which fits and rotates upon the post 4, the spider or frame carrying on its outer portion inner and outer substantially cylindrical shells 9 and 10 to the outer and inner faces of which respectively are secured the plates 11 and 12 which constitute the heddle driving cams.

The post 4 supports on its upper end a mandrel 13 about which the weaving takes place and by which the diameter of the tubular fabric is determined. This post is properly made to mount, in substantially the manner shown, mandrels of different diameters to produce tubes of different sizes.

On the outer end of the hub 8 is mounted, and keyed or otherwise suitably secured so that it will turn in unison with the sleeve, the hub 14 of a gear 15 which is the main
5 driving gear for the shuttles.

The rim of the cup shaped base supports a number of brackets 16 shown in detail in Figures 7 and 8. In one design of the loom there are twelve of these brackets, and they
10 are equally spaced around the circumference of the loom. The brackets rest upon the rim of the cup and are provided with bottom lugs 17 at each side through which pass bolts for securing them to the cup, and
15 on their upper ends are opposite laterally projecting lugs 18, to which is bolted a cap or covering ring 19. These brackets are all substantially radial to the loom and each carrier on the extremity which faces toward the centre upper and lower bearings
20 20, 21, in which is mounted a shaft 22. The bearings are separated to provide a space which is occupied by a pinion 23 for driving the shuttles. On the bearings also are inwardly projecting lugs 24 and 25, the upper
25 one of which has a groove or guideway 26 in its upper side and the lower one a groove or guideway 27 in its under side. These lugs with their grooves are guides for the
30 shuttles.

The shuttle which cooperates with these guides is shown in Figures 5 and 6, and it includes a base 28 curved to conform to the circular line in which the several guide lugs
35 are located, and on the outer side of such base are upper and lower runners 29 and 30 which enter the guideways 26 and 27 respectively. Between the runners 29 and 30 is mounted a gear segment 31 which is
40 adapted to enter between the lugs 24 and 25 and to mesh with the pinion 23. The runners and the gear segment are longer than the space between any two brackets so that the shuttle will be properly supported and
45 meshed with the driving means at all times and will pass into engagement with the guides and driving pinion of each successive bracket in its travel before leaving the preceding bracket. The other features and
50 structural details of the shuttle will be later described, meanwhile attention is directed to the heddle construction shown in Figures 2, 3 and 4.

The form of heddle about to be described is designed in unit groups, each group or
55 unit comprising four heddles and a frame. The frame is composed of side bars 32 and 33, a bottom cross bar 34, a top cross bar 35, and a longitudinal intermediate bar 36.
60 The width of this frame is such that it fits between two adjacent brackets 16, and its length such that it projects nearly to the bottom of the space between the cams 11 and 12. The side bars of each frame are se-
65 curely bolted or otherwise fastened to the

brackets 16 so that they are located substantially as shown in Figure 1; that is, as close as possible to the line in which the driving pinions 23 are located and therefore as close as possible to the shuttle path. In
70 each of the heddle frames are arranged four heddles in substantially the relative positions shown in Figure 4, there being inner and outer heddles 37 and 38 in the space between one of the side bars and the inter-
75 mediate longitudinal bar of the frame, and another pair of inner and outer heddles 39 and 40 in the space between this middle bar and the other side bar. The heddles are of gridiron construction consisting each of a
80 frame which fits and slides in guide grooves in the longitudinal bars of the guide frame, with intermediate heddle elements 41, each having an eye 42^a. These elements 41 may be rods or flat strips of steel or any other
85 suitable material riveted, bolted or otherwise secured to the top and bottom members of the heddle frame, those elements of the inner and outer heddles being laterally offset so that the warp thread which passes
90 through each eye of one heddle will go through the space between the elements of the other heddle. The length of the heddles is determined by the extent of shed opening and the necessity of giving them
95 such length that there will be no interference by the transverse member of any heddle with the threads guided by the adjacent heddle. From the bottom of each heddle an arm 42 extends downwardly. From the arm
100 of each inner heddle a stud 43 projects inwardly to engage the inner cam 11 and from the arm of the outer heddle a stud 44 projects outwardly to engage the outer cam 12. The parts which are here called studs are
105 preferably made as pins carrying anti-friction rolls.

Referring now to Figures 14 and 15, which show the development of the inner and outer
110 cams respectively, it will be seen that the inner cam is formed by plates, of which the edges are substantially similar but reversed and are so placed as to leave between them a groove 45 in which the stud 43 runs. This
115 groove has a substantially horizontal lower part 45^a, a substantially horizontal upper part 45^b and an inclined connecting part which merges on gradual curves with the upper and lower parts respectively. In a
120 similar manner the plates 12 which form the outer cam are so shaped and arranged as to provide a groove 46 into which the stud 44 projects, and having upper and lower substantially horizontal portions 46^a and 46^b
125 connected by inclined portions which merge with the horizontal portions on smooth curves. The features of the cam 46 are opposite to those of the cam 45, that is, any particular section of one cam which includes an upper horizontal part of the cam is be-
130

side the section of the other cam which includes a lower horizontal section, and vice versa, while the inclined parts of each cam slope oppositely to the inclined parts of the other cam, whereby the heddles of each pair are reciprocated oppositely to one another, which is the condition required to form the shed.

The cams and shuttles travel in unison and the number of inclines in each cam groove is equal to the number of shuttles, and the cams are timed with relation to the shuttles so that the shed progressively opens in advance of each traveling shuttle and changes in rear of the shuttle and in advance of the next traveling shuttle. In the loom herein illustrated there are four shuttles, but the same principles are obviously applicable to one having two shuttles or only one shuttle, or more than four.

One feature of the invention is that each of the heddles is independently removable, and to that end the top member 35 of the heddle guiding frame is removable and in the upper portion of each of the cam grooves there is an opening or gateway, the gateway to the inner cam groove being shown at 47 in Figure 14 and that to the outer cam groove at 48 in Figure 15. These gateways are adapted to permit removal of the studs 43 and 44, so that by removing the bar 35 of the frame and turning the cam to bring a gateway opposite to the driving stud of any one of the heddles, such heddle is released and may be lifted out of place. When the heddles have been removed, the guiding frame can be disconnected from the supporting brackets and removed. These features make it a simple matter to assemble the loom in the first place and afterwards to remove and substitute or repair individual heddles and their guides.

In the spaces between the brackets 16 are placed warp guides and tension devices. These comprise the following parts: Brackets 49 shown in detail in Figures 9 and 10 are secured in part to the outer wall of the base 3 and in part to the brackets 16; having lugs 50 and 51, which engage the outer side of the base, and rest on a shoulder 52 of the bracket 16, respectively. Attaching bolts or screws or the like are passed through these lugs. Each of the brackets 49 has an upwardly and outwardly projecting arm and a ledge 53. On the ledges of the adjacent brackets are mounted the ends of guide bars 54, each of which bridges the space between the two brackets and has eyes 55 equal in number to the warp threads which are controlled by any one unit group of heddles, and in which the warp threads are placed. Also fixed in brackets 49 and extending from one to the other across the space between them are a fixed bar 56, a supporting rod 57, a stop rod 58 and an adjusting bar 59. The

latter has trunnions on its ends which occupy bearings in holes 60 in the brackets, in which they are adapted to turn, and these bars are made fast by set screws 61. The adjusting bar 59 carries a series of hooks 62 equal in number to the warp threads in the particular sector of the loom, and the supporting rod or pivot rod 57 supports an equal number of tension fingers 63, each of which is connected with one of the hooks 62 by a spring 64. These fingers are adapted to swing about the rod 57, which serves as a pivot, and to bear against the stop rod 58, and each has a guide 65 formed by bending over a lug 66 provided on its outer side near the free end thereof. The warp threads are led from a creel under a guiding bar 67 which is fastened just above the floor, and thence around the tension devices, each thread passing through one of the eyes 55 in the bar 54, thence into the guide 65 of the tension finger 63 and thence around the bar 56 to the heddle, and through the eye in the heddle to the weaving point. The courses of two warp threads are indicated in Figure 1 by the broken lines 68 and 69. The function of the finger 63 is to maintain a yielding tension on the warp, giving way when the shed is opened and taking up the slack when the heddle eyes cross the plane of the weaving point. The tension may be varied by loosening the set screws 61 and turning the bar 59 one way or the other so as to stretch the spring 64 more or less.

Referring again to Figures 5 and 6, I will call attention to the adjustable self-compensating spreader and weft packer. This device comprises a bar 70 and a link 71 mounted upon brackets 72 and 73, respectively, which project from the shuttle base and carry the bobbin 74. The bar 70 is mounted upon bracket 72 by a universal joint consisting of a hinge 75, a block or plate 76 and a pivot 77. The latter pivot permits the bar to swing in and out toward and away from the weaving point and the hinge 75 permits it to swing up and down. Link 71 is connected at one end to the bar 70 by a pivot 78 and at the other end to the bracket 73 by a somewhat similar universal swivel to that already described, so that it also may move in the same manner. This link is telescopic and comprises an outer sleeve and an inner rod 79 which slides within the sleeve and is pushed outward by a spring 80. A part of this rod is formed as a screw passing through a plate 81 and carrying adjustable lock nuts 82 on opposite sides of this plate. This plate is swivelled by means of a stud 83 in a plate 84 which has a swivel stud 85 mounted and adapted to turn in a bearing in the bracket 73. Preferably the pivot connection between link 71 and bar 70 is made through an ear 86 which is riveted, bolted, brazed, welded or otherwise secured to the bar 70 and is en-

gaged with the pivot 78. A spreader 87 is mounted upon the bar 70 and is arranged so that its perimeter embraces lug 86. The opposite edges of this spreader lead divergently from the opposite sides of the bar 70 and then merge together on a smooth curve, the outline of the spreader being such as to open the shed closely adjacent to the weaving point widely enough to permit the packer to enter and crowd the filling against the weaving pin. 88 represents a plate attached to the bar 70 in any convenient manner, which carries tension devices around which the filling thread passes and from which it goes through an opening in the spreader and a passage in the packer to the weaving point.

The swivels or pivots 77, and 85 and the adjusting nuts 82 permit the packer to be adjusted with respect to the weaving pin, while the spring 80 in the telescopic link applies a pressure to the packer and also allows it to yield when necessary. The hinges or swivels 75 and 83 allow the packer and spreader to rise and descend, whereby the filling thread is allowed to take its natural course and not to be crowded too tightly or to be opened too widely as might happen if the packer were rigid and the take-up were not adjusted with perfect accuracy.

The drive for the entire loom is delivered through the gearing shown as a whole at 89 in Figure 1, to which power is delivered from any source and by which power is transmitted to a pinion 90 meshing with a gear 91 fixed to the rotating cam holder. Power is also transmitted from the same gear train through connections clearly shown in Figure 1 to a flexible shaft 92 which drives take-up rolls 93 by which the finished web is withdrawn from the loom. By adjustment of the speed of rotation of these rolls the rate of delivery of the woven tube and also the closeness of weave thereof are regulated in a manner well known in the art.

The loom construction heretofore described lends itself readily to the modified form of heddle which is illustrated in Figures 17 to 20 inclusive. Here, instead of the heddles being of gridiron form consisting of a number of rods or bars connected to one frame, the individual heddles are all separate from each other and each is independently driven by one of the cams previously described. Heddles in this modification are designated 94 and are guided in upper and lower guides 95 and 96, the former being placed across two adjacent brackets 16 and the latter having a lip 97 by which it is attached to the rim of the cup shaped base between two of the brackets. These guides have openings with grooves or guideways in their inner and outer faces adapted to receive the opposite edges of the heddles, or ribs formed upon such edges. Every alter-

nate heddle bar 94 has an inwardly projecting stud like the stud 43 adapted to engage and be driven by the inner cam, while the intermediate heddle bars have outwardly projecting studs like the stud 44 adapted to engage and to be operated by the outer cam. Thus the adjacent heddle bars are moved in alternation oppositely to one another, and they are so moved in exact correspondence with the progress of the shuttle. The modification of construction last described combines the advantage of a more exact control of the shed than is possible where each heddle comprises a number of elements rigidly connected together moving a number of ends in unison, with all the advantages of the heddle construction first described which enables a large number of ends to be brought into the loom through a small space whereby a large number of warps may be built into the tubular fabric. This modification also has the characteristic of the first described form, which consists in bringing the heddle eyes as close as they can possibly be brought to the path in which the shuttle travels.

The characteristic last mentioned is one of the most important improvements in the loom. The location of the heddles directly outside of the shuttle driving pinions, and practically as near to the same as they can be brought without interfering, causes that part of the shed which has the widest opening to be located very near the shuttle, and this makes it unnecessary either to give the heddles an excessive amount of motion or to provide the shuttle with a shed opener to enable the bobbin and associated parts to pass without interfering with the warp threads. It is true that the shuttle has strips 98 and 99 just inside the base and projecting slightly beyond the edges thereof, but these strips are merely guards to insure that the warp threads will not come in contact with the base and be soiled thereby. They are not provided for the purpose of opening the shed more widely and in the main they do not have any such effect. In machines where the heddles are at a considerable distance outside of the shuttle path it is necessary to give them an excessive range of movement, or else to provide the shuttle with a shed opener in order to avoid interference with the warps. These necessities are absent from my loom.

Various modifications may be made from the particular invention described without departing from the invention. For example, the driving gear 15 or its equivalent may be mounted directly upon the cam holding cylinder or shell 9 by means of brackets substantially as shown in Figure 16, instead of providing the gear with a hub and mounting it on the sleeve 8.

It will be readily appreciated that the

novel features of construction and arrangement herein described make the loom exceedingly compact and simple by eliminating outstanding movable parts, and by providing a cam drive for the heddles.

In the foregoing description I have used terms indicating direction, such as "up" and "down," "above," "below," etc., in reference to the particular embodiment of the machine herein illustrated and without intending to imply thereby that such machine must necessarily be vertical or must necessarily have its shuttles travel in a horizontal plane. All that the terms "vertical" and "horizontal" mean in this specification are respectively in the direction of the weaving axis and in or parallel to the plane of the shuttle path; while such terms as "above" and "below" have only the significance of one side or the other, or more or less distant from such plane.

In the following claims the term "contiguous" and words of similar meaning as applied to the heddle elements mean that adjacent heddle elements, such as the bars or rods 41 of one form or the bars 94 of the other form in each group or unit are arranged near together without the intervening guides which are a feature of certain prior constructions. By reason of this so-called contiguous arrangement it is made possible to place heddle bars nearer together and thereby to introduce a greater number of warp threads into the loom than is possible in those looms where all of the individual heddles are separated by intermediate guides.

Having now described the principles of my invention and shown a form of machine in which such principles may be embodied, I declare that what I claim and desire to secure by Letters Patent is:—

1. A circular loom including a base, brackets mounted upon said base and spaced apart in circular arrangement about a common center, shuttle driving shafts and pinions mounted upon said brackets, heddle guides mounted between the brackets in a position substantially tangent to the outer sides of the pinions, a plurality of heddles mounted to reciprocate in each of said guides, and driving cams directly engaged with said heddles formed to reciprocate oppositely to one another the heddles which guide adjacent warp threads.

2. In a circular loom, a cup shaped base having an upstanding external wall, inner and outer cylindrical cams mounted with an intervening annular space to rotate within said wall around the axis of the latter, brackets mounted on the rim of said wall projecting inwardly toward said axis, and having at their inner limits bearings adapted to mount a driving shaft and pinion and heddles mounted between said brackets

adapted to reciprocate and projecting within the aforesaid wall into said intervening space with alternate heddles in engagement with said inner and outer cams respectively to be reciprocated by the latter.

3. A circular loom comprising a base, concentric cylindrical cams mounted to rotate within the outer limits of said base, constructed and arranged with an annular space between them, and with cam paths on those surfaces of such cams which form the walls of such space, brackets mounted on said base spaced about the center of the loom and extending over the cams toward such center, heddle guides secured to said brackets and crossing the spaces between them, and heddles fitted to reciprocate in said guides and having means, connected with alternating heddles, for engagement respectively and exclusively with one or the other of said cams.

4. A circular loom according to claim 3 in which the heddle guide is a frame secured to the contiguous brackets and projecting therefrom into the annular space between said cams.

5. A circular loom according to claim 4 in which the heddle guide is a frame having longitudinal side members secured to the adjacent brackets and projecting into the annular space between the cams, said longitudinal side members having parallel guideways, and the heddles being constructed as frames each occupying one of the guideways in both side members and having elements provided with eyes for the yarn, each of said heddles having likewise an extension passing into engagement with one of the cams, the adjacent heddles being thus engaged with different cams.

6. In a circular loom, the combination with a circular series of brackets, of substantially rectangular frames arranged between said brackets, cylindrical cams coaxial with said series of brackets, one of which has a cam groove in its inner face and surrounds the lower ends of said frames and the other of which is within the frames and has a cam groove in its outer face, and a pair of heddles mounted in each of said frames to slide back and forth lengthwise; one heddle of each pair having a projection entering the groove of the outer cam and the other having a projection entering the groove of the inner cam, the heddles being removable from one end of the frame, and the cams having gateways adapted to be brought beside said projections respectively and through which the projections may pass when the heddles are so removed.

7. In a circular loom, the combination with a circular series of brackets, of heddle guides mounted upon and between said brackets, a set of relatively movable heddle members mounted upon said guides, certain

of the members having pins projecting outwardly and others having pins projecting inwardly, inner and outer cylindrical cams concentric with the said series of brackets
5 arranged with an annular space between them into which said heddle members project, the outer cam having a cam groove on its inner surface receiving the aforesaid
10 outer projections and the inner cam having a groove on its outer face receiving said inner projections, whereby the cams are adapted to reciprocate the heddle members.

8. In a circular loom, the combination with a circular series of brackets, of heddle
15 guides mounted upon and between said brackets, a set of relatively movable heddle members mounted upon said guides, certain of the guides having pins projecting outwardly and others having pins projecting
20 inwardly, inner and outer cylindrical cams concentric with the said series of brackets arranged with an annular space between them into which said heddle members project, the outer cam having a cam groove on
25 its inner surface receiving the aforesaid outer projections and the inner cam having a groove on its outer face receiving said inner projections, whereby the cams are adapted to reciprocate the heddle members,
30 and each of said cams having a gateway adapted to be brought into registry with the projections of the several heddle members, whereby said members may be disengaged from the cams to permit removal of the
35 members.

9. The combination with a support of a series of brackets spaced apart on said support and arranged to surround a central point, upper and lower guides connected to
40 said brackets and bridging the space between

them, each of said guides having closely adjacent guideways, separate heddle bars arranged in said guideways and movable independently of one another, and inner and
45 outer cylindrical cams co-axial with said brackets and arranged with a space between them into which the lower ends of said heddle bars project, adjacent bars having pins extending laterally in relatively opposite
50 directions and being engaged with the inner and outer cams respectively, whereby said cams are enabled to reciprocate the heddle bars next contiguous to one another independently of each other.

10. In a circular loom the combination of
55 a shedding mechanism and a gear driven shuttle motion which comprises a circular series of brackets having provisions for supporting shuttle driving means and provisions for supporting and guiding a shuttle, 60 a base by which said brackets are firmly supported and held in a circular arrangement surrounding the center of the loom, coaxial cylindrical cams mounted to rotate
65 about the axis of the loom within said base and beneath said brackets, having an annular space between them and having cam paths in their walls which define such annular space, heddle guides arranged in the
70 spaces between adjacent brackets, and a multiplicity of heddle elements mounted in each of said guides reciprocatively, and said heddle elements having projections extending into the annular space between the cams and into engagement alternately with the
75 cam paths on the different cams.

In testimony whereof I have affixed my signature.

JAMES HIRST.