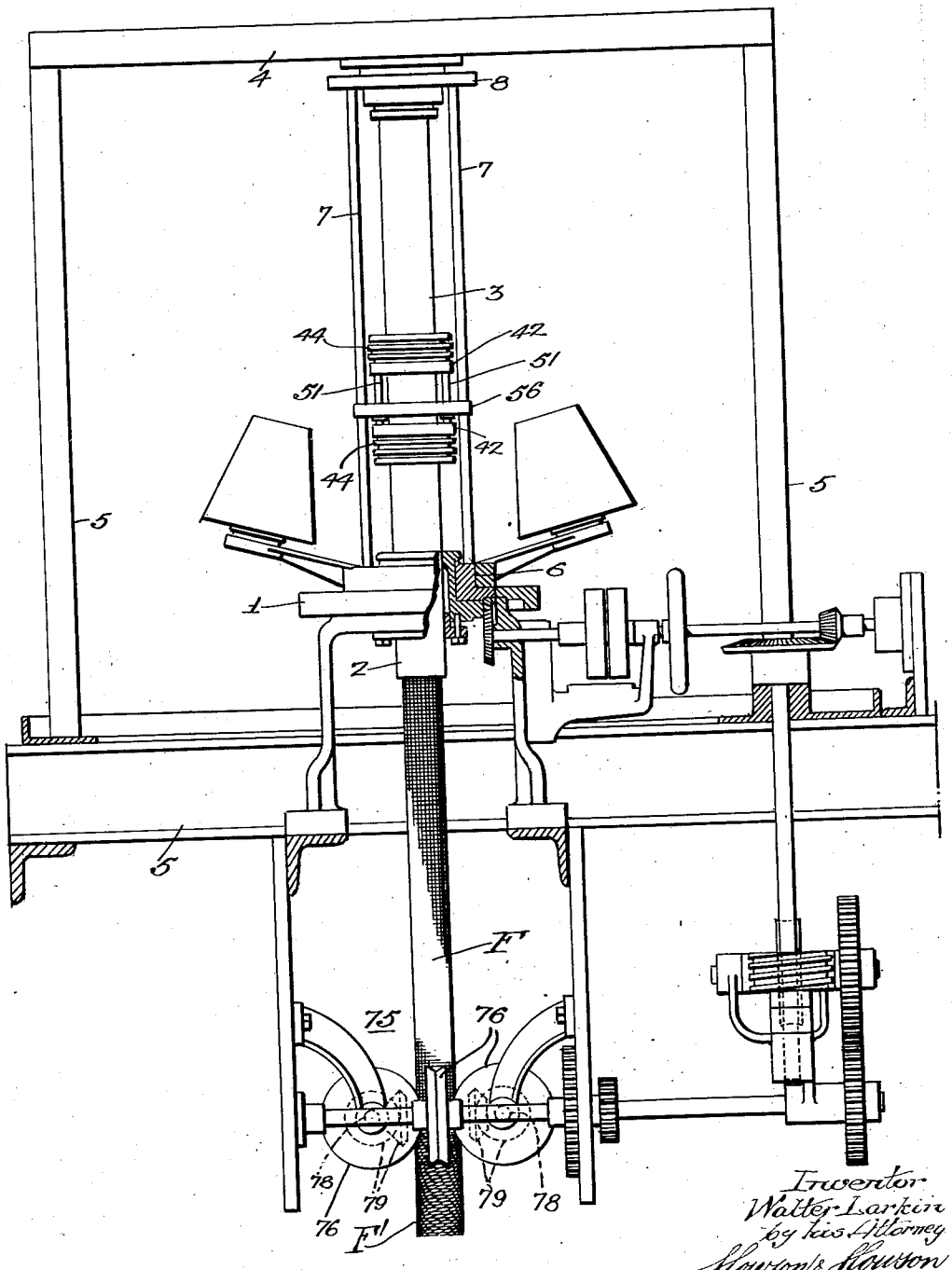
Oct. 14, 1941. W. LARKIN 2,259,384

KNITTING HEAD

Filed Nov. 12, 1940 5 Sheets-Sheet 1

Fig. 1.



Inventor
Walter Larkin
by his Attorney
Howson & Howson

Oct. 14, 1941. W. LARKIN 2,259,384

KNITTING HEAD

Filed Nov. 12, 1940 5 Sheets-Sheet 2

Fig. 10

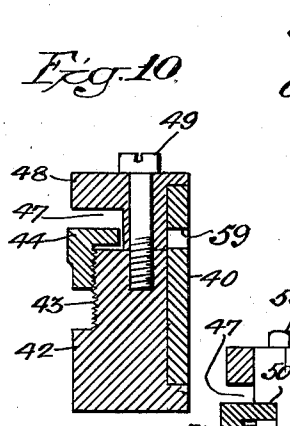


Fig. 2

Fig. 12

Inventor
Walter Larkin
by his Attorneys
Howson & Howson

Oct. 14, 1941. W. LARKIN 2,259,384

KNITTING HEAD

Filed Nov. 12, 1940 5 Sheets-Sheet 3

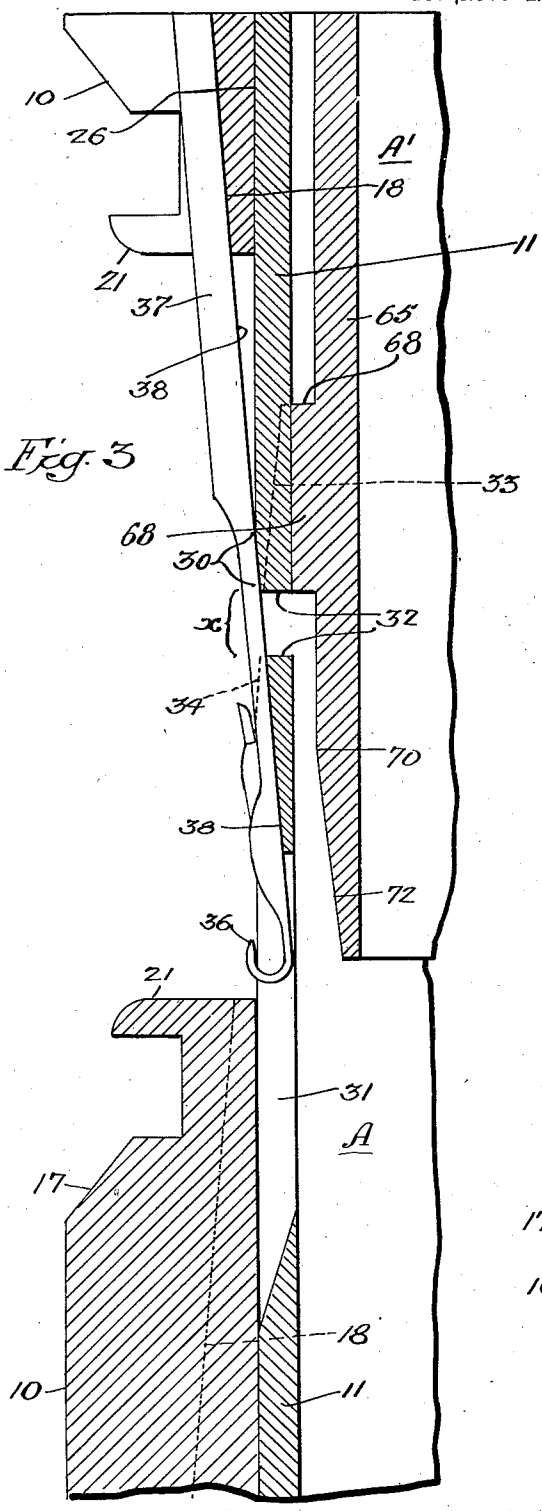


Fig. 3

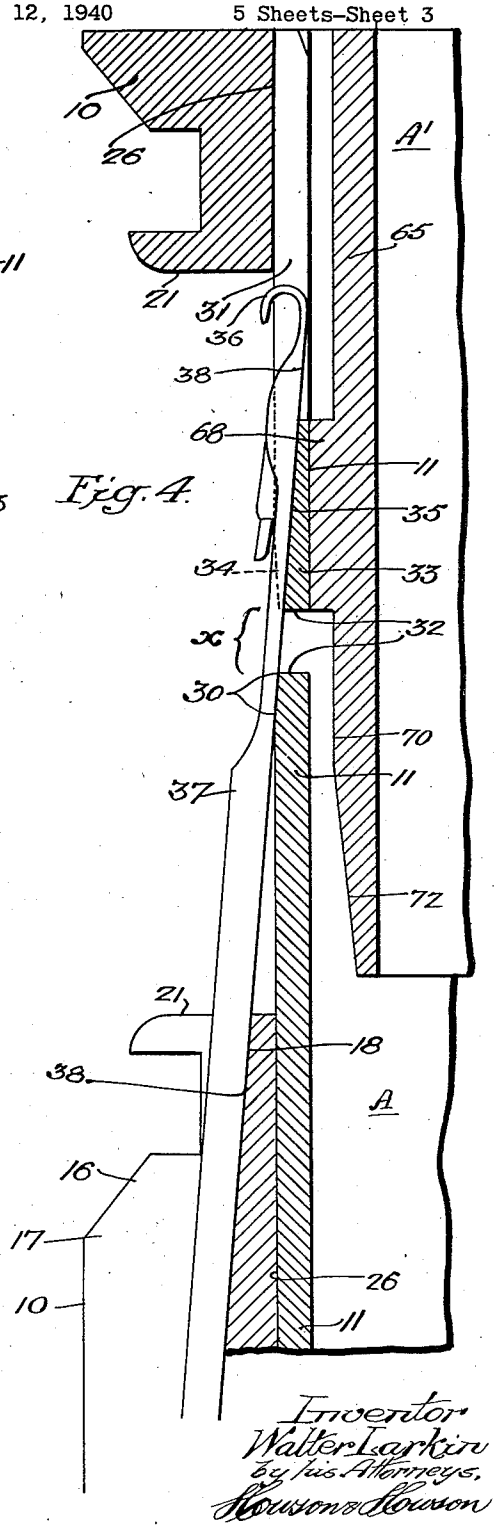


Fig. 4

Inventor
Walter Larkin
By his Attorneys,
Howson & Howson

Oct. 14, 1941. W. LARKIN 2,259,384

KNITTING HEAD

Filed Nov. 12, 1940 5 Sheets-Sheet 4

Fig. 6

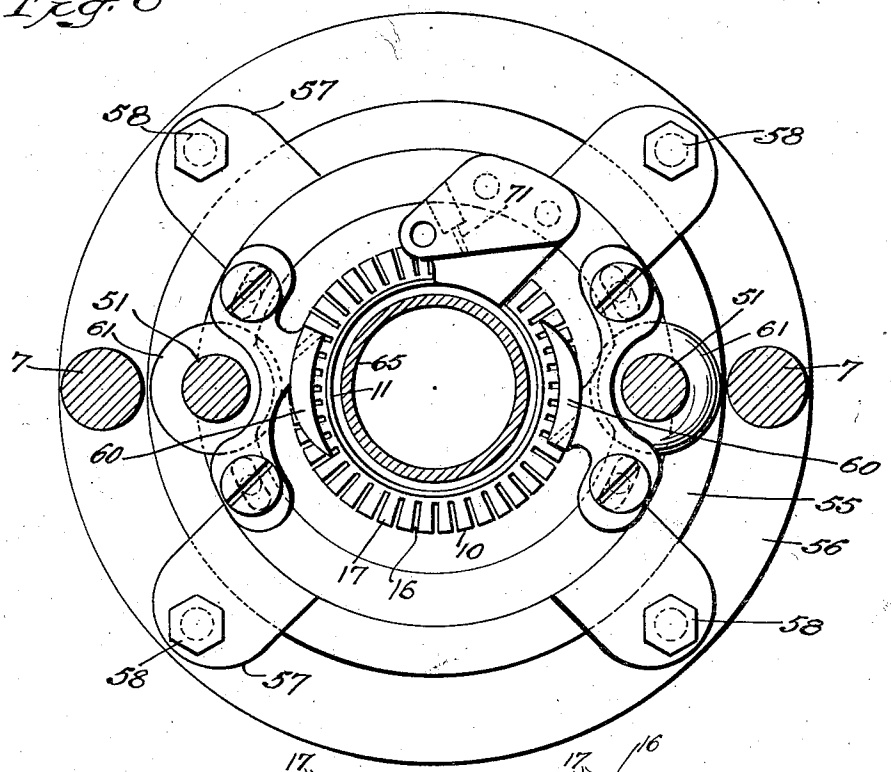
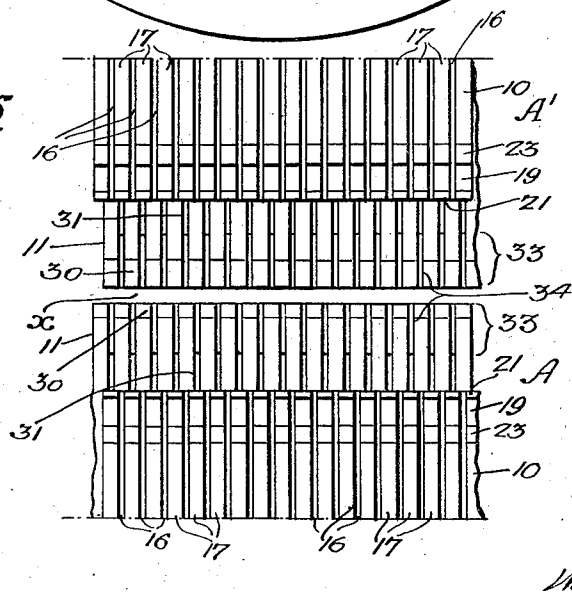


Fig. 5.



Inventor
Walter Larkin
By his Attorneys
Howson & Howson

Oct. 14, 1941. W. LARKIN 2,259,384

KNITTING HEAD

Filed Nov. 12, 1940 5 Sheets-Sheet 5

Fig. 9.

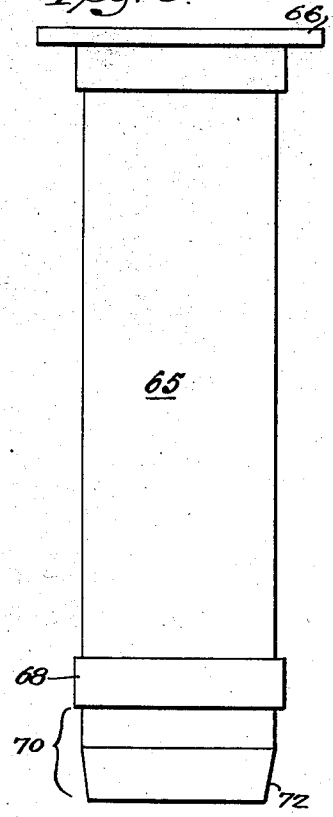


Fig. 8.

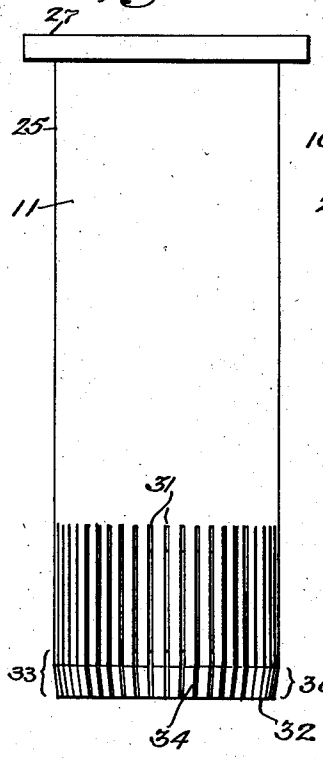


Fig. H.

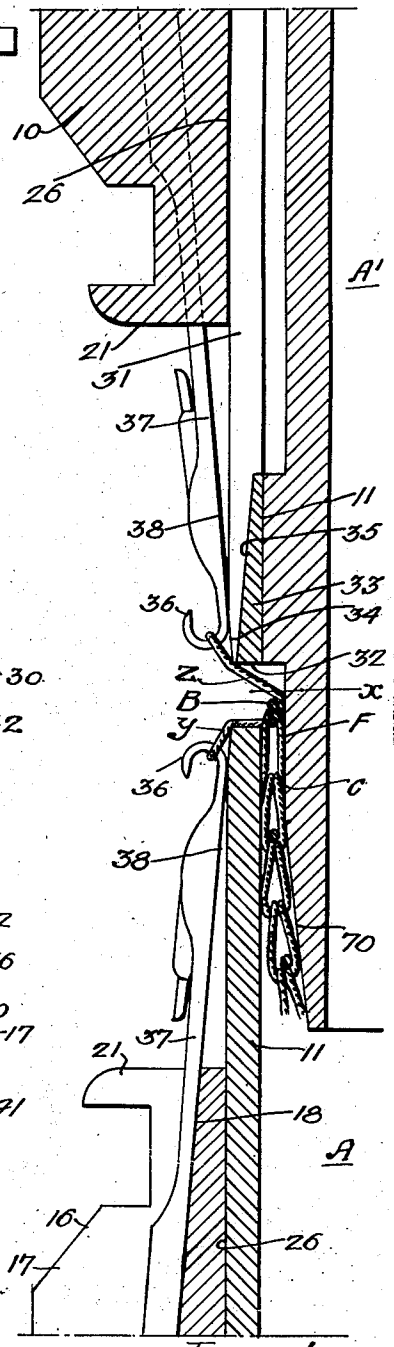
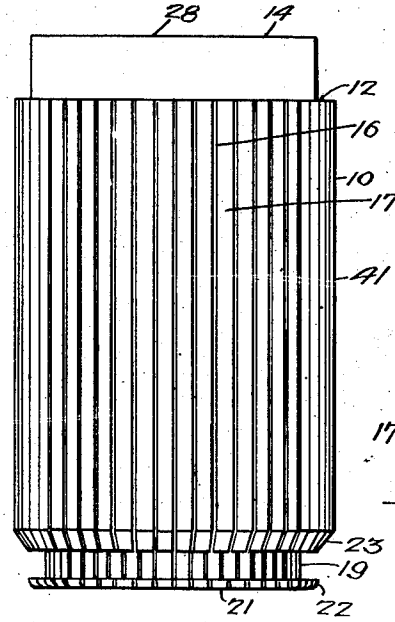


Fig. 7



Inventor
Walter Larkin
By his Attorneys
Howson & Howson

Patented Oct. 14, 1941 2,259,384

UNITED STATES PATENT OFFICE

2,259,384

KNITTING HEAD

Walter Larkin, Norristown, Pa., assignor to Fidelity Machine Company, Wilmington, Del., a corporation of Delaware

Application November 12, 1940, Serial No. 365,346

25 Claims. (Cl. 66—9)

This invention relates to a knitting head for a circular knitting machine adapted for knitting seamless tubular ribbed fabric having a wire, a textile yarn, a rubber strand, or a combination of such filaments laid-in in predetermined courses of the stitches of which the tube is composed, as disclosed, for example, in my copending application Serial No. 359,793, filed October 4, 1940.

The knitting head of the present invention is particularly adapted for knitting tubes of relatively small diameters, with the stitch wales of the fabric disposed in close lateral relation to each other to produce a compact fabric.

The needles of the knitting head are divided into two series, with the needles of one series alternating with the needles of the other series circumferentially of the knitting head, one of said series being adapted to produce the stitches of the inside wales of the fabric, and the other to produce the stitches of the outside wales thereof.

The needles of each series are slidably mounted, for independent longitudinal movement, in separate needle cylinders and the two cylinders are arranged in axial alignment with respect to each other, with an annular work slot formed between the adjacent ends of the twin-cylinders for the passage of the knitted tube into and through the interior bore of one or the other of the cylinders.

Normally, in machines employing axially aligned twin-cylinders, there are twice as many needle grooves in each cylinder as there are needles, i. e. there is a vacant slot between each two occupied slots in each cylinder to accommodate the hook ends of the needles of the other cylinder, during movement of the needles to clearing position in the knitting operation. In cases where the wales of the fabric are to be formed in close lateral relation to each other, the partitions between successive needle grooves in each cylinder are necessarily thin and fragile. However, with the thinnest possible practical partitions, the needle grooves are necessarily spaced a considerable distance apart laterally. This condition places a serious limitation on the fabrics possible to produce in such machines, as the spacing of the needle grooves determines the spacing of the stitch wales, and the spacing of the stitch wales determines the circumferential compactness of the fabric.

One object of the present invention is to provide a novel form of needle cylinder for use in knitting machines employing twin-cylinders arranged in axial alignment, whereby the wales of the fabric may be produced in laterally abutting relation to each other, if desired.

Another object of the invention is to make each cylinder as a unit of annular stepped formation composed of two separable concentric parts of relatively different diameters, with the end of the inner part of smaller diameter which is adjacent the work slot extended axially beyond one end of the outer part of larger diameter; to form the grooves for the needles of that particular unit in the outer peripheral face of the outer larger part; to form clearance slots for the hook ends of the needles of the other unit in the axially extended portion of the smaller inner part; and to form the bases of the needle grooves at an angle to the axis of the units so that hook ends of the needles of one unit, when moved to clearing position in the grooves of the larger part of that unit, will enter the clearance recesses in the smaller part of the other unit.

Another object of the invention is to provide a novel form of tubular mandrel within the bore of one of the cylinder units to extend from that unit into the bore of the other of the axially aligned twin-units, across the work slot formed between the adjacent ends of the inner parts of said units, to form the inlay wire, etc., at the work slot, into convolutions of predetermined diameters less than the diameters of the internal bores of the respective cylinder units, for free movement through the bore of one of the cylinder units with the knitted tube.

Another object of the invention, in forming each cylinder unit of two concentric parts, is to provide as thin an annular edge as possible at the work slot, in order to effect the knitting on a circle of lesser diameter than the bore of the cylinder, and to form the stitches of minimum length in the wales to produce longitudinal compactness in the tubular fabric.

Another object of the invention is to make the inner parts of the cylinder units removable from and interchangeable with respect to the outer parts of the units, whereby it is necessary to replace only the inner part when wear occurs at the work slot.

The construction and operation of the knitting head forming the subject matter of the present invention will be fully disclosed hereinafter, reference being had to the accompanying drawings, of which:

Fig. 1 is a diagrammatic side elevation of a circular knitting machine of the general type to

which the knitting head of the present invention is particularly adaptable;

Fig. 2 is an enlarged longitudinal sectional elevation of the knitting head;

Figs. 3 and 4 are sectional elevations, on a still further enlarged scale, illustrating the extended movement of the needles beyond the needle grooves of the outer part of one cylinder unit into the clearance slots of the inner part of the other of the twin-units;

Fig. 5 is a fragmentary flat development view of the outside of the two needle cylinder units, at and adjacent the work slot therebetween;

Fig. 6 is a sectional plan view taken on the line 6—6, Fig. 2, with the needles removed;

Fig. 7 is an outside elevation of the outer part of a cylinder unit;

Fig. 8 is an outside elevation of the inner part of a cylinder unit;

Fig. 9 is an outside view of the mandrel;

Fig. 10 illustrates a detail of the invention;

Fig. 11 is a view similar to Figs. 3 and 4 with the needles in casting position; and

Fig. 12 illustrates a modification of the invention.

As shown in Fig. 1, a machine of the type to which the knitting head structure of the present invention is particularly adaptable, normally comprises a rigid base member 1, to which is rigidly secured a lower cylinder supporting tube 2. Axially aligned with the cylinder supporting tube 2 is a second or upper cylinder supporting tube 3. The supporting tube 3 is rigidly mounted in a super-structure 4. The base member 1 and superstructure 4 are rigidly supported by a common framework 5.

Rotatably mounted in or on the base 1, for rotation about the lower support tube 2, is a cam ring and yarn cone supporting and driving ring 6. The supporting and driving ring 6 is driven by the usual gearing, common to this type of machine, from any suitable source of power. Rigidly secured in the driving ring 6, and extending vertically therefrom, is a plurality of cam ring supporting posts 7, 7, the upper ends of which may, if desired, be secured in a collar 8 freely rotatable on and about the upper cylinder support 3 adjacent the super-structure 4.

As shown in Fig. 2, identical lower and upper cylinder units A and A¹, respectively, are secured to the adjacent axially spaced ends of the lower and upper cylinder supporting tubes 2 and 3, respectively. The units A and A¹ are spaced apart axially to form an annular work slot x therebetween. As the cylinder units A and A¹ are identical in structure, detailed description of one will suffice for both.

As shown in Figs. 2, 7 and 8, each cylinder unit comprises an outer part 10 and an inner part 11 concentric to the outer part 10. The outer part 10 is in the form of a hollow cylinder or sleeve and is provided with an annular shoulder 12 adapted to rest against the end 13 of the supporting tube 2 or 3, as the case may be, said shoulder being provided by reducing the one end of the cylinder in diameter to form a neck 14 adapted to fit snugly into the supporting tube 2 or 3. Any suitable means may be provided for securing the outer cylinder element 10 to the supporting tube as, for example, by the screws 15 shown in Fig. 2.

As shown in Fig. 2, the outer cylinder element 10 is provided in its peripheral surface with a plurality of needle grooves 16 which extend longitudinally of said element, in planes radiating from the axis of said element. The grooves 16, 16 are spaced apart circumferentially of the element to form partitions 17, 17 therebetween.

Also as shown in Fig. 2, the base surfaces 18 of the needle grooves 16 are disposed at an angle with respect to the axis of the element 10 and converge toward the work slot x formed by and between the adjacent ends of the inner parts 11, 11 of the units A and A¹, respectively.

The end of the element 10, opposite to that on which the neck 14 is formed, is provided with an annular groove 19 for reception of a resilient annular needle retainer 20. Between the annular groove 19 and the end surface 21, the element 10 is provided with a narrow annular flange 22 through which the needle grooves 16, 16 extend. Adjacent the opposite side of the annular groove 19 the element 10 is circumferentially beveled, as indicated at 23.

The inner element 11 of each cylinder unit is composed of a relatively thin tube 25, which is adapted to fit snugly within the interior bore 26 of the element 10. One end of the tube 25 is provided with an annular flange 27, which is adapted to bear against the end surface 28 of the neck 14 of the element 10 and to be secured thereto by means of screws or bolts 29, to prevent relative circular or axial movement of the inner element 11 with respect to the outer element 10.

The opposite end of the inner element 11 is circumferentially beveled, as indicated at 30, on an angle corresponding to the angle of the bases 18 of the needle grooves 16 in the outer element 10. The beveled face 30 of the inner part 11 forms a continuation of the bearing surfaces provided by the groove bases 18, for supporting the needles during independent longitudinal movements thereof during the knitting operation.

The second or beveled end 30 of the inner element 11 is provided with a plurality of recesses or slots 31 which are formed therein and extend longitudinally thereof, parallel to the axis of the element 11, in circumferentially spaced relation around said element 11.

Immediately adjacent the end surface 32 of the element 11, which forms one side or wall of the work slot x, said element is provided with an annular portion 33 in which is formed longitudinal grooves 34. The grooves 34 form continuations of the slots or openings 31, 31 respectively.

With the two units A and A¹ assembled in the knitting head of the machine, the recesses or slots 31 in the inner element 11 of one unit lie in longitudinal alignment with the needle grooves 16 in the outer element 10 of the other unit, and the base surfaces 35 of the end grooves 34 of the inner element 11 of each unit lie in alignment with the base surfaces 18 of the needle grooves 16 in the outer element 10 of the other unit, as clearly shown in Figs. 2, 3 and 4, to receive the hook ends 36 of the needles 37 when said needles are moved to clearing position across the work slot x.

As shown in Figs. 2, 3 and 4, the axially spaced end surfaces 32, 32 of the inner elements 11, 11 of the cylinder units A and A¹ respectively, form and define the annular work slot x.

Also as shown in Figs. 2, 3 and 4, the ends of the inner elements 11, 11, in which the needle-receiving slots or openings 31 and grooves 34 are formed, extend a substantial distance axially beyond the end surfaces 21, 21 of the outer elements 10, 10 with which the inner elements 11, 11 are respectively associated. When a needle 37 is extended to clearing position, as shown in

Figs. 3 and 4, with the back edge 38 of the shank of the needle bearing against the base surface 18 of needle groove 16 in outer element 10 of the unit with which the needle is primarily associated and against the circumferentially beveled surface 30 of the inner element 11 of the same unit, the back edge 38 of the extended needle also bears against the base surface 35 of the needle-receiving groove 34 in the annular portion 33 of the inner element 11 of the other of said units, with the hook 36 of the needle 37 disposed in the needle opening 31 which forms a continuation of the groove 34 into which the needle has been projected.

With the above noted construction, each needle cylinder element 10 is provided with only the same number of needle grooves as there are needles in the series associated with the respective cylinder elements, as there is no necessity for forming intermediate grooves in these needle cylinder elements to receive the hook ends of the needles of the other series, consequently the partitions 17 between successive needle grooves 16, 16 can be made of substantial width, greater than the width of the needle groove. Furthermore, the inter-cooperating needles of the two opposed series may be spaced apart laterally to an extent only sufficient to provide space for the yarn between each two needles, as a result of which the wales of the fabric formed by the immediately adjacent needles can be made in substantially laterally abutting relation to each other.

As a result of the opposite angularity of the bases 18 of the needle grooves 16 in the diametrically opposite sides of the outer elements 10 of the two units A, A1, the needles are operated in paths which converge inwardly toward the work slot x, whereby the actual formation of the fabric is effected on a circle of minimum diameter, inside the bore of the inner element 11 of the cylinder unit A, in the present instance, as shown in Fig. 11.

As a result of the angularity of the base surfaces 18 of the needle grooves 16, the ends of the needles 37, opposite to those on which the hooks 36 are formed and which carry the operating butts 39 (Fig. 2) at diametrically opposite points in each needle cylinder element 10 are in divergent relation to each other, which causes the butts 39 of the needles 37 to lie on a circle of relatively larger diameter than the circle occupied by the hooks 36 of the needles, consequently providing greater lateral spacing between adjacent butts for freer operation of said butts by the operating cams of the machine.

As shown in Fig. 2, the operating cams 40 are of the usual cylindrical form and rotate around and in contact with the outer cylindrical peripheral surfaces 41, 41 of the elements 10, 10 respectively. The cams 40 are secured, in the usual manner, in cam rings 42, 42. Each cam ring 42 is externally threaded at 43 for reception of an internally threaded adjusting ring 44. Each adjusting ring 44 is provided with an inturned flange 46 which projects into an annular groove 47 formed between the end of the cam ring 42 and a complementary ring 48, secured to the ring 42 by bolts 49 to provide unitary solidity of the cam ring. The flanges 46, 46 of the adjusting rings 44, 44 are disposed in transverse grooves 50, 50 formed in posts 51, 51 which have a slidable fit in bearings 52, 52 formed in the cam rings 42, 42 and the complementary rings 48, 48. The two posts 51, 51 are rigidly secured in a supporting ring 55. The ring 55, in turn, is mounted within a ring 56 carried by or formed integral with the supporting posts 7, 7. The ring 55 is provided with radial lugs 57, 57 (Fig. 6) which overlie the ring 56 and are secured thereto by bolts or screws 58, 58.

The posts 51, 51 are formed with loose ends 45, 45 which are adapted to be secured to the posts 51, 51 respectively by bolts or screws 53, 53 to grip the flanges 46 of the adjusting rings 44 tightly after the rings 44, 44 have been rotated to adjust the cam rings 42, 42 so that the cam slots 59, 59, of the cams 40, 40, in which the butts 39, 39 of the needles 37, 37 operate, will operate the needles in proper relation to the work slot x.

The ring 55 supports diametrically opposite yarn guides or feeds 60, 60 for feeding a pair of yarns under the hooks 36 of the needles 37 to form two courses of stitches, in the present instance, for each revolution of the knitting cams 40, 40 relative to the fixed needle cylinder units A, A1.

The ring 55 also carries yarn tensioning discs 61, 61 adjacent the guides 60, 60, with tension springs 62, 62 encircling the posts 51, 51. Adjusting collars 63, 63 on the posts 51, 51 regulate the tension applied to the knitting yarn by the discs 61, 61.

A tubular mandrel 65 (Fig. 9) is mounted within one of the inner parts 11 of one of the needle cylinder units A or A1, as the case may be. In the present instance, the mandrel 65 is mounted within the upper unit A, and is provided with an annular flange 66 which rests on top of the annular flange 27 of the upper inner element 11. The flange 66 is secured to the flange 27 in any suitable manner, as by screws 67.

The mandrel 65 is provided with an annular boss 68 or the annular solid portion 33 of the encircling tube element 11, if desired, may be thickened inwardly to provide a space 69 between the outside of the mandrel and the inside of the tube 11, above the ring portion 33 of the tube 11, to provide clearance for the hooks of the needles entering the clearance openings 31 in the tube 11.

The lower end 70 of the mandrel 65 projects downwardly into the upper end of the lower tube 11, past the work slot x, to receive an inlay wire, etc., B which is fed into the work slot x against and between the stitches y of the outside wales of the fabric F hanging on the needles of the lower unit A and the stitches z of the inside wales hanging on the needles of the upper unit A1, when the needles are in stitch casting position as shown in Fig. 11, with the fabric F moving downwardly into the tube 11 of the lower unit A through the annular space C formed between the inner surface of the lower tube 11 and the outer surface of the lower end 70 of the mandrel 65.

The wire, etc., B is fed into the work slot x by a feeding or guiding eye 71 carried by the ring 55 between the two yarn feeds 60, 60 (Fig. 6) to place an inlay element B in alternate courses, in the present instance, although an inlay feeder 71 may be provided for each yarn feed 60 if desired, or for any number of yarn feeds if and when the machine employs four, six or any number of yarn feeds greater than the two disclosed in the present case.

The guide 71 draws the inlay firmly about the cylindrical end 70 of the mandrel 65 within the work slot x to form the inlay into convolutions

having an inner diameter substantially equal to the outer diameter of the lower cylindrical end 10 of the mandrel, and in order to relieve the resistance to the movement of the knitted tube F downwardly into the lower element 11, as created by the inlay B being drawn firmly about the mandrel, the portion of the mandrel immediately adjacent the extreme lower end thereof is slightly beveled or tapered, as indicated at 12 (Fig. 9).

In the case of a spring wire being used for the inlay element B, as disclosed in the above noted copending application, the wire convolutions after flexing of the wire around the mandrel, have a tendency to unwind, due to the inherent resiliency of the wire, and twist the fabric tube about its axis, in a direction opposite to the direction in which the wire guide travels around the mandrel. This twists the wales from a parallel relation to the axis of the fabric tube into an angular relationship to the axis of the fabric tube. The unwinding tendencies of the wire convolutions tend to expand the fabric tube radially. This would cause the fabric tube to bind in the inner tube 11 through which the fabric tube passes from the work slot.

In order to overcome the above noted tendencies of the fabric tube to twist and expand, the machine is provided with a holding device which grips the fabric tube after it leaves the inner tube 11 of the knitting head.

The holding device 15, as shown in Fig. 1, includes a plurality of endless belts or grooved wheels 16, 16 on shafts 18, 18 which are geared together at 19, and driven at a peripheral speed equal to the rate of production of the fabric tube F.

As soon as the fabric tube F is discharged from the holding device 15, the wire B under its inherent resiliency, causes the tube F to twist about its axis, as shown at F^1. This throws the wales at an angle to the tube axis which lays the wales one against the other laterally, as shown clearly in the aforesaid copending application. This foreshortens the stitches in the successive courses, by tilting each stitch at an angle. These two conditions combined produce a fabric tube of maximum compactness.

In some cases, the tube in its compact form F^1, supra, is sprayed or otherwise treated with a substance, such as liquid latex, to fill the interstices of the fabric. In other instances, the fabric tube F is sprayed internally as it is being knit, i. e., shortly after a course of stitches passes below the free end of the mandrel, it comes into a filling or impregnating zone within the lower inner tube 11.

The zone of impregnation or filling is created by ejecting the impregnating substance from a nozzle head 80 (Fig. 2) which is suspended within the lower tube element 11, in axial alignment therewith on the end of a pipe 81 which is hung from a disc 82 seated on top of the annular flange 26 of the upper tube element 11.

It will be understood that when the fabric tube F is sprayed while it is being knit, the wales are straight, i. e., parallel to the axis of the fabric tube, under which conditions the interstices of the knitted tube are of maximum size and leaving greater space to receive the impregnating or filling substance, and as soon as the fabric tube F leaves the holding device 15 it twists, as before noted, and consolidates the impregnated tube into a solid compact form.

If a heavier coating is desired on the inside of the tube F, a more viscous liquid or semiliquid coating substance may be applied by the apparatus shown in Fig. 12, wherein a saucer-like element 82 is secured to the lower end of the pipe 81 in place of the spray head 80. The outer edge of the saucer 82 is substantially the same diameter as the interior of the tube, or slightly smaller, and is provided with small circumferentially spaced notches 83 through which the viscous coating material flows evenly and runs together below the saucer 82 to form a circumferentially and longitudinally continuous coating on the inside of the tube, while the circumferential edge of the saucer intermediate the notches 83, engages the inside of the tube and centers the saucer therein to provide a coating of uniform thickness.

I claim:

1. A knitting head comprising twin needle cylinder units aligned and spaced axially with an annular work slot therebetween, each unit having a circular concentric step formation including a cylindrical portion of one diameter at and adjacent said work slot, and a cylindrical portion of larger diameter spaced from said work slot, said larger portion having longitudinal needle grooves formed in its outer peripheral surface, and said smaller portion having longitudinal needle recesses formed in its outer peripheral surface between said work slot and said relatively spaced larger portion, with said recesses alternating with said grooves circumferentially of said knitting head.

2. A knitting head comprising twin needle cylinder units aligned and spaced axially with an annular work slot therebetween, each unit having a circular concentric stepped formation including a cylindrical portion of one diameter at and adjacent said work slot, and a cylindrical portion of larger diameter spaced from said work slot, said larger portion having longitudinal needle grooves formed in its outer peripheral surface with the base surfaces of said grooves disposed at angles to the axis of said head and converging toward said axis and said work slot, and said smaller portion having longitudinal needle recesses formed in its outer peripheral surface between said work slot and said relatively spaced larger portion, with said recesses alternating with said grooves circumferentially of said knitting head.

3. A knitting head comprising twin needle cylinder units aligned and spaced axially with an annular work slot therebetween, each unit having a circular concentric stepped formation including a cylindrical portion of one diameter at and adjacent said work slot, and a cylindrical portion of larger diameter spaced from said work slot, said larger portion having longitudinal needle recesses formed in its outer peripheral surface with the base surfaces of said grooves disposed at angles to the axis of said head and converging toward said axis and said work slot, and said smaller portion having longitudinal needle recesses formed it its outer peripheral surface between said work slot and said relatively spaced larger portion, with said recesses alternating with said grooves circumferentially of said knitting head, said recesses in each unit having base surfaces in angular alignment respectively with the base surfaces of the needle grooves in the other of said twin units.

4. A knitting head comprising twin needle cylinder units aligned and spaced axially with an annular work slot therebetween, each unit having a circular concentric stepped formation in-

cluding a cylindrical portion of one diameter at and adjacent said work slot, and a cylindrical portion of larger diameter spaced from said work slot, said larger portion having longitudinal needle grooves formed in its outer peripheral surface with the base surfaces of said grooves disposed at angles to the axis of said head and converging toward said axis and said work slot, and said smaller portion having longitudinal needle recesses formed in its outer peripheral surface between said work slot and said relatively spaced larger portion, with said recesses alternating with said grooves circumferentially of said knitting head, said recesses in each unit having base surfaces in angular alignment respectively with the base surfaces of the needle grooves in the other of said twin units and the ends of said smaller portions adjacent said work slot having beveled needle bearing surfaces in angular alignment respectively with the bases of the needle grooves in the respectively associated larger portions of the units intermediate the recesses in the smaller portions of the units.

5. A knitting head comprising twin needle cylinder units aligned and spaced axially with an annular work slot therebetween, each unit having a circular concentric stepped formation including a cylindrical portion of one diameter at and adjacent said work slot, and a cylindrical portion of larger diameter spaced from said work slot, said larger portion having longitudinal needle grooves formed in its outer peripheral surface, and said smaller portion having longitudinal needle recesses formed in its outer peripheral surface between said work slot and said relatively spaced larger portion, with said recesses alternating with said grooves circumferentially of said knitting head, and an inlay controlling mandrel within said knitting head in the plane of said work slot.

6. A knitting head comprising twin needle cylinder units aligned and spaced axially with an annular work slot therebetween, each unit having a circular concentric stepped formation including a cylindrical portion of one diameter at and adjacent said work slot, and a cylindrical portion of larger diameter spaced from said work slot, said larger portion having longitudinal needle grooves formed in its outer peripheral surface, and said smaller portion having longitudinal needle recesses formed in its outer peripheral surface between said work slot and said relatively spaced larger portion, with said recesses alternating with said grooves circumferentially of said knitting head, and an inlay controlling mandrel within said knitting head in the plane of said work slot and tapering off from said work slot to a free end of said mandrel.

7. A knitting head comprising twin needle cylinder units aligned and space axially with an annular work slot therebetween, each unit having a circular concentric stepped formation including a cylindrical portion of one diameter at and adjacent said work slot, and a cylindrical portion of larger diameter spaced from said work slot, said larger portion having longitudinal needle grooves formed in its outer peripheral surface, and said smaller portion having longitudinal needle recesses formed in its outer peripheral surface between said work slot and said relatively spaced larger portion, with said recesses alternating with said grooves circumferentially of said knitting head, an inlay controlling mandrel within said knitting head in the plane of said work slot, and means for supporting said mandrel at one of its ends within said knitting head to one side of said work slot with the opposite end of said mandrel extending across and terminating beyond the opposite side of said work slot.

8. A knitting head comprising twin needle cylinder units aligned and spaced axially with an annular work slot therebetween, each unit having a circular concentric stepped formation including a cylindrical portion of one diameter at and adjacent said work slot, and a cylindrical portion of larger diameter spaced from said work slot, said larger portion having longitudinal needle grooves formed in its outer peripheral surface, and said smaller portion having longitudinal needle recesses formed in its outer peripheral surface between said work slot and said relatively spaced larger portion, with said recesses alternating with said grooves circumferentially of said knitting head, an inlay controlling mandrel within said knitting head in the plane of said work slot, means for supporting said mandrel at one of its ends within said knitting head to one side of said work slot with the opposite end of said mandrel extending across and terminating beyond the opposite side of said work slot, and means extending axially of said knitting head through and beyond said opposite end of the mandrel for applying a coating substance to the interior wall of the knitted tube.

9. A knitting head comprising twin needle cylinder units aligned and spaced axially with an annular work slot therebetween, each unit having a circular concentric stepped formation including a cylindrical portion of one diameter at and adjacent said work slot, and a cylindrical portion of larger diameter spaced from said work slot, said larger portion having longitudinal needle grooves formed in its outer peripheral surface, and said smaller portion having longitudinal needle recesses formed in its outer peripheral surface between said work slot and said relatively spaced larger portion, with said recesses alternating with said grooves circumferentially of said knitting head, an inlay controlling mandrel within said knitting head in the plane of said work slot, means rotatable about said knitting head to lay an inlay element in said work slot against the stitches of the fabric tube being knitted, means located axially beyond said mandrel for gripping said fabric tube to prevent twisting thereof, and means for operating said holding means at a linear speed commensurate with the speed of production of said fabric tube by said knitting head.

10. A needle cylinder unit of circular concentrically stepped formation including a cylindrical portion of one diameter having needle grooves in its outer peripheral surface, and a cylindrical portion of lesser diameter projecting axially beyond one end of the first said portion with needle receiving recesses in its outer peripheral surface in alternating relation to said grooves circumferentially of said unit.

11. A needle cylinder unit of circular concentrically stepped formation including a cylindrical portion of one diameter having needle grooves in its outer peripheral surface, and a cylindrical portion of lesser diameter projecting axially beyond one end of the first said portion with needle receiving recesses in its outer peripheral surface in alternating relation to said grooves circumferentially of said unit, with the bases of said grooves disposed at a predeter-

mined angle to the axis of said unit and converging toward the exposed end of said smaller diameter portion.

12. A needle cylinder unit of circular concentrically stepped formation including a cylindrical portion of one diameter having needle grooves in its outer peripheral surface, and a cylindrical portion of lesser diameter projecting axially beyond one end of the first said portion with needle receiving recesses in its outer peripheral surface in alternating relation to said grooves circumferentially of said unit, with the bases of said grooves disposed at a predetermined angle to the axis of said unit and converging toward the exposed end of said smaller diameter portion, and a circumferential bevel on the outer peripheral surface of said smaller diameter portion adjacent said exposed end thereof, the angle of said bevel being coextensive with the angle of said groove base surfaces.

13. A needle cylinder unit of circular concentrically stepped formation including a cylindrical portion of one diameter having needle grooves in its outer peripheral surface, and a cylindrical portion of lesser diameter projecting axially beyond one end of the first said portion with needle receiving recesses in its outer peripheral surface in alternating relation to said grooves circumferentially of said unit, with the bases of said grooves disposed at a predetermined angle to the axis of said unit and converging toward the exposed end of said smaller diameter portion, said recesses having base surfaces disposed at angles corresponding in degree with the angles of said groove base surfaces but arranged in opposite divergent relation toward said exposed end of said smaller diameter portion of the unit.

14. A needle cylinder unit comprising inner and outer separable concentric elements, said outer element being of cylindrical form with needle grooves in its outer peripheral surface, said inner element being of tubular form within and projecting axially beyond one end of said outer element, with needle recesses formed in the peripheral surface of said axially extended portion thereof in alternating relation to said grooves circumferentially of said unit.

15. A needle cylinder unit comprising inner and outer separable concentric elements, said outer element being of cylindrical form with needle grooves in its outer peripheral surface, said inner element being of tubular form within and projecting axially beyond one end of said outer element, with needle recesses formed in the peripheral surface of said axially extended portion thereof in alternating relation to said grooves circumferentially of said unit, and means for securing said elements in said concentric relationship with the recessed end of said inner element extended beyond the one end of said outer element.

16. A needle cylinder unit comprising inner and outer separable concentric elements, said outer element being of cylindrical form with needle grooves in its outer peripheral surface, said inner element being of tubular form within and projecting axially beyond one end of said outer element with needle recesses formed in the peripheral surface of said axially extended portthereof in alternating relation to said grooves circumferentially of said units, and a hollow mandrel within said tubular element with one end projecting axially beyond said extended end of said inner tubular element.

17. A needle cylinder unit comprising inner and outer separable concentric elements, said outer element being of cylindrical form with needle grooves in its outer peripheral surface, said inner element being of tubular form within and projecting axially beyond one end of said outer element with needle recesses formed in the peripheral surface of said axially extended portion thereof in alternating relation to said grooves circumferentially of said unit, a hollow mandrel within said tubular element with one end projecting axially beyond said extended end of said inner tubular element, and a spray head coaxial with said outer elements and said mandrel beyond the exposed end of said mandrel.

18. A needle cylinder unit comprising inner and outer separable concentric elements, said outer element being of cylindrical form with needle grooves in its outer peripheral surface, said inner element being of tubular form within and projecting axially beyond one end of said outer element with needle recesses formed in the peripheral surface of said axially extended portion thereof in alternating relation to said grooves circumferentially of said unit, a hollow mandrel within said tubular element with one end projecting axially beyond said extended end of said inner tubular element, a spray head coaxial with said outer elements and said mandrel beyond the exposed end of said mandrel, an annular flange on the opposite end of said inner element secured to the opposite end of said outer element an annular flange on said mandrel secured to the annular flange of said inner element, and a disc on said spray head secured to the annular flange of said mandrel for securing said inner and outer elements said mandrel and said spray head in concentric relatively extended relation to each other.

19. A needle cylinder unit comprising inner and outer separable concentric elements, said outer element being of cylindrical form with needle grooves in its outer peripheral surface, said inner element being of tubular form within and projecting axially beyond one end of said outer element with needle recesses formed in the peripheral surface of said axially extended portion thereof in alternating relation to said grooves circumferentially of said unit, a hollow mandrel within said tubular element with one end projecting axially beyond said extended end of said inner tubular element, and means intermediate the inner surface of said tubular element and the outer surface of said mandrel for maintaining said tubular element and said mandrel in radially spaced relation to each other.

20. A needle cylinder unit comprising inner and outer separable concentric elements, said outer element being of cylindrical form with needle grooves in its outer peripheral surface, said inner element being of tubular form within and projecting axially beyond one end of said outer element with needle recesses formed in the peripheral surface of said axially extended portion thereof in alternating relation to said grooves circumferentially of said unit and an annular flange on the opposite end of said inner element overlying and separably secured to the opposite end of said outer element.

21. A needle cylinder unit comprising inner and outer separable concentric elements, said outer element being of cylindrical form with needle grooves in its outer peripheral surface, said inner element being of tubular form within

and projecting axially beyond one end of said outer element with needle recesses formed in the peripheral surface of said axially extended portion thereof in alternating relation to said grooves circumferentially of said unit, and an annular flange on the opposite end of said inner element overlying and separably secured to the opposite end of said outer element, with the base surfaces of said needle grooves in said outer element being arranged at convergent angles to the axis of said unit in a direction toward the extended end of said inner element.

22. A needle cylinder unit comprising inner and outer separable concentric elements, said outer element being of cylindrical form with needle grooves in its outer peripheral surface, said inner element being of tubular form within and projecting axially beyond one end of said outer element with needle recesses formed in the peripheral surface of said axially extended portion thereof in alternating relation to said grooves circumferentially of said unit, and an annular flange on the opposite end of said inner element overlying and separably secured to the opposite end of said outer element, with the base surfaces of said needle grooves in said outer element being arranged at convergent angles to the axis of said unit in a direction toward the extended end of said inner element, said extended portion of said inner element being beveled on an angle coextensive with the angle of said needle groove base surfaces.

23. A needle cylinder unit comprising inner and outer separable concentric elements, said outer element being of cylindrical form with needle grooves in its outer peripheral surface, said inner element being of tubular form within and projecting axially beyond one end of said outer element with needle recesses formed in the peripheral surface of said axially extended portion thereof in alternating relation to said grooves circumferentially of said unit and an annular flange on the opposite end of said inner element overlying and separably secured to the opposite end of said outer element, with the base surfaces of said needle grooves in said outer element being arranged at convergent angles to the axis of said unit in a direction toward the extended end of said inner element, said extended portion of said inner element being beveled on an angle coextensive with the angle of said needle groove base surfaces, and said recesses having base surfaces disposed on oppositely divergent angles of the same degree relative to said unit axis as the base surfaces of said needle grooves.

24. A needle cylinder unit comprising inner and outer separable concentric elements, said outer element being of cylindrical form with needle grooves in its outer peripheral surface, said inner element being of tubular form within and projecting axially beyond one end of said outer element with needle recesses formed in the peripheral surface of said axially extended portion thereof in alternating relation to said grooves circumferentially of said unit and an annular flange on the opposite end of said inner element overlying and separably secured to the opposite end of said outer element, with the base surfaces of said needle grooves in said outer element being arranged at convergent angles to the axis of said unit in a direction toward the extended end of said inner element, said extended portion of said inner element being beveled on an angle coextensive with the angle of said needle groove base surfaces, and said recesses having base surfaces adjacent the exposed extended end surface of said inner element disposed on oppositely divergent angles of the same degree relative to said unit axis as the base surfaces of said needle grooves and terminating in slots passing completely through the cylindrical wall of said inner element.

25. A needle cylinder unit having an axial bore of predetermined diameter, a main body portion of predetermined outside diameter, and an axially extended reduced portion of lesser outside diameter than said body portion, said body portion being provided with circumferentially spaced needle grooves having base surfaces arranged on angles relative to the axis of the unit and converging toward said axially extended reduced portion, said reduced portion having a frusto-conical needle-bearing surface at its extreme extended end where the angle of said surface is coextensive with the angles of the groove bases in said outer portion, the transverse plane of the smaller end of the frustrum being coincident with the transverse plane of said extreme end of said axially extended portion, said smaller end of said frustrum having a diameter slightly larger than the diameter of said internal bore, to provide a narrow annular end surface on said unit, whereby the knitting operation will take place within said bore at said extreme end of said unit.

WALTER LARKIN.