L. A. SUBERS.

MACHINE FOR CONSTRUCTING A LAMINATED COHESIVE INTERWOUND FABRIC BAND.

APPLICATION FILED OCT. 22, 1913.

1,188,571.

Patented June 27, 1916.

12 SHEETS—SHEET 1.

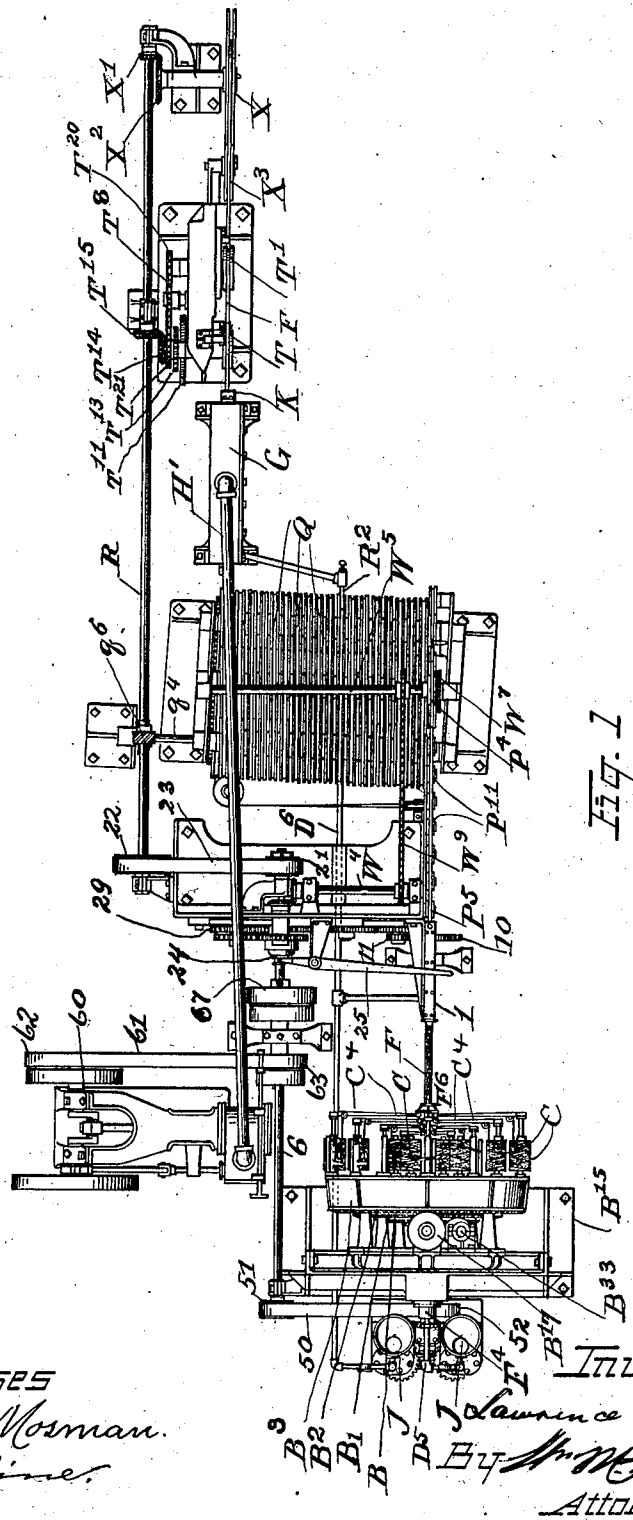


Fig. 1

Witnesses
Ernest Mosman.
S. L. Spline.

Inventor
Lawrence A. Subers
By Wm. M. Maguire
Attorney

L. A. SUBERS.

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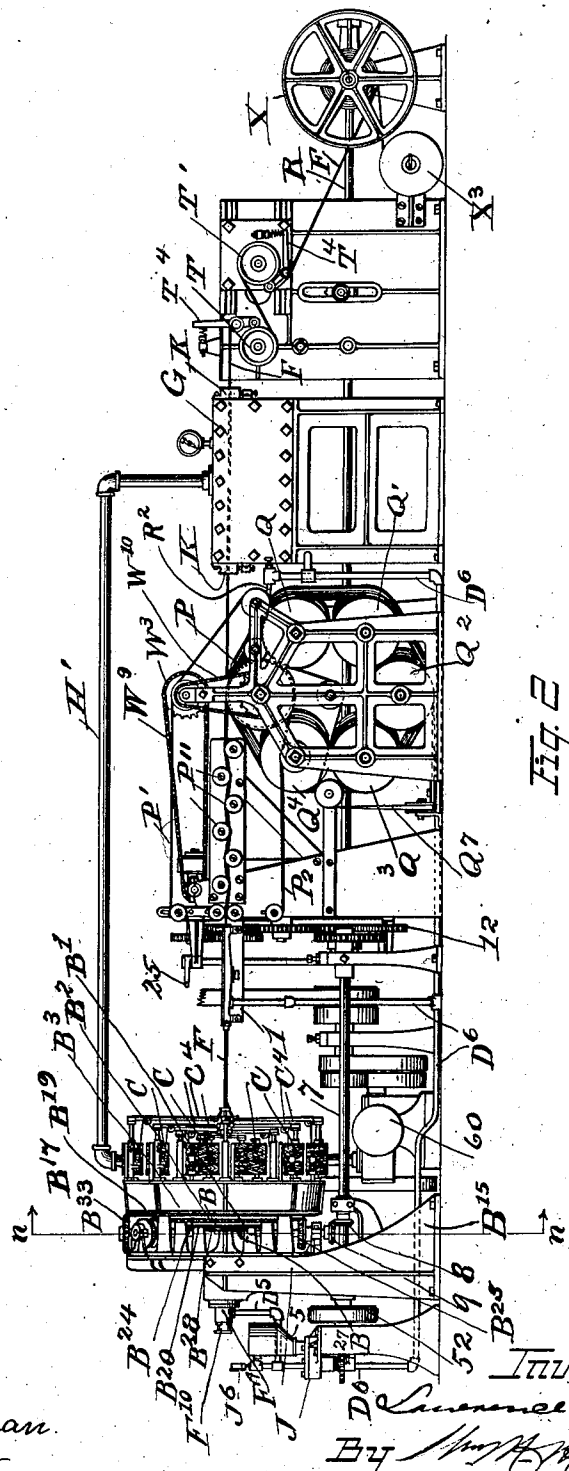


Fig. 2

Witnesses.
Ernest Mosman.
S. L. Siline.

Inventor
Lawrence A. Subers
By Wm. M. Hoyne
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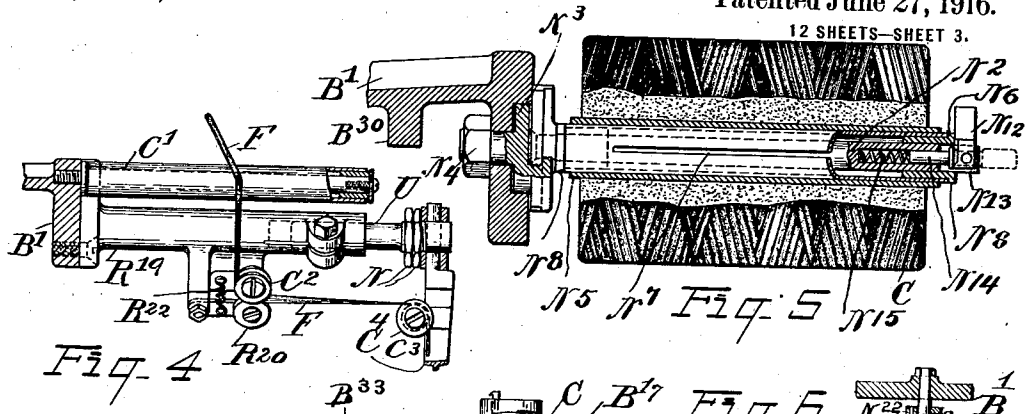


Fig. 4

Fig. 5

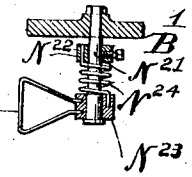


Fig. 6

Fig. 3

Witnesses
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Inventor
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By Wm. M. O'Connor
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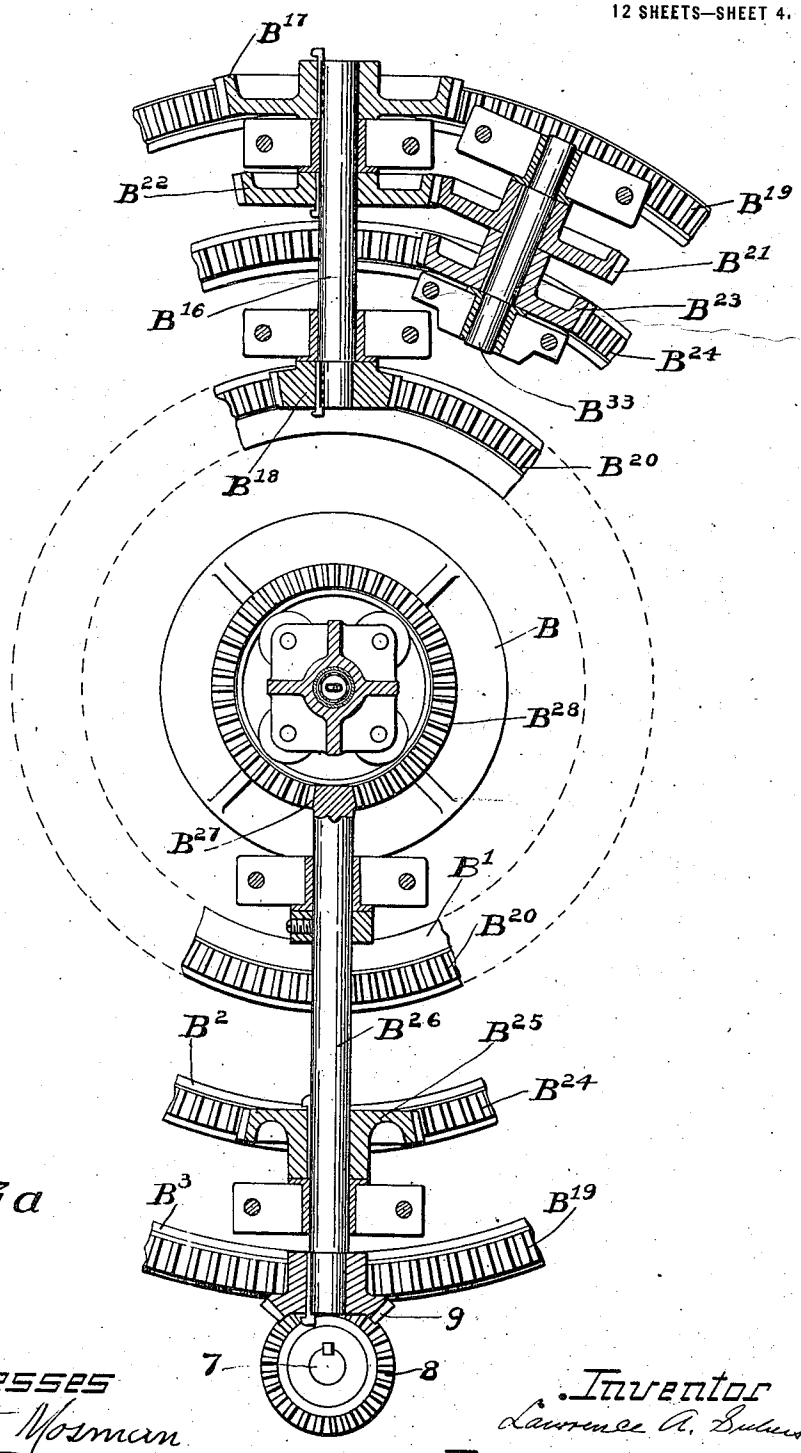


Fig. 3a

Witnesses
Ernest Mosman
S. L. Cline.

Inventor
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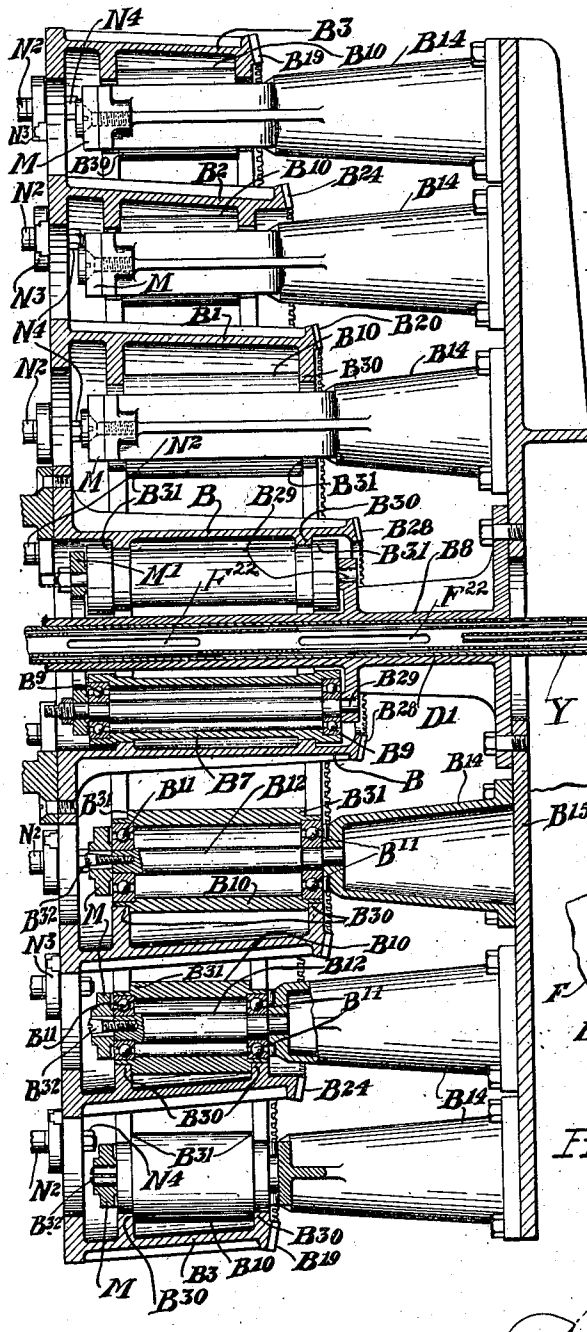


Fig. 7

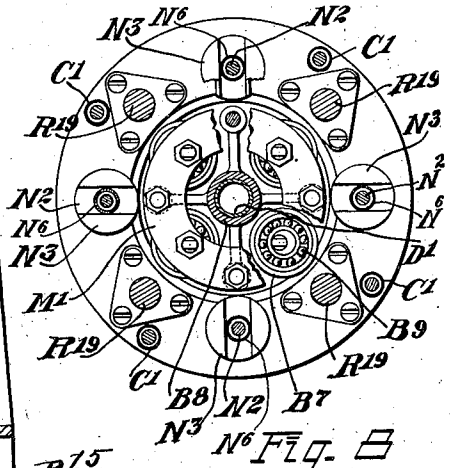


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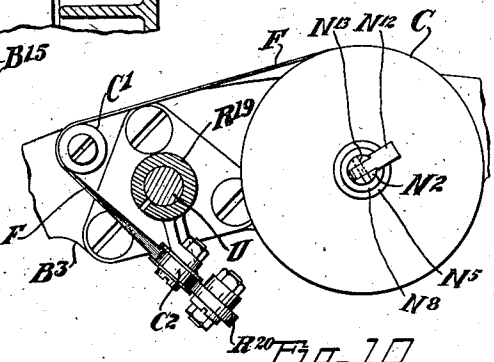


Fig. 10

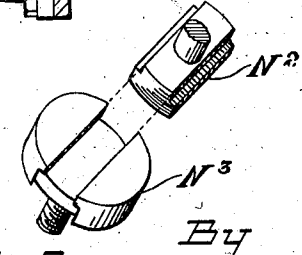


Fig. 9

Witnesses

Ernest Mosman

S. L. Spline.

Inventor

Lawrence A. Subers

Wm. M. Monroe

Attorney

L. A. SUBERS.

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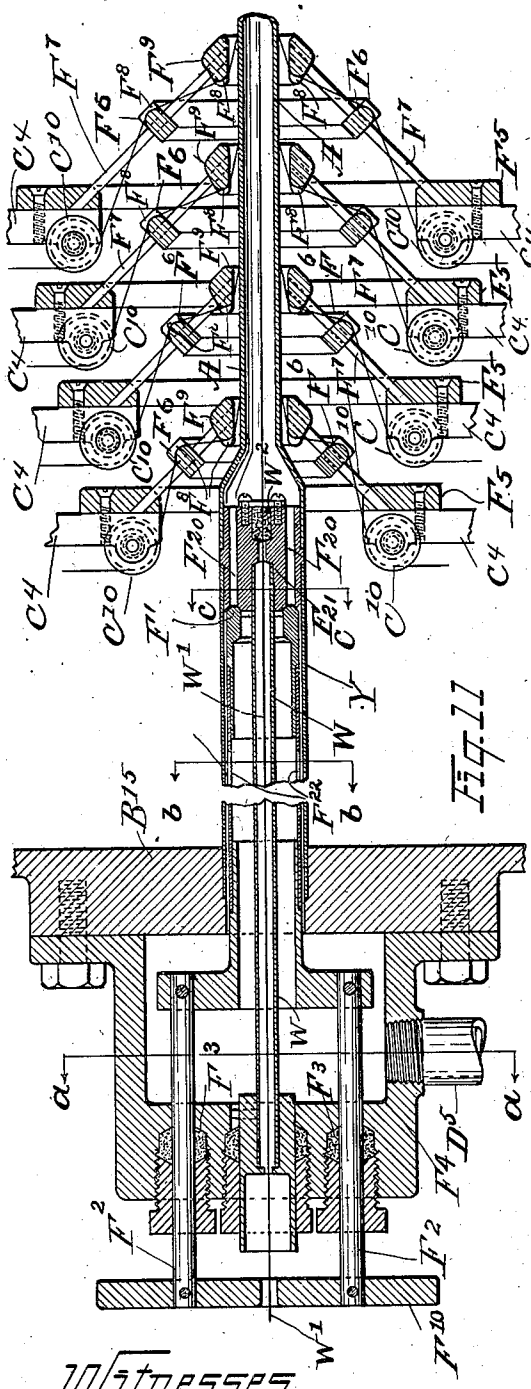


Fig. 11

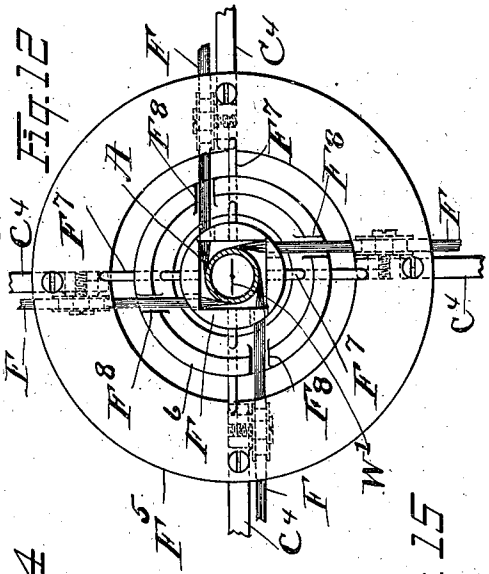


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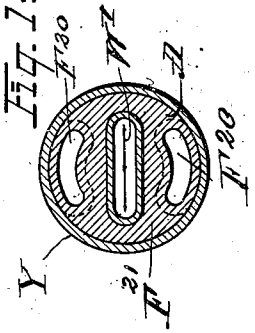


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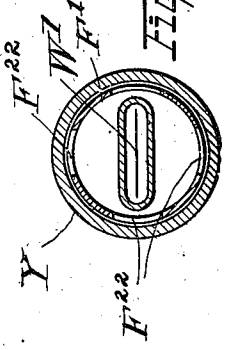


Fig. 15

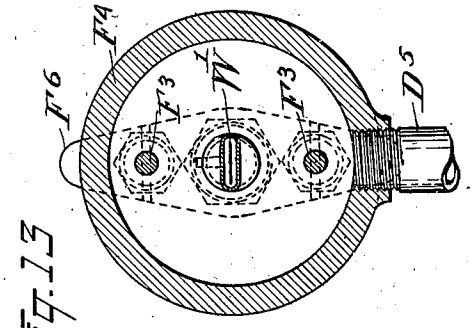


Fig. 13

Witnesses
Ernest Mosman.
S. L. Spline

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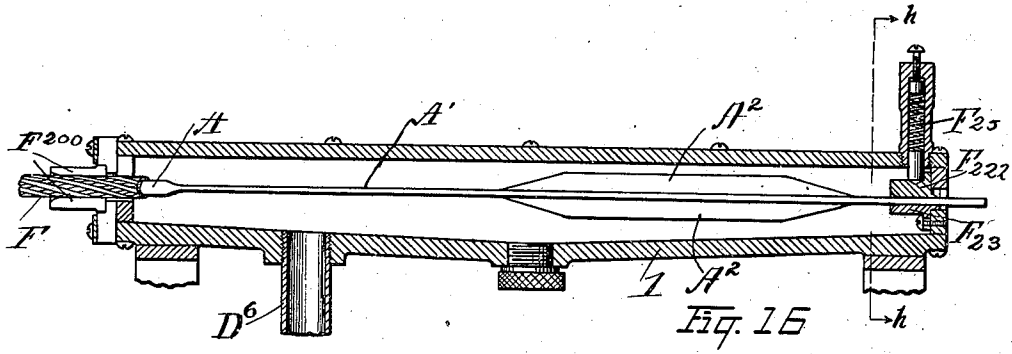


Fig. 16

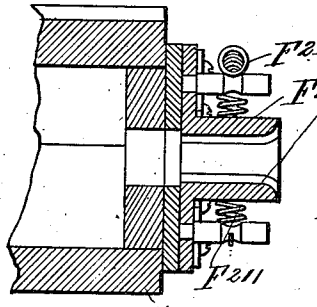


Fig. 21

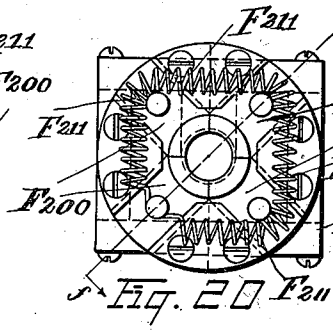


Fig. 20

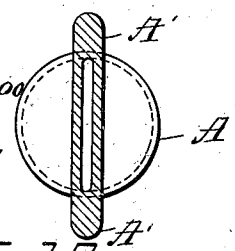


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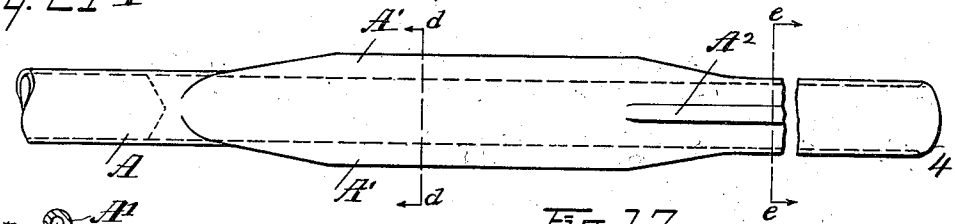


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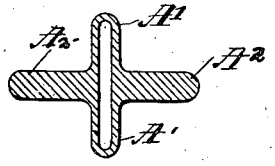


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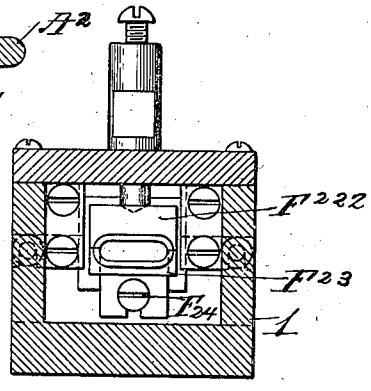


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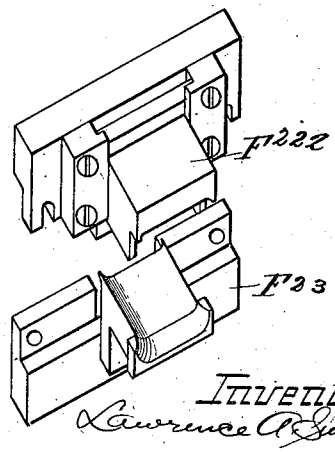


Fig. 23

Witnesses
Ernest Nosman.
S. L. Spline

Inventor
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By Wm. M. Morrison
Attorney

L. A. SUBERS.

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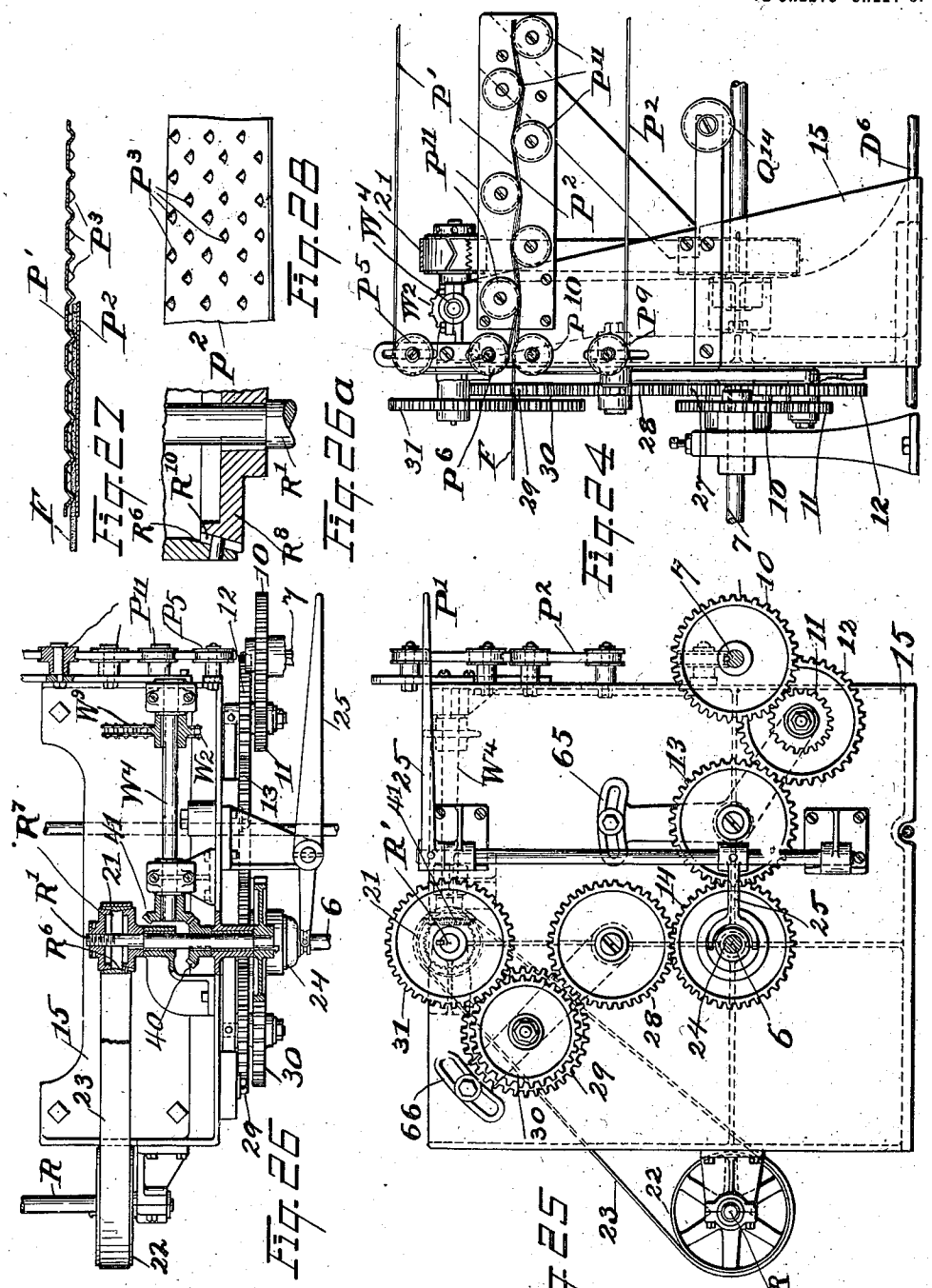


Fig. 24

Fig. 25

Fig. 26

Fig. 26a

Fig. 27

Fig. 28

Witnesses
Ernest Mosman.
S. L. Eglinne

Inventor
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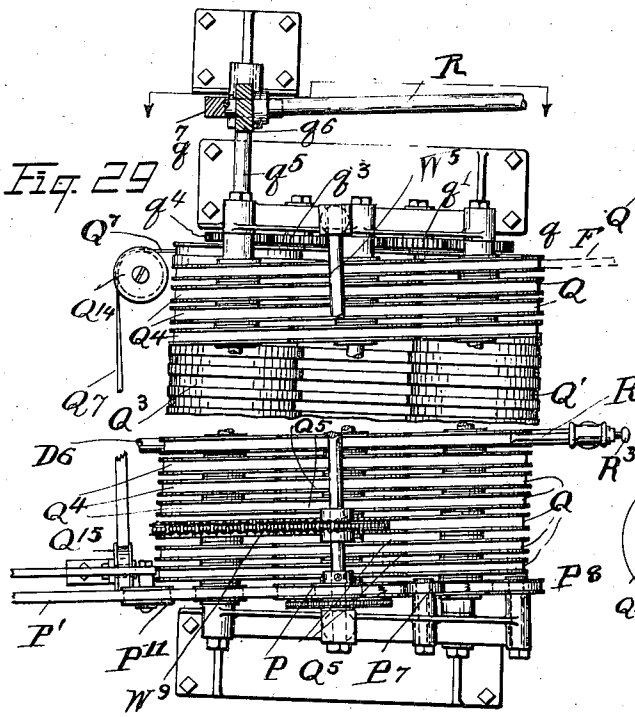


Fig. 29

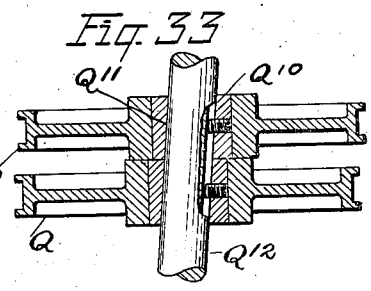


Fig. 33

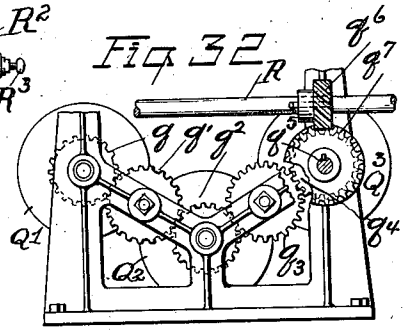


Fig. 32

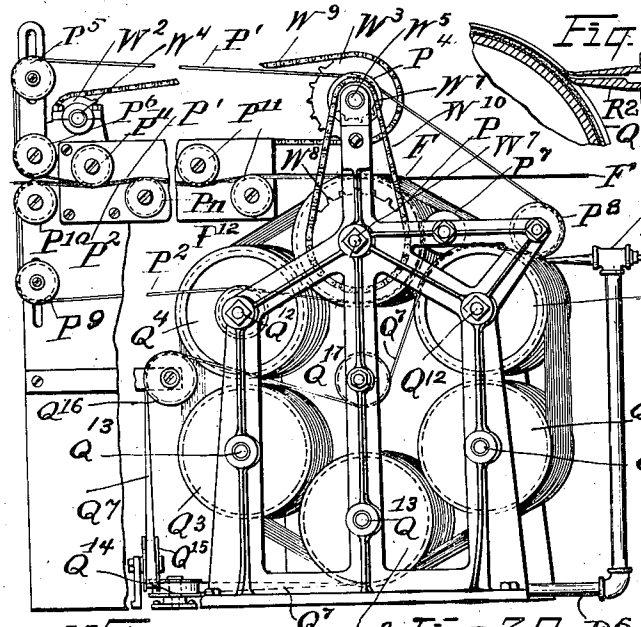


Fig. 30

Fig. 34

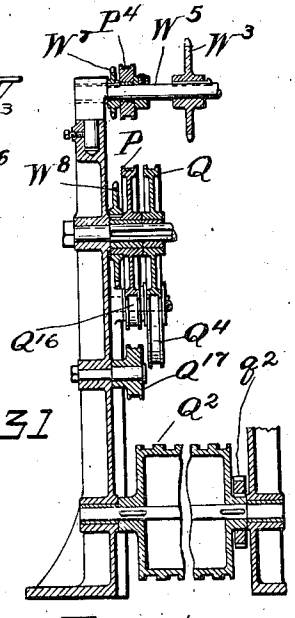


Fig. 31

Witnesses

Ernest Norman.

S. L. Eline.

Inventor

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By Wm. M. Morrow

Attorney

L. A. SUBERS.

MACHINE FOR CONSTRUCTING A LAMINATED COHESIVE INTERWOUND FABRIC BAND.

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12 SHEETS—SHEET 10.

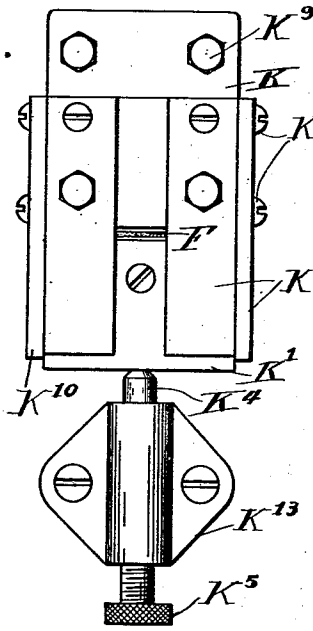


Fig. 37

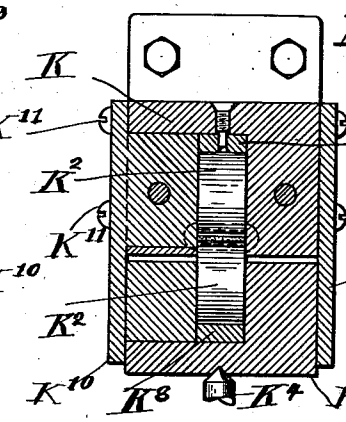


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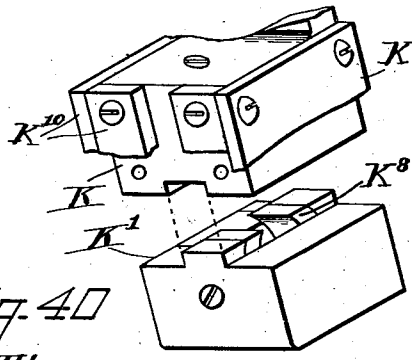


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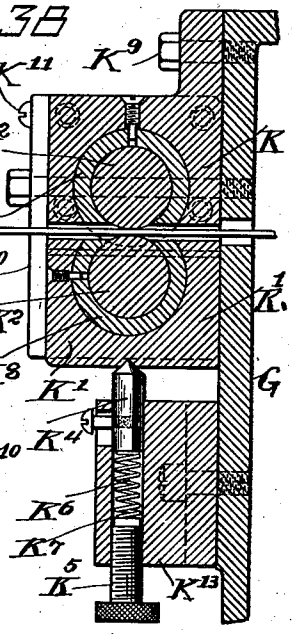


Fig. 39

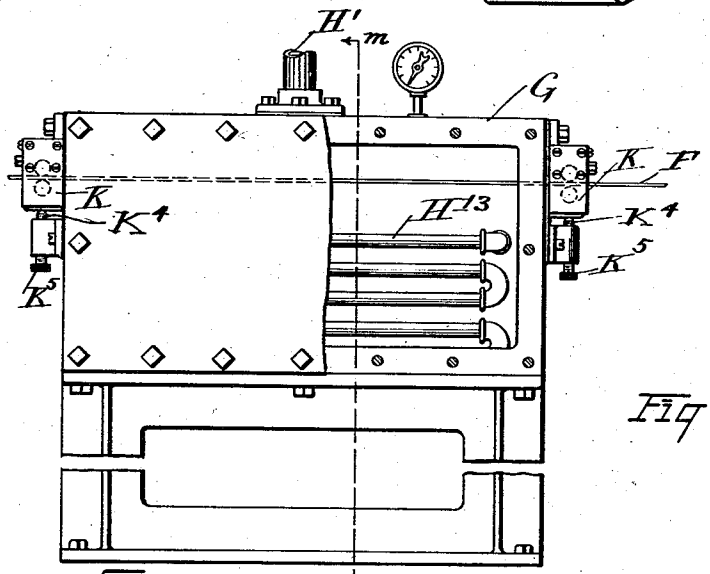


Fig. 35

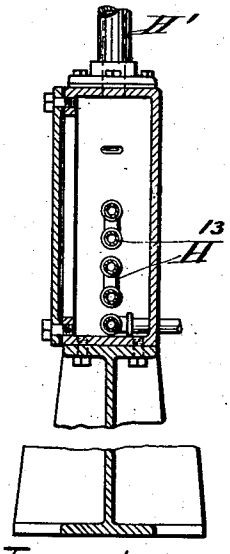


Fig. 36

Witnesses

Ernest Mosman.

S. L. Sylvine.

Inventor

Lawrence A. Subers

By Wm. M. Mosman

Attorney

L. A. SUBERS.

MACHINE FOR CONSTRUCTING A LAMINATED COHESIVE INTERWOUND FABRIC BAND.

APPLICATION FILED OCT. 22, 1913.

1,188,571.

Patented June 27, 1916.

12 SHEETS—SHEET 11.

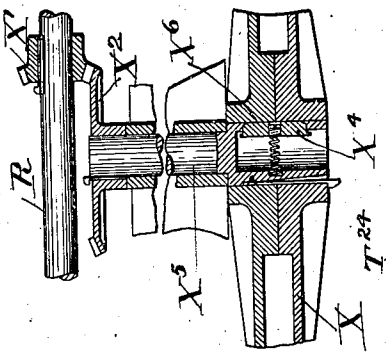


Fig. 43

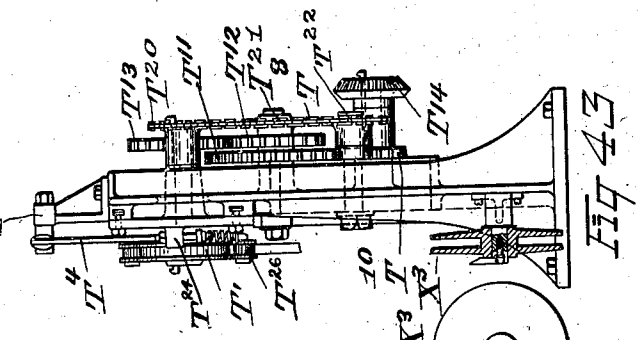


Fig. 45

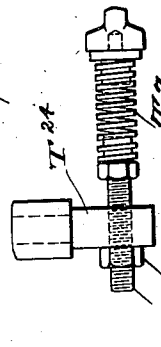


Fig. 46

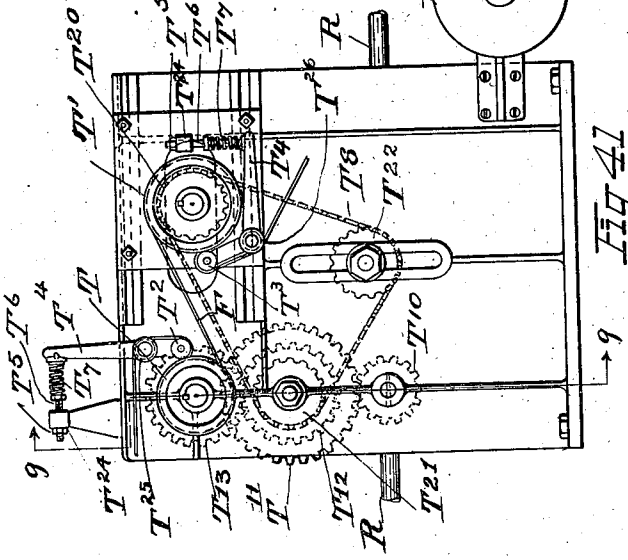


Fig. 47

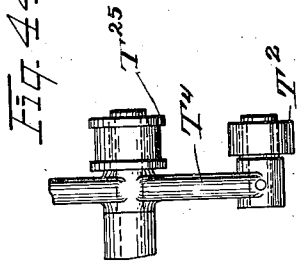


Fig. 44

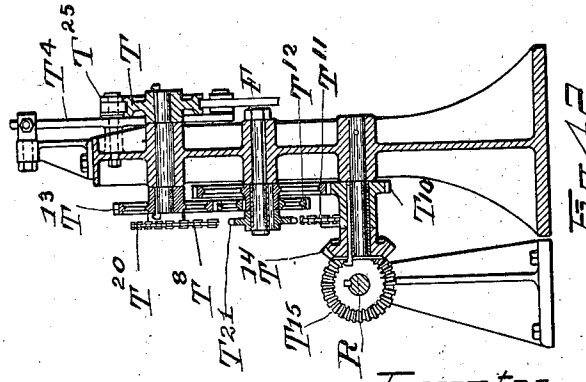


Fig. 42

Witnesses
Ernest Mosman.
S. L. Sylvine.

Inventor
Lawrence A. Subers
By Wm. M. Monroe
Attorney

L. A. SUBERS.

MACHINE FOR CONSTRUCTING A LAMINATED COHESIVE INTERWOUND FABRIC BAND.

APPLICATION FILED OCT. 22, 1913.

1,188,571.

Patented June 27, 1916.

12 SHEETS—SHEET 12.

Fig. 50

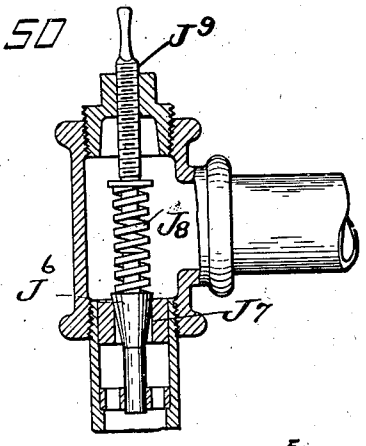


Fig. 49

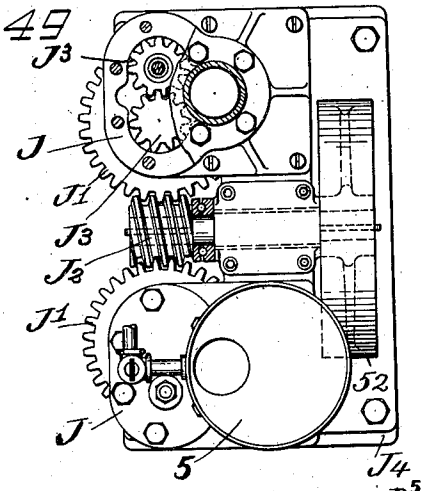


Fig. 47

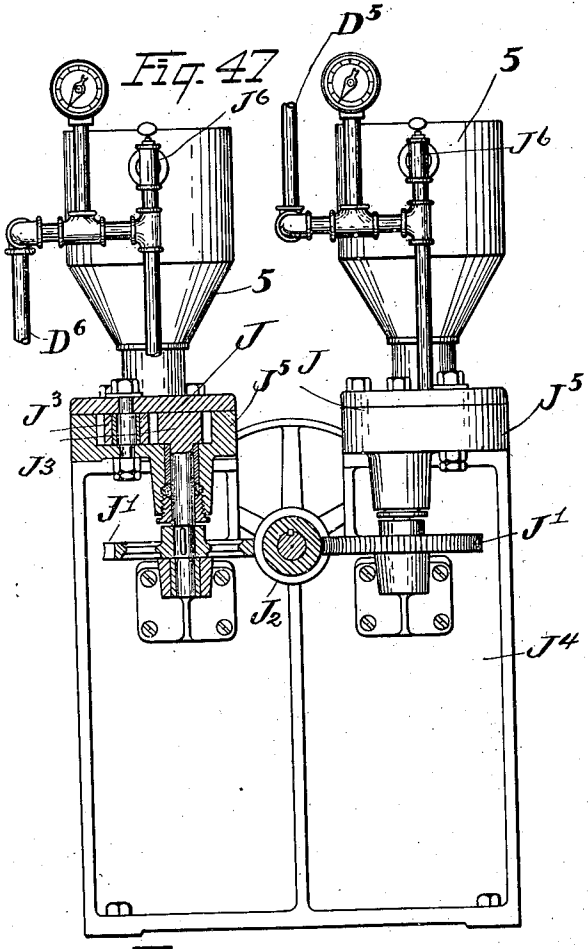
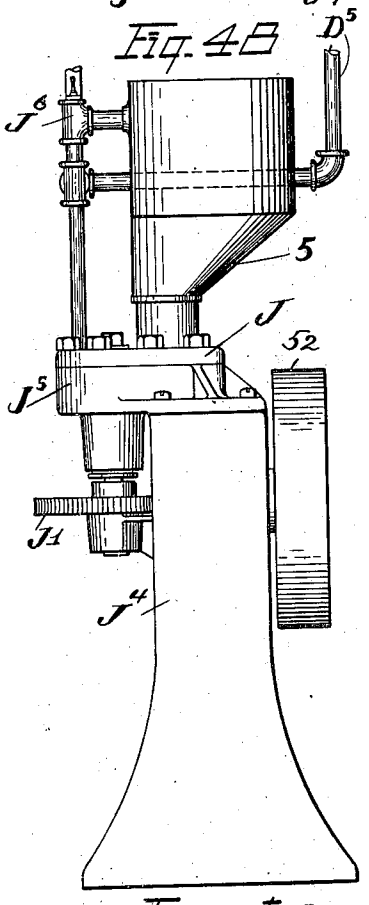


Fig. 48



Witnesses

Ernest Mosman.

S. L. Spline.

Inventor

Lawrence A. Subers

By Munn & McCormick

Attorney

UNITED STATES PATENT OFFICE.

LAWRENCE A. SUBERS, OF EAST CLEVELAND, OHIO.

MACHINE FOR CONSTRUCTING A LAMINATED COHESIVE INTERWOUND FABRIC BAND.

1,188,571. Specification of Letters Patent. Patented June 27, 1916.

Application filed October 22, 1913. Serial No. 796,592.

To all whom it may concern.

Be it known that I, LAWRENCE A. SUBERS, a citizen of the United States, and resident of East Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Machines for Constructing a Laminated Cohesive Interwound Fabric Band, of which I hereby declare the following to be a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

The objects of the invention are to provide efficient and practical means for forming an unwoven, laminated, cohesive, interwound fabric band, consisting of yarn elements, and in coating and permeating the yarn elements and band with liquid rubber or other adhesive material, the yarn elements being interwound and laminated upon a preferably hollow tube or mandrel to form a fabric tube which is afterward collapsed to a band form, having a selvage edge, the rubber being preferably solidified by evaporating the solvents contained therein, by exposing them upon suitable conveying devices to the drying influence of the atmosphere, or other drying agencies, so that the yarn elements and finished band are sufficiently treated with coating material for the adhesion desired, and for vulcanization if rubber is used as the coating substance.

In order that the bands produced from the machine may have special characteristics derived from the method of interwinding and coating, the preferred manner of interwinding, laminating, and coating the bands may be described as follows:

First of importance are the mechanical means employed for interwinding and laminating the yarn elements at any predetermined angle upon a mandrel, so that the extensibility of the finished compressed band can be controlled according to the angle at which the yarn elements are laminated, as for instance at 2°, 4°, 7°, or 10° or at a greater or less angle as may be desired, or a portion of the yarn elements may be laid parallel to the mandrel by the non-rotation of the reel upon which the same are stored. The mechanical means include specially designed and constructed reels which rotate about a hollow forming tube or mandrel, alternate reels rotating preferably in opposite directions, to interwind and laminate thereon a series of yarn elements, under a predetermined amount of tension. These yarn elements are stored on spools or tubes rotatably mounted on said reels, said yarn elements being guided to and spaced about the mandrel at equal intervals. A series of adjustable spacing devices are important to the proper action of the machine and are employed when constructing bands having different angles of interwinding. In forming these laminated, cohesive, interwound bands at various angles by the several means herein described, slightly different forms of mandrels or forming tubes may be required, the lengths and diameters of the several portions thereof varying according to the angle of interwinding desired.

Further features of the invention consist in means for impregnating the fabric band with the coating material and which comprise preferably a chamber filled with the coating material maintained under pressure and through which the mandrel passes, and laterally extended vanes upon the mandrel which are set at a predetermined angle to each other thereon, and which widely separate the band elements in their passage through the coating chamber. A number of such expanding vanes permit a lesser amount of expansion over each individual vane, and thereby decrease the amount of the pulling force required. By means of this expansion the crossing points of the yarn elements are changed, and also their normal angle to the longitudinal axis of the mandrel is changed, so that the coating material has access to every part.

Next in importance is a pulling device adapted to pull the fabric from the mandrel at a predetermined rate of speed relative to the rate of speed of the winding reels, and preferably consists of upper and lower metal bands which move with the fabric band against the tension of the yarns and against the resistance due to the friction upon the mandrel. The fabric band is held between the upper and lower metal bands, one or both of which are provided with projections which hold the fabric band under adjustable resilient pressure, and maintain a firm hold upon the band and prevent the distortion and narrowing thereof under the pulling strain. Means are also provided for regulating the speed of the pulling devices, and separate means are employed for regulating

the speed of rotation of the reels, thus providing two methods of regulating the comparative rates of speed of the winding and pulling devices.

An important feature comprises a series of drums and rolls over which passes an endless belt whose speed is so controlled that the fabric band is delivered thereto with comparatively no tension, whereby its desired width is maintained, and, while being conveyed thereover, the latter is exposed to the drying action of the air which partially evaporates the solvents in the coating material. Means for quickly extracting the remaining solvents and gases in the coating material on the fabric band and which might necessitate long exposure to the air is provided by passing the fabric band through a chamber wherein a predetermined amount of heat and percentage of vacuum are maintained. Also, according to the coating material to be treated, compressed air, or gas, or a mixture of gases with or without the application of heat or cold may be used therein to attain the purpose desired. The solvents which are evaporated from the coating material on the band and which in the case of liquid rubber compositions are reduced to gaseous form by the action of the vacuum drying chamber, may be allowed to escape from the exhaust of the vacuum pump or may be condensed by the usual method and reclaimed, as may be desired.

Means are also provided for producing a predetermined amount of stretching of the fabric band so that its extensibility in a fabric made therefrom can be controlled as desired.

A hollow flat mandrel permits the passage of a layer or ribbon of the adhesive material to the interior of the fabric band, or a band of metal or other flexible substance may be passed therethrough, with or without a coating compound to the interior of the fabric band providing a permanent reinforcement therefor.

The invention also provides means by which an adhesive coating of various compositions may be applied to the constituent yarns after they have been interwound and laminated on the mandrel and means for temporarily expanding the band to give access for the coating to all the yarns, and finally means by which a coating of still different composition or material may be applied to the outside of the fabric band if desired.

Finally the invention includes means for winding the finished fabric band upon a suitable reel and for interwinding a band of non-adhesive material to protect the coils of the fabric band from adhering together.

The invention further includes the combination and arrangement of parts, and construction of details, hereinafter further described, shown in the accompanying drawings, and specifically pointed out in the claims.

In the accompanying drawings Figure 1 is a plan view of the complete machine showing the reels, drying mechanism, vacuum chamber, stretching device and winding devices; Fig. 2 is a side elevation of the same; Fig. 3 is a face view of the several spool carrying reels showing the driving mechanism therefor; Fig. 3ª is a transverse section on line *n—n* Fig. 2 showing the gearing arrangement for driving the reels; Fig. 4 is a side elevation of the guide rollers for the yarns; Fig. 5 is a longitudinal section of one of the spools and its support; Fig. 6 is a detail view of one of the spring tension devices for the spools; Fig. 7 is a longitudinal section of the mandrel and reels which rotate thereabout; Fig. 8 is a face view of one of the reels showing ball bearings therefor; Fig. 9 is a perspective view of one of the spool supports; Fig. 10 is an enlarged view showing a portion of a reel, a spool, and guides for yarns; Fig. 11 is a longitudinal section of the mandrel, and guide rings over which the yarns are fed to the mandrel, and the valve which controls the supply of rubber to the interior thereof; Fig. 12 is a face view of one of the ring shaped guides, and the yarn guiding rollers therefor; Fig. 13 is a transverse section on line *a—a* Fig. 11 of the mandrel and supports; Fig. 14 is a transverse section on line *c—c* Fig. 11 of the mandrel, and Fig. 15 is a similar section on line *b—b* Fig. 11; Fig. 16 is a longitudinal section of the coating chamber showing the laterally extended mandrel therein; Fig. 17 is a plan view of the mandrel shown in Fig. 16; Fig. 18 is a transverse section of the mandrel on line *d—d* Fig. 17; Fig. 19 is a similar section taken on line *e—e* Fig. 19; Fig. 20 is a face view of the entering gate leading to the coating chamber; Fig. 21 is a section thereof taken on line *f—f* Fig. 20; Fig. 22 is a transverse section of the coating chamber on line *h—h* Fig. 16; Fig. 23 is a perspective view of the various parts of the outlet gate leading from the coating chamber; Fig. 24 is a side elevation of the driving mechanism for the various parts of the machine; Fig. 25 is a face view thereof; Fig. 26 is a horizontal section through the center line of the upper driving shaft; Fig. 26ª is a longitudinal section of the expansion pulley shown in Fig. 26; Fig. 27 is a longitudinal section showing the propelling bands for the fabric band; Fig. 28 is a perspective view of a portion of the upper band; Fig. 29 is a plan view of the drying device; Fig. 30 is a side elevation thereof; Fig. 31 is a vertical section through the center thereof; Fig. 32 is a face view of spiral and spur gears employed in driving the

drying drums; Fig. 33 is a transverse section of the upper drying rolls and inclined bearings therefor; Fig. 34 is a vertical section showing the method of supplying an exterior coating to the band while on the drying device; Fig. 35 is a side elevation of the vacuum and heating chamber; Fig. 36 is a transverse section thereof on line *m—m* Fig. 35; Fig. 37 is a face view of one of the gates leading to and from the vacuum chamber; Fig. 38 is a transverse section thereof, and Fig. 39 is a longitudinal section thereof; Fig. 40 is a perspective view of the principal parts thereof; Fig. 41 is a face view of the band stretching device; Fig. 42 is a transverse section thereof on line *g—g* Fig. 41; Fig. 43 is an edge view thereof; Fig. 44 is a view of the pressure levers employed in the stretching device; Fig. 45 is a view of pressure applying means therefor; Fig. 46 is a section showing driving gears for the winding device; Fig. 47 is a partial vertical section of the rubber pressure pumps; Fig. 48 is a side elevation thereof; Fig. 49 is a plan view thereof; Fig. 50 is a section showing the pressure regulating valve.

In these drawings the construction and operation of the reels is in all cases shown to be the same and is illustrated in Figs. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11 in detail. Here B, B′, B^2 and B^3 are four reels arranged to rotate, one within the other, about a central stationary standard B^8 on the frame B^{15} and supporting a tube Y for the passage of fluid rubber therethrough. The inner reel B (see Fig. 3) is mounted upon the rollers B^7 secured in the arms of the standard B^8. Within the rollers B^7 are secured the roller or ball bearings B^9 to decrease the friction, thereby reducing the power for operation. The rollers are mounted upon spindles B^{29}. The other reels are mounted upon rollers B^{10}, B^{10}, having ball bearings B^{11}, B^{11}, and rotating upon spindles B^{12}, secured in brackets B^{14}, upon the bracket or frame B^{15}. The spindles B^{12} and B^{29} upon which the rollers B^7 and B^{10} rotate are eccentrically mounted to permit of fine adjustment of the reels so that they will operate in concentric paths. This adjusting means also permits of bringing the rollers B^7, B^7 and B^{10}, B^{10} into and out of engagement with the reels so that the reels can be easily put in place or removed when desired. When the rollers and reels are in engagement the flanges B^{30} on the reels engage shoulders B^{31} on the rollers and the reels cannot be removed until the eccentric spindles are turned. Plates M, M, secure the outer ends of the spindles B^{12}, B^{12}. Taper plugs B^{32} screwed into the split ends of the eccentric spindles B^{12}, B^{12} clamp them to plate M, so that they cannot turn when the machine is in operation. A ring M′ supports the outer ends of the spindles B^{29}, B^{29}.

A reel operating shaft B^{26}, shown in Figs. 2, 3, and 3^a, is provided with two bevel gears B^{27} and B^{25} which engage the marginal gears B^{28} and B^{24} on the respective first and third reels B and B^2 and rotate them in the same direction. The other reels, viz. the second and fourth, B′ and B^3 are rotated in the reverse direction by means of the marginal gear B^{24} engaging the bevel gear B^{23} on the short shaft B^{33}, the bevel gear B^{21} on shaft B^{33} engaging gear B^{22} on the short shaft B^{16}, bevel gears B^{18} and B^{17} thereupon respectively engaging the marginal gear B^{20} on the second reel B′ and marginal gear B^{19} on fourth reel B^3. Upon each reel is mounted a predetermined number of rotatable spools C, C upon which the yarn elements composing the band are stored for use. These yarn elements in the fabric described consist of flat strips composed of groups of loose yarns lying parallel to each other and of a predetermined number and diameter and are applied to the mandrel as the reels revolve about it, all the spools being filled with similar yarn elements composed of loose yarns equal in the number of yarns so that all the yarn elements which compose the band will be exactly alike. The spools are adjustably secured to the reels by means of stems N^2 slidingly movable in transversely grooved bases N^3 and clamping nuts N^4 as shown in Figs. 5, 7, 8, 9 and 10, and are spaced thereon in such a manner as to apply the yarn elements in equally spaced rows upon the mandrel, to form the laminated-cohesive-interwound band. In each spool the yarn elements are wound upon a tube N^5 as shown in Fig. 5 which can be forced by light pressure upon a special tube N^6 having one or more longitudinal slots N^7, and slightly expanded to provide the spring pressure to hold the spool C and having at each end self-lubricating bushings N^8, N^8 which bear on the stem N^2 on which therefore the spool C rotates. A locking arm N^{12} pivoted upon a projecting end N^{13} of the stem N^2 and engaged by a pin N^{14} pressed by a spring N^{15} longitudinally secured in the stem N^2, holds the spool C from coming off the stem N^2 but when turned to the position shown in dotted lines Fig. 5 permits the spool and tube N^6 to be withdrawn.

Elongated guide rollers C′, C′, (see Figs. 3, 4, 7, 8 and 10) first receive the yarn elements from the spool and guide them between pairs of flanged and spring pressed guide rollers C^2, C^2 and R^{20}, R^{20}, the spring R^{22} providing a predetermined amount of tension, and thence to the flanged guide roller C^3, C^3 rotatably mounted upon the radial rods C^4, C^4.

The rods C^4 extend across the faces of

the reels and are spaced out from the faces of the reels and from each other so as not to interfere with each other as the reels revolve in the opposite directions. For convenience in gaining access to the spools the rods C^4 are set substantially directly over each other on reels rotating in the same direction. If the rods are spaced out too far apart or not far enough apart the yarn elements will overlap, depending upon the width of said elements and the diameter of the mandrel or forming tube. They are adjustable by means of pins U, U, which in turn are secured in split clamping supports R^{19}, R^{19} on which the rollers C^2, C^2 are mounted. Lock nuts N, N, secure the rods C^4 in place, while their inner ends are provided with terminal guide rollers C^{10}, C^{10}.

A coiled spring N^{24} mounted upon a stem N^{21} and adjustable by the set collar N^{22} operates the sleeve N^{23}, to which is attached a pressure finger N^{20} which rests upon the spool of yarns and exerts a constantly decreasing amount of pressure upon the spool, as the diameter of the spool decreases, and hence provides a practically constant tension upon the yarns as they pass to the mandrel.

As shown in Figs. 1, 2, 11 and 12, the alternate reels rotate in opposite directions and the rods C^4, C^4, from each reel shown as four in number are secured at their lower ends to rings F^5, F^5. The four guide rods C^4, C^4, are secured to and equally spaced about these rings and the rollers C^{10} pass the yarn elements F inside the rings F^5, F^5, which form the supports for second and third guide rings F^6, F^6 and F^9, F^9. Rods F^7, F^7 connect the rings for each set of guide rods C^4, C^4. The guide rings F^6, F^6, are provided with four channels F^8, F^8 on their outer faces and guide rings F^9, F^9, are provided with four channels F^8, F^8 on their inner faces, through which the yarns pass directly to the mandrel A at the predetermined angle. The channels F^8, F^8 are so arranged as to bind the yarn elements and prevent them from slipping or drawing sidewise out of proper alinement and yet permitting them to be pulled freely off from the reels. In this manner the guides are brought as near to the surface of the mandrel A as the angle of winding will permit and are spaced apart at a predetermined distance.

The yarn elements are guided to the hollow mandrel A by means described, and are interwound on the cylindrical portion by the rotation of the reels B, B′, B^2 and B^3. The mandrel A is attached to the tube Y which passes through the hollow standard B^8 and is secured to the bracket B^{15}. Through the mandrel A is forced the interior coating material for the fabric band by means of the pipe D^5. The forward extremity of the mandrel is free for the passage of the band thereover, and the outer end is open at 4 permitting the issue of the coating material to the center of the band. The flow of liquid rubber and other adhesive material through the mandrel to coat the interior of the fabric band is governed by the cylindrical valve F′, which closes openings F^{20}, F^{20} in a seat F^{21}, Fig. 11. The valve is operated by rods F^2, F^2, which pass through stuffing boxes F^3, F^3 in the hollow head F^4 into which the inlet pipe D^5 for rubber leads. Openings F^{22} permit the coating material to surround the valve so that it will not stick. A guide tube W permits the passage of a metallic core W′ into the hollow mandrel A when it is desired to insert the core into the fabric band. The metal core passes through a stuffing box W^2 and is coated in the hollow mandrel. These rods F^2, F^2 are manually operated by a cross bar F^{10} allowing the passing of rubber through the mandrel when the valve F′ is opened, and shuts off the flow of rubber when the valve is closed.

The preferred form of hollow mandrel is clearly shown in Figs. 11, 12, 16, 17, 18, and 19, where A is the cylindrical portion over which the fabric band is drawn and upon which the fabric is constructed, as described above. A′, A′ are oppositely placed lateral extensions or widened portions of the mandrel located thereon within the coating chamber, and A^2, A^2 are similar oppositely placed extensions upon the mandrel formed preferably at right angles to the extensions A′, A′. The mandrel flattened at its extended or widened portions and also at its outer extremity 4, passes through the rubber receptacle and as the fabric band passes over these extensions it is first expanded in one direction and afterward in another, which has the useful effect of temporarily separating the fibrous strands and elements so that the rubber coating will have access to and coat the entire exposed surface thereof. The expansion of the fabric has the further useful effect of temporarily changing the relative angles at which the yarn elements cross each other and thereby exposing the surfaces of the crossing points to the coating material, so that no spaces or corners will be left uncovered and the rubber will be thoroughly incorporated with all portions of the layers of the fabric. This action of expansion by the lateral extensions A′ and A^2, may be repeated by successive series of lateral extensions until the fabric band is sufficiently coated for the purpose desired. The expanding devices in each pair have their extremities inclined and slightly overlap the extremities of the adjacent pair of expanding devices. This construction enables the fabric to pass easily from one set of expand-

ing devices to another and to remain under a certain amount of tension all the time.

The liquid rubber or other adhesive material is stored in suitable tanks 5, connected with suitable pumps J, J, to the pipes D^5 and D^6 respectively. The rubber applying receptacle 1, (Figs. 16, 21, and 22) is provided with a resilient closure where the cylindrical portion of the mandrel enters therein, consisting of guided sliding sections F^{200}, F^{200} controlled by one or more springs F^{211}. This closure makes close contact with the fabric band as it passes over the mandrel into the rubber receptacle, and prevents the liquid rubber from escaping, yielding sufficiently to allow a knot or other small obstruction to pass. A similarly acting closure protects the end of the receptacle where the flattened portion emerges therefrom, consisting of gates F^{222} and F^{23}, gate F^{23} secured by screw F^{24} and gate F^{222} sliding a predetermined amount under the pressure of the spring F^{25} suitably secured, thus permitting only the desired amount of liquid rubber to pass through on the fabric band.

The fabric is propelled along the mandrel by means of a pulling roll P shown in Figs. 29 to 31 inclusive, over which it passes after leaving the coating chamber, and by means of flexible metallic bands P' and P^2 between which it is compressed. In order to grip the fabric band firmly and not squeeze out the coating material therein, the upper metal mand P' is provided with projections P^3, P^3, on its inner face as shown in Figs. 27 and 28, which grip but do not injure the band. The upper metal band P' passes over the guide rolls P^4, P^5, P^6, P^7 and P^8 and pulling roll P, and the lower band P^2 passes over the guide rolls P^9, P^{10}, P^{12} and pulling roll P, and the metal bands inclosing the fabric band F between them pass between the staggered rollers P^{11}, P^{11} which compress them tightly together so as to carry the fabric band with them. The lower band P^2 separates from the fabric band F and the upper metallic band P' on the pulling roll P, while the upper metallic band P' separates from the fabric band on the roll P^8, the fabric band F then being carried over the drying roller Q, the drums Q', Q^2, Q^3 and the rollers Q^4, Q^4, and Q^5, Q^5 by the metallic endless conveyer band Q^7. The construction and mode of operation of the drying rollers and drums may be described as follows: Sprocket wheels W^2 and W^3, and sprocket wheels W^7 and W^8 mounted respectively on shaft W^5 and roll P together with chains W^9, W^{10} rotate the pulling roll P. The three driven rolls or grooved drums Q', Q^2, and Q^3 are operated to move in unison by means of the train of gears q, q', q^2, q^3, and q^4, the shaft q^5, and the spiral gears q^6 and q^7, operated by the shaft R, which passes in the rear of the machine. The shafts Q^{13} of the grooved drums Q', Q^2, Q^3, are parallel and inclined and over all the grooves of these drums passes the flexible band or tape Q to which the extremity of the fabric band is first attached until it has been wound over all the drums and rollers of the drying device, when it can be fed through the remaining devices of the machine. The endless flexible band or tape Q^7 after passing around all the grooves in the drums Q', Q^2 and Q^3 and rollers Q, Q^4, and Q^5 is led around the idler rolls Q^{14}, Q^{15}, Q^{16}, and Q^{17} to the roller Q in line with pulling roll P. The groove idler rollers Q, Q^4, and Q^5 are rotatively mounted upon their bushings. At a point distant from the first roller in the series, a nozzle R^2 discharges a coating of predetermined density upon the outer surface of the fabric band, the amount being regulated by the needle valve R^3, the coating being supplied through the pipe D^6 from the pump J. The relative speeds of the pulling device and of the drying rollers and drums can be regulated to accommodate the amount of shrinkage of the fabric band on the drying device by means of the expansion pulley 21 (see Figs. 24, 25, 26, and 26^a) upon the driving shaft R' from which the shaft R which drives the drying mechanism receives its power. After passing over the drying rolls the band passes if desired through the vacuum chamber G. In the chamber G a vacuum is produced as nearly perfect as practicable by suction through the tube H'. In this chamber the solvents in which the rubber coating has been dissolved are evaporated to a predetermined degree. A coil of steam pipe H^{13} or any other suitable heating system furnishes heat to assist in the evaporation of the solvents from the liquid rubber or other adhesive material used on the laminated band.

In Figs. 35 to 40 inclusive are shown the vacuum chamber and its inlet and outlet gates. Here K and K' are the upper and lower halves of the inlet and outlet gates inclosing rollers K^2, K^2 between which the band passes to exclude the outer air, the lower half of the casing being made slightly adjustable on the upper half by means of a spring pressed pin K^4 and an adjusting screw K^5 which engages the spring K^6 confined in an opening K^7 in the bracket K^{12} secured to the chamber G. This permits of compressing the laminated band between the rollers to a predetermined amount and thereby fills practically all the opening between the rolls. The partial rings K^{18}, and K^8 of arguto or other self lubricating material, since free oil would be detrimental to the rubber on the fabric band, form bearings for the rolls K^2, K^2. The upper half of the gate K is secured to the wall of the chamber G by screws K^9, K^9, while the lower half of the gate K' is adjustably secured to the up-

per half K by gibs K^{10}, K^{10}, which are held by screws K^{11}, K^{11}.

After passing through the drying chamber the fabric band passes through a stretching device shown in Figs. 1, 2, and 41 to 45 inclusive. Here T, T′ are grooved rollers, one of which T′ is larger than the other, over which the fabric band passes, and by means of which a certain amount of stretching capability is removed from the band. The result of this operation is to produce a band having the exact amount of stretching capability left in it which when it is incorporated in the fabric will make the fabric capable of expanding to the desired degree. To effect this result the band first passes over the smaller roll T and next over the larger roll T′ and is compressed against the grooved surfaces of the rolls by means of the smaller guide rolls T^2 and T^3 and spring pressed levers T^4, T^4. Adjustment of pressure is made by the rods T^6, T^6, over which the springs T^7, T^7 are sleeved, being screwed into the standards T^{24}, T^{24} and locked in position by the nuts T^5, T^5. T^{25}, and T^3 are flanged idler guide rolls. The rollers are operated by means of sprocket chains T^8, sprocket wheels T^{20}, T^{21} and idler T^{22}, spur gears T^{10}, T^{11}, T^{12}, T^{13}, and bevel gears T^{14}, T^{15}, and rear shaft R. Details of the lever and spring tension are shown in Figs. 44 and 45.

After passing through the stretching device the fabric band is wound upon a reel X shown in Figs. 1, 2, and 46, which is operated by means of the shaft R and bevel gears X′ and X^2, and a band of Holland cloth or metal mounted upon an adjacent reel X^3 is interposed between the layers of the band to prevent them from sticking together. The reel X is driven by the spring pressed key X^4 in the shaft X^5 engaging the bearing surface X^6 of the reel X.

The mechanism for operating the various portions of the devices are as follows: 6 is the main drive shaft. This shaft through clutch 24 operates the reel driving shaft 7 which in turn operates the reels through the bevel gears 8 and 9. The shafts 6 and 7 are operatively connected by means of spur gears 10, 11, 12, 13 and 14 mounted upon a standard 15. By changing gear 11 mounted on the lever 65, the reels may be driven at different speeds for winding the yarn elements at different angles. R′ is a shaft mounted upon the standard 15 and is operated from the main shaft 6 by the spur gears 31, 30, 29, 28, and 14. Shaft R′ may be driven at different speeds by changing gear 30 mounted on the lever 66. The shaft W^4 is also mounted on the standard 15 and is operated from shaft R′ by bevel gears 41 and 40. The propelling roll P is actuated from shaft W^4 and therefore different speeds of propelling the fabric band on the mandrel may be obtained by substituting different gears in place of gear 30. The shaft R is driven from the shaft R′ by means of the expansion pulley 21 and pulley 22 and belt 23. A belt 50 from the main shaft and pulleys 51 and 52, operate the pressure pumps for rubber. Two pumps are employed, one of which supplies fluid coating material to the inside of the tubular mandrel and the other provides fluid coating material to the nozzle which coats the exterior of the fabric band, and also to the chamber 1 where the yarns are coated on the mandrel. In order that the desired pressure of rubber may be obtained in the mandrel the rubber pump is operated before the rest of the machine when power is applied to the main driving pulley 67, the shafts 7, R′, R and W^4, being started by throwing in the clutch 24 by clutch lever 25. In order that the speed of the shaft R may be varied to suit the shrinkage of the fabric band on the drying rolls Q, Q^4, Q^5 and drums Q′, Q^2, Q^3, the pulley 21 is made expansible by means of a split rim having inwardly inclined conical surfaces R^6 against which a flanged head R^7 engages to spread the free end of the split rim. The flanged head R^7 is longitudinally adjustable upon the screw threaded shaft R′. A sleeve R^8 keyed to the shaft R′ coöperates with the movable head to spread the rim, and the rim is caused to rotate by means of the pin R^9 engaging the slot R^{10} in the sleeve R^8. The suction pump 60 exhausts the air from the vacuum chamber G, through the pipe H′ and is operated by a belt 61 from the main shaft 6 moving over pulleys 62 and 63.

In Figs. 1, 2, 47, 48, 49, and 50 are shown the detail structure of the pumps J, J. Here J′, J′ are worm wheels operated by a common worm J^2, and J^3, J^3, are the rotating gears whose teeth act as plungers to force the coating material through the pipes which lead to the mandrel and exterior coating device respectively. J^4 is the standard which supports the pump casings J^5, J^5. The valves J^6, J^6, regulate the pressure of the rubber in the pipes D^5 and D^6 by means of the spring J^8 and the screw threaded rod J^9 which is adjusted so that when the pressure in the pump reaches a predetermined amount the valve J^6 lifts and allows the excess rubber to flow back into the tanks 5.

It is evident that in this machine any desired form of material other than that herein specifically described may be used as the constituent elements of the fabric band. It is also obvious that any suitable adhesive substance may be used to coat the elements composing this fabric band and may be applied at any predetermined high temperature with or without vacuum for solidifying the same, without departing

from the spirit of the invention or scope of the claims.

I do not confine myself to the exact arrangement of the various mechanical parts, provided any modifications would be of material advantage in the development and perfection of the machine as outlined by the drawings and specifications of this machine, nor do I confine myself to the use of liquid rubber or other liquid adhesive material, but may use this rubber or other adhesive material in any other form desired for the purpose indicated.

It is evident that wherever it is desirable, for the purpose of reducing the friction of the yarn elements while being interwound and laminated on the forming tube to form a fabric band or for softening the coating material on the yarn elements or on the fabric band as it passes through the various coating devices or other parts of the machine, any solvents such as naphtha, benzol, gasolene, etc., according to the nature of the coating material used, may be applied in any desired manner, without departing from the spirit of the invention or scope of the claims.

It is obvious that one or more of the four reels may not rotate, so that a predetermined number of the yarn elements may be laid parallel to the longitudinal axis of the mandrel, while the remaining wheels rotate and wind the yarn elements on the mandrel at a predetermined angle, without departing from the spirit of the invention or scope of the claims. It is also evident that the reels may be mounted singly in successive positions along the mandrel and rotate thereabout when a high speed of rotation and production is required for certain bands in which the yarn elements are wound at a wide angle, without departing from the spirit of the invention or scope of the claims. It is also obvious that any other suitable mechanism can be used to pull the fabric band from the mandrel, without departing from the spirit of the invention or scope of the claims.

It is evident that the vacuum or heat chamber may be so extended and enlarged as to inclose the complete band forming devices, without departing from the spirit of the invention or scope of the claims.

It is obvious that suitable mechanism may be employed for automatically stopping the machine in case a spool of yarns becomes exhausted or in case a yarn breaks, or in case the fabric band itself breaks or becomes entangled in the operating mechanism, without departing from the spirit of the invention or scope of the claims.

It is obvious that the construction of the mandrel may be modified to suit special conditions of interwinding and lamination of the yarn elements or of the passage of coating substance therethrough, without departing from the spirit of the invention or scope of the claims.

It is evident that any desired number of reels may be employed, or any number of spools may be mounted on any or all reels, and that any number of close lying parallel yarns may be wound as a unit on a spool for the purpose of making different fabric bands of the same general construction, without departing from the spirit of the invention or scope of the claims.

It is obvious that sufficient reels may be employed to construct a band of any desired number of laminations or layers of yarn elements, without departing from the spirit of the invention or scope of the claims.

By the term "yarn element" as used in these specifications and claims is meant a group of close lying parallel yarns or threads of a predetermined number and diameter forming a flat band, but other suitable materials may be utilized according to the character of the band to be produced.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:

1. In an automatically acting machine for constructing a tubular laminated band from flexible elements, a fixed mandrel having a free outer end, annular rotatable guide members concentric with said mandrel for winding and regularly spacing said flexible elements about said mandrel, and reels upon which said flexible elements are stored, said reels rotatable with said guides alternately in opposite directions.

2. In a machine for forming a band composed of interwound cohering laminated groups of close lying parallel yarn elements, a rigid hollow mandrel open at the outer end, reels rotatable about the mandrel, spools on said reels upon which said yarn elements are wound, guides on said reels adapted to direct the yarn elements to said mandrel, a device for supplying fluid rubber or other adhesive material to said mandrel and thence to said yarn elements, a pulling and flattening device for the band, a main shaft and mechanism operatively connecting said shaft and reels and pulling device.

3. In a machine for manufacturing a flat laminated band of cohering interwound groups of close lying parallel yarn elements and for saturating the same with fluid rubber or other adhesive substance, in combination, a hollow mandrel, reels rotatable alternately in opposite directions about said mandrel, spools carrying groups of yarn elements thereon, guides for said groups of yarn elements, means for injecting fluid rubber through said hollow mandrel to saturate

said elements, a flattening and pulling device for the fabric, and operating means for said reels and pulling device.

4. In a machine for manufacturing a flat fabric band, and for saturating the same with rubber, a stationary hollow mandrel, reels rotatable about said mandrel alternately in opposite directions, thread spools and guides for the thread thereon, means for injecting fluid rubber or other adhesive material through the mandrel into the fabric band, means for flattening the tubular fabric thus formed into a band, means for drying the same, means for winding the completed band and means for automatically operating said reels and pulling devices.

5. In a device of the character described, the combination with a stationary mandrel and a series of reels rotatable thereabout in opposite directions, of a series of guide rods depending from each reel and rotatable therewith, a support secured to each set of guide rods, and a channeled guide member secured to each support.

6. In a device of the character described, a mandrel, a series of reels rotatable thereabout in opposite directions, an annular guide support operatively connected with each reel, a series of channeled guides secured to said support and encircling said mandrel, spools for storing flexible elements upon said reels, and means for guiding said flexible elements from said spools to said channeled guides.

7. In a device of the character described, a stationary mandrel, a series of reels rotatable about said mandrel, a series of spools thereon, a guide support connected to rotate with said reels and a series of channeled guides encircling said mandrel and connected with said supports.

8. The combination with a stationary mandrel, of a series of guide supports rotatable thereabout, a series of spaced channeled guides having guide channels alternately on their outer and inner faces, said guides spaced apart, and secured respectively to said supports.

9. The combination with a series of rotatable concentric guide supports and a central stationary mandrel, of a series of channeled guide rings secured to said supports, and outwardly spaced therefrom and from each other, the guide channels therein being formed alternately on the inner and outer sides of said rings.

10. The combination with a mandrel of annular guides for yarn elements rotatable thereabout, said guides spaced apart and provided with guide channels, the outer annular guide approaching more closely to the surface of the mandrel, and having the guide channels therein arranged on its inner face.

11. The combination with a mandrel, of a series of spaced guide members for yarn elements rotatable thereabout, the last guide member of said series being brought more closely to the surface of the mandrel than the other guide members.

12. In a mandrel on which a hollow fabric band is constructed, a flattened hollow body and flattened lateral extensions thereon, arranged thereon at intervals on opposite sides thereof, one set of extensions lying at an angle to the other set of extensions.

13. In a mandrel on which a hollow fabric band is constructed, a flattened hollow body and flattened lateral extensions thereon, integral therewith, arranged thereon at intervals and in angular relation to each other, said mandrel being supported at one end, the opening therein extending therethrough.

14. In combination, in a mandrel on which a hollow fabric band is constructed, a flattened hollow mandrel body supported at one end, and sets of devices oppositely placed upon the mandrel for expanding the fabric, one set of expanding devices arranged at an angle to another set, and a receptacle for fluid rubber through which the mandrel and expanding devices pass.

15. In a mandrel on which a hollow fabric band is constructed, the combination with a hollow flattened body portion open at the outer end, of fabric expanding means arranged thereon at intervals, said expanding means comprising extensions arranged in oppositely placed pairs, the pairs of extensions arranged at different angles, and provided with inclined extremities, the extremities of one pair of extensions overlapping the extremities of an adjacent pair.

16. In an automatically acting machine for the manufacture of a flattened tubular band composed of flexible fabric elements, the combination with a stationary tubular mandrel having a flattened extremity, of means for winding said fabric elements on said mandrel, one series thereof in one direction and another series in an opposite direction, means for pulling said tubular fabric from said mandrel and for flattening the same, means for injecting liquid rubber through said tubular mandrel into said tubular fabric, means for coating said flattened band on the outer side with liquid rubber, and means for drying and stretching the band.

17. In combination, in an automatically operating machine for the manufacture of a flattened tubular band composed of laminated-cohesive-interwound flexible fabric elements, a series of concentric reels and spools spaced thereon, a frame on which said reels are rotatably mounted, a central tubular mandrel, or forming tube, said man-

drel having a flattened extremity, the said reels arranged to wind said flexible band elements upon the cylindrical part of said mandrel, pulling and compressing devices for the band, said tubular mandrel adapted to convey liquid rubber to the fabric elements of said band, and means for rotating said reels.

18. The combination with concentric reels, of a frame on which they are rotatable, a central tubular mandrel, spools on said reels adapted to contain parallel lying yarns of a predetermined number wound as a unit thereon, standards on said reels, rods radially secured to said standards at their outer ends and adjustable thereon, guiding means for the yarns secured to the inner ends of said rods, elongated guide rollers on said reels, pressure guide rollers on said standard, and flanged guide rollers on said rods.

19. In a device for the manufacture of a hollow fabric band, a hollow mandrel, upon which the fabric is wound, secured rigidly at the inner end and free at the outer end, the body and outer extremity of the said mandrel being flattened, substantially as and for the purpose described.

20. In a fabric band making machine, the combination with a mandrel upon which said fabric is wound, said mandrel having a flattened portion and lateral extensions thereof intermediate of its ends, and also having a continuous central opening, of means for winding yarn elements thereon to form a fabric, a rubber chamber through which said mandrel passes, and means for pulling and drying the fabric.

21. In a fabric band making machine, a hollow mandrel secured at its inner end and having a flattened body and outer extremity, devices rotatable about the mandrel for winding yarn elements thereon to form said fabric band, means for feeding a reinforcing core through said hollow mandrel, and for supplying a coating to said reinforcing core, a coating chamber through which said fabric and mandrel passes, and a pulling and shaping means for the fabric.

22. In combination with a hollow mandrel secured at one end, upon which a hollow fabric may be wound, a closure for the outer end of the mandrel, said closure having an opening through which a reinforcing core for the fabric band is introduced, and means for introducing rubber into said hollow mandrel to coat said reinforcing core.

23. In a machine for constructing a hollow laminated cohesive interwound band from yarn elements, in combination, a hollow mandrel, rotatable devices for winding said yarn elements upon said mandrel, means for forcing a coating substance through said mandrel into the interior of said band, a coating chamber through which said mandrel passes, means upon said mandrel for expanding said band while in the coating chamber, a pulling device for the band, a drying device for the band, a stretching device, and means for operating said winding, and pulling and drying devices at predetermined comparative rates of speed.

24. In a machine for constructing a hollow laminated cohesive interwound band from yarn elements, in combination, a hollow mandrel, devices for winding said yarn elements upon said mandrel, means for coating the interior and exterior surfaces of said hollow band, a device for pulling the hollow band from the mandrel, a device for drying the coated band, adjustable means for operating the winding devices, and adjustable means for operating said pulling devices, whereby the comparative rates of speed of the winding and pulling devices can be regulated.

25. In a drying device for a machine for manufacturing a coated fabric, a series of rolls comprising an upper series and a lower series, said rolls mounted upon parallel shafts, the said upper rolls being inclined to the axis of their shafts, means for rotating the lower series of rolls, and an endless band passing over all the rolls to which said fabric band is temporarily attached.

In testimony whereof, I hereunto set my hand this 21st day of October 1913.

LAWRENCE A. SUBERS.

In presence of—
ERNEST MOSMAN,
S. L. EXLINE.