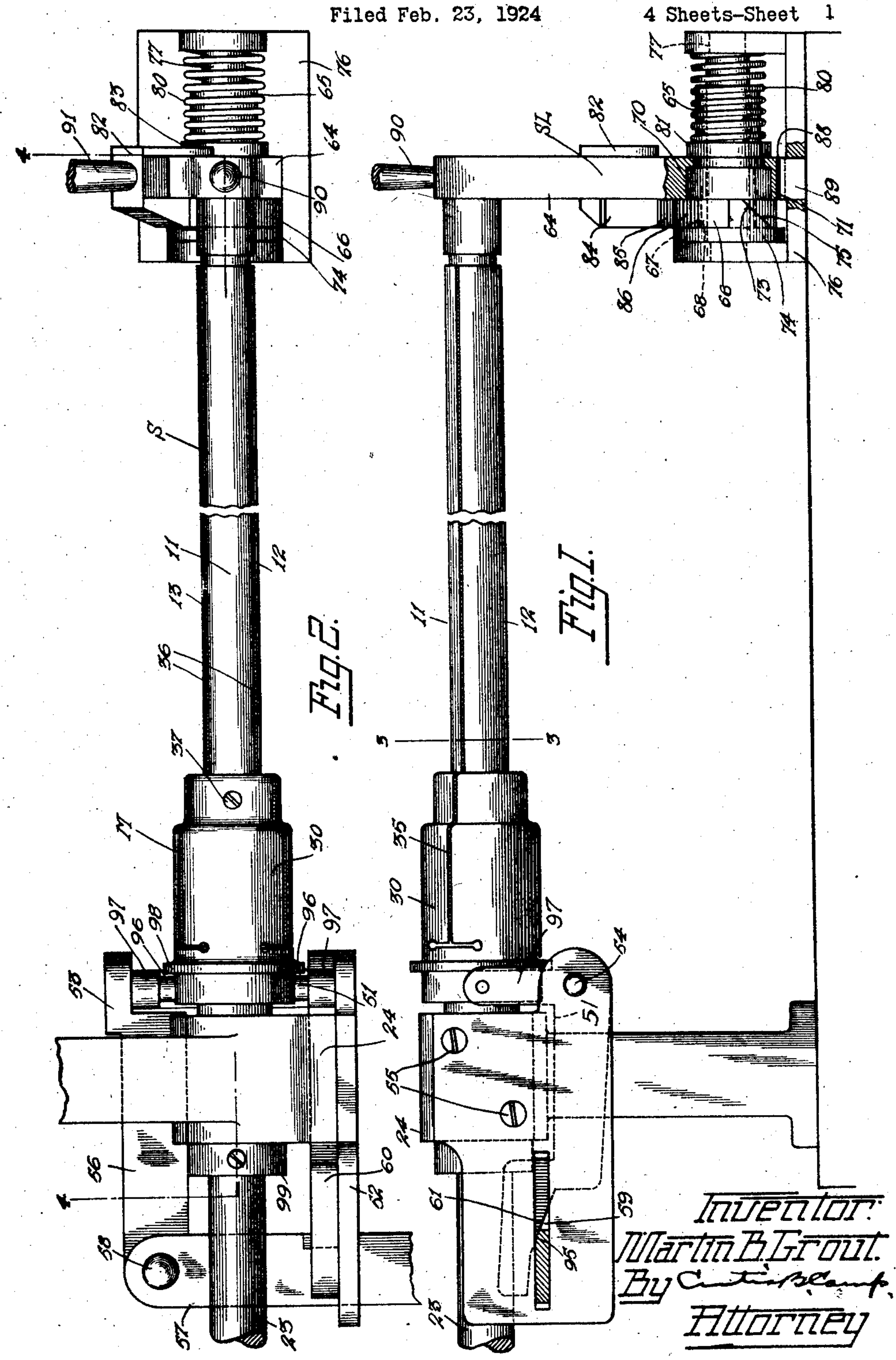
July 3, 1928. 1,675,489

M. B. GROUT

MANDREL

Filed Feb. 23, 1924 4 Sheets-Sheet 1

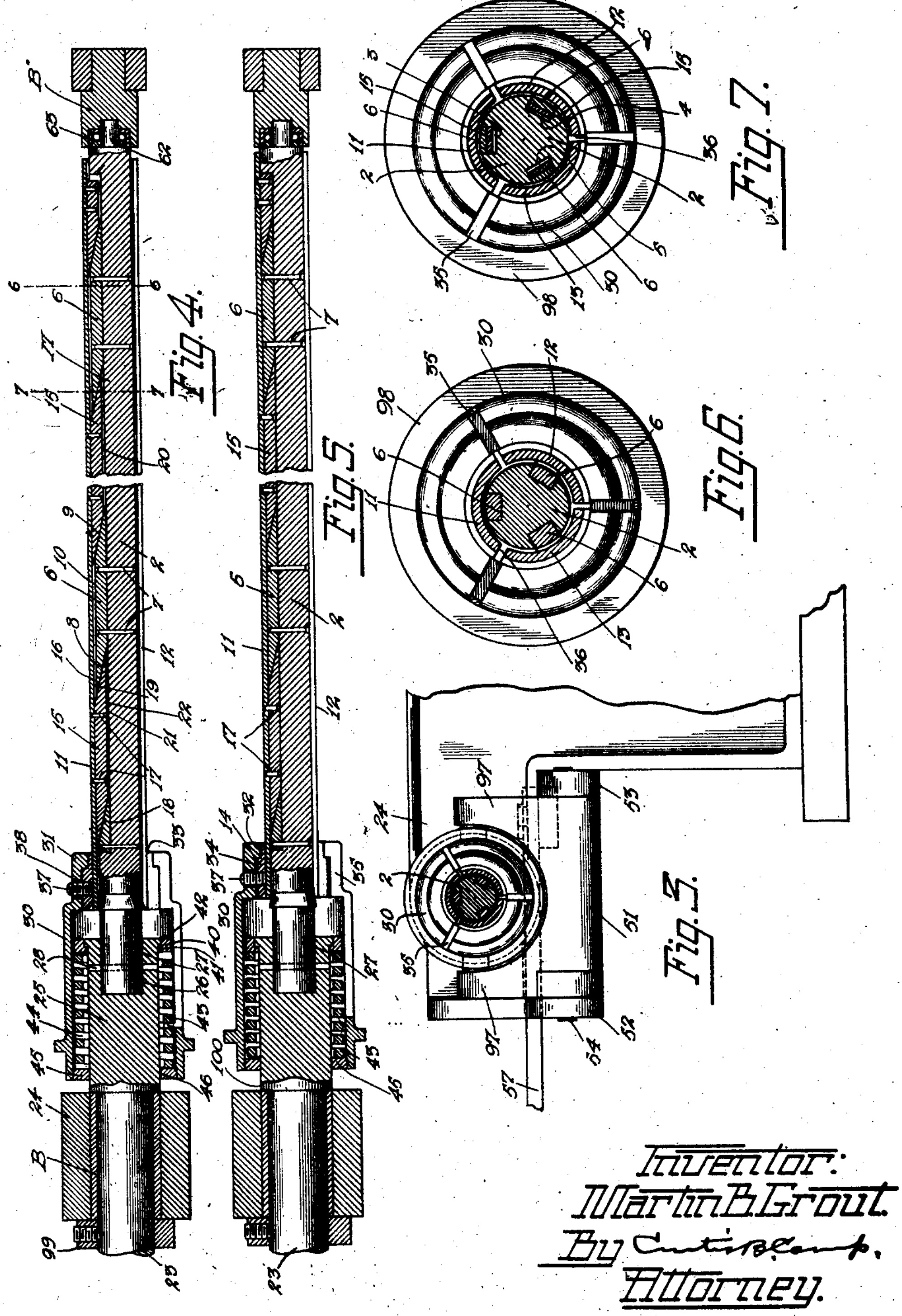


July 3, 1928. 1,675,489

M. B. GROUT

MANDREL

Filed Feb. 23, 1924 4 Sheets-Sheet 2

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M. B. GROUT

MANDREL

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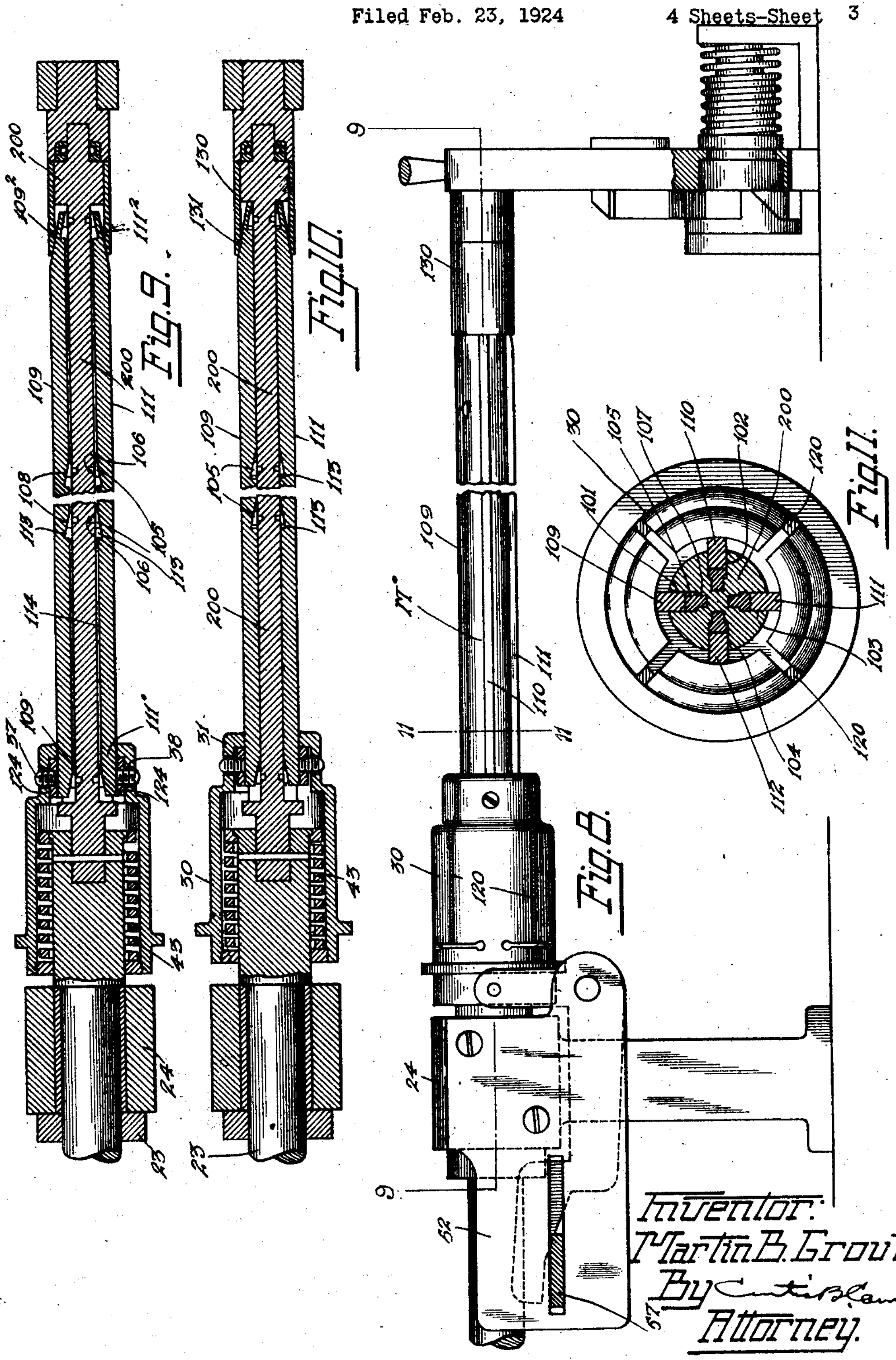


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July 3, 1928. M. B. GROUT 1,675,489

MANDREL

Filed Feb. 23, 1924 4 Sheets-Sheet 4

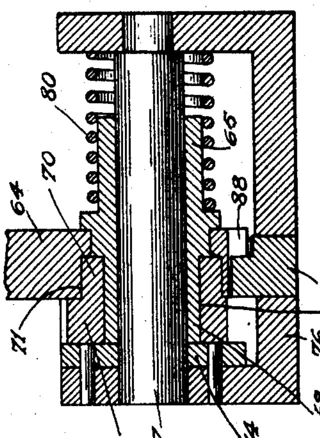


Fig.14.

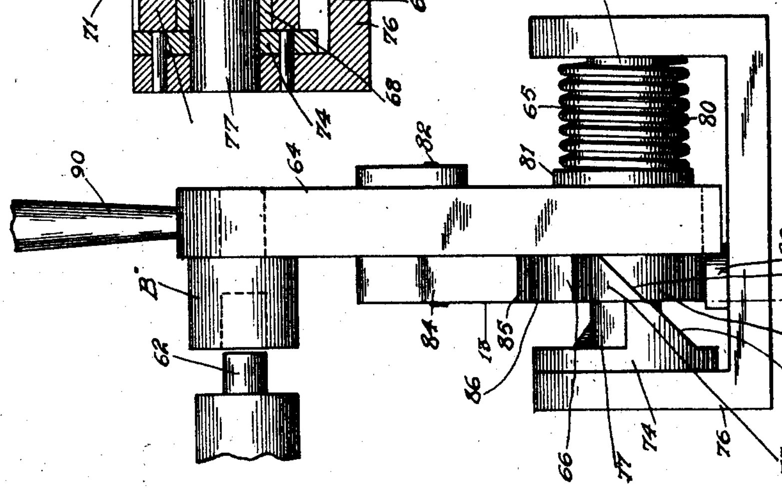


Fig.12.

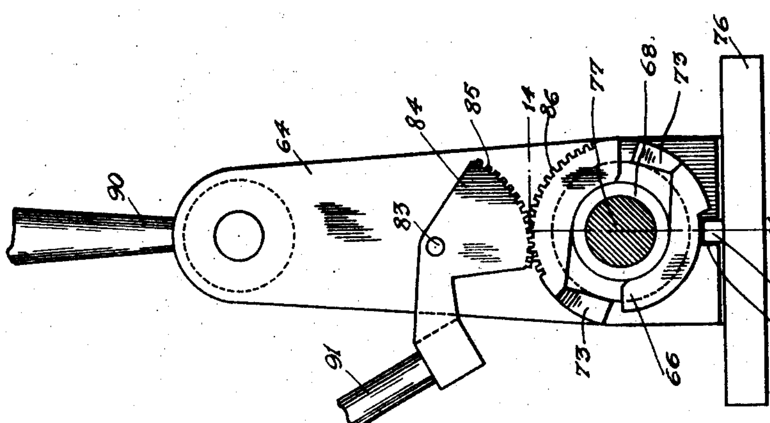


Fig.13.

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Patented July 3, 1928. **1,675,489**

# UNITED STATES PATENT OFFICE.

MARTIN B. GROUT, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

## MANDREL.

Application filed February 23, 1924. Serial No. 694,561.

My invention relates to mandrels, and has to do more particularly with winding mandrels, such as are used in connection with winding machines of the multiple type, and which are associated with the winding spindle of the multiple winding machine. Multiple winding machines of the above type permit the simultaneous winding of a plurality of electromagnet coils on the winding mandrel, and an object of my invention is the provision of an improved mandrel which is simple in construction and operation and provided with positive means for gripping the tube to rotatably secure it on the mandrel upon which the electromagnet coils are wound.

Different types of mandrels have been devised for use in connection with winding machines of the multiple type, such as collapsible or expanding mandrels, but these have been deficient, especially the means for gripping the bore of the tube to rotatably secure it to the mandrel during the winding operation. The types of mandrels above mentioned are provided with various means, such as fingers, movable bars or ribs, for gripping the bore of the tube to secure the same on the mandrel but these various gripping means are deficient in that the gripping means does not grip the bore of the tube upon which the electromagnets are wound equally throughout its length, and this inequality of the gripping means of the mandrel results in finished coils which are not uniform in shape and of a predetermined size as to diameter. Mandrels of the above type are also provided with means such as dogs, springs or other means for expanding and collapsing the mandrel which requires complication of mechanism that necessitates manual adjustment each time a new tube is placed on the mandrel or a finished tube removed.

To overcome these deficiencies in mandrels of the expanding type as now in use, I have designed an expanding mandrel which obviates the above mentioned defects, and a feature of my invention is the provision of a mandrel which is provided with a core member and a sectional shell, the sections of which are superimposed on the core. Suitable means associated with the core and sections of the shell of the mandrel cause the shell sections to remain normally in their expanded position, the said means acting upon each other to expand the shell equally throughout its length which permits the mandrel of my invention to hold its true diameter throughout its entire length when in its expanded position.

Another feature of my invention is the provision of means for controlling the collapsing and expansion of the mandrel, which means is in the form of a controlling lever connected with a yoke member operatively associated with a barrel or sleeve which is linked to the sections of the shell of the mandrel, and through the agency of a suitable spring supported in the sleeve the tension is such as to hold the shell sections superimposed upon the core of the mandrel in their expanded position. The lever when moved rocks the yoke which is operatively associated with the lever and sleeve to which the shell sections of the mandrel are secured, to cause the said shell sections superimposed upon the core of the mandrel to collapse through the agency of suitable means secured to the shell sections and the core of the mandrel.

Another feature of my invention is the provision of a mandrel comprising a core which supports a plurality of rib members and means secured to the core of the mandrel for cooperating with the rib members to hold the rib members in their expanded position through the agency of suitable spring means. The means for holding the rib members in their expanded position through the agency of the spring means expands the ribs equally throughout their length, which thus permits the mandrel to hold its true size and form throughout its entire length when in its expanded position.

Another feature of my invention is the provision of a sliding bearing support which may be moved longitudinally by means of suitable lever means to permit the end of the mandrel to be disassociated from its bearing so that a tube supported on the mandrel may be removed when the said mandrel is collapsed.

The above named features, as well as others, will be more fully described in the ensuing specification, and for a more complete understanding of my invention reference may be had to the accompanying drawings in connection with the detailed description in which like reference characters in the several views denote like parts, and in which:

Fig. 1 is an elevation of the mandrel of my invention illustrating its supporting means and controlling lever for controlling the expansion and collapsing of the mandrel.

Fig. 2 is a plan view of Fig. 1.

Fig. 3 is a sectional view along the line 3—3 of Fig. 1.

Fig. 4 is a sectional view along the line 4—4 of Fig. 2 to clearly illustrate the construction of the expanding mandrel in its expanded position.

Fig. 5 is a sectional view similar to Fig. 3 illustrating the mandrel in its collapsed position.

Fig. 6 is an enlarged sectional view along the line 6—6 of Fig. 4.

Fig. 7 is an enlarged sectional view along the line 7—7 of Fig. 4.

Fig. 8 is an elevation of another form of mandrel illustrating its supporting means and controlling lever for controlling the expansion and collapsing of the mandrel.

Fig. 9 is a sectional view taken on the line 9—9 of Fig. 8 illustrating the mandrel in its expanded position.

Fig. 10 is a sectional view of the mandrel similar to Fig. 9 but illustrating the mandrel in its collapsed position.

Fig. 11 is a sectional view taken on the line 11—11 of Fig. 8.

Fig. 12 is an enlarged elevation of the support which rotatably supports one end of the mandrel.

Fig. 13 is a sectional view along the line 13—13 of Fig. 12; and

Fig. 14 is a sectional view along the line 14—14 of Fig. 13.

Referring now more in detail to my invention as illustrated in the accompanying drawings, and referring particularly to Figs. 1 to 7, inclusive, the mandrel M illustrated comprises a core 2 cylindrical in shape, and which is provided with three slots 3, 4 and 5, cut in the peripheral face of the core member 2, each slot being spaced 120 degrees apart. A plurality of core members 6 are secured to the slots 3, 4 and 5 by means of suitable rivets 7. The core members 6 are spaced equi-distant in the slots 3, 4 and 5 with respect to each other throughout the length of the slots 3, 4 and 5, and each core member 6 is in alignment with a core member 6 in an adjacent slot. The ends of the core members 6 secured in the slots 3, 4 and 5 are provided with angularly disposed faces 8 and 9 for purposes as will presently be described and their faces 10 are arcuate in shape to conform with the peripheral face of the core 2.

The shell S which comprises the expanding and collapsible portion of the mandrel M comprises three sections 11, 12 and 13, arcuate in shape, and which when slidably supported by the core 2, as will be more fully hereinafter described, are in concentric relation with the core 2. Any suitable means may be employed to construct the shell sections 11, 12 and 13, such as a tube of proper size which is slotted its entire length, the said slots being spaced around its peripheral face 120 degrees apart, and when thus cut, the sections formed by this slotting operations form the shell members or sections 11, 12 and 13. I place a ferrule upon one end of the tube and secure it thereto in any suitable manner before slotting so that when the three shell sections 11, 12 and 13 are formed, the ends of each section 11, 12 and 13 is provided with a shouldered lug 14. When the sections 11, 12 and 13 are slidably supported on the core 2 in concentric relation therewith, the lugs 14 on the three sections 11, 12 and 13 form as a whole a ferrule for purposes as will presently be described. While I have described one method of constructing the shell sections 11, 12 and 13, I do not, however, wish to be limited to the exact structure as just described, as other methods of construction are readily apparent.

The shell sections 11, 12 and 13 are each provided with a plurality of shell members or ribs 15, which are secured to the inner peripheral face 16 of each section equi-distant from its edges by means of suitable rivets 17 and equi-distant along the shell sections 11, 12 and 13 with respect to each other throughout the length of the shell sections. Each rib 15 is in alignment with a rib 15 secured to an adjacent shell section, and the ends of the ribs 15 secured to the respective shell sections 11, 12 and 13 are provided with angularly disposed faces 18 and 19, for purposes as will presently be described.

The shell sections 11, 12 and 13 are slidably supported on the core 2, and these shell sections 11, 12 and 13 are associated, respectively, with the slots 3, 4 and 5, and the ribs 15 on the respective sections 11, 12 and 13 cooperate, respectively, with the core members 6 in their associated slots 3, 4 and 5, and as all the shell sections are similarly supported, the detailed description of the means provided for slidably supporting the shell section 11 will suffice. The shell section 11 when placed upon the core 2 preparatory to its being slidably supported thereon, is positioned to place the ribs 15 secured to the section 11 in alignment with the slot 3, with its ribs 15 above the opening or gaps 20 between the spaced core members 6 in the slot 3. When the shell section 11 of the sectional shell S is thus positioned with its ribs 15 located in relation to the gaps 20 between the core members 6 as just described, the angular faces 18 and 19 of the ribs 15 have an inclination opposite that of the angular faces 8 and 9 of the core members 6. The shell section 11 is now ready to be slidably attached to the core 2 and to accomplish this, the shell section 11 is moved forward, causing the angular faces 19 of the ribs 15 to engage the angular faces 9 of the core members 6 in the slot 3, and the continued forcing of the shell section 11 forward causes the angular faces 19 of the ribs 15 to ride or slide on the angular faces 9 of the core members 6 in the slots 3. Due to the opposite inclination of the angular faces 18 and 19 of the ribs 15 and the angular faces 8 and 9 of the core members 6, the shell section 11 is forced or drawn down in relation to the center of the core 2 until the bottom faces 21 of the ribs 15 engage the bottom face 22 of the slot 3. When in this position, as clearly illustrated in Fig. 5 the section 11 is in its collapsed position with the ribs 15 resting in the openings or gaps 20 between the core members 6 spaced in the slot 3 with the angular faces 18 and 19 of the ribs 15 engaging the angular faces 8 and 9 of the core members 6. The sections 12 and 13 are also slidably supported upon the core 2 in the same manner as just described in connection with the shell section 11 with their respective ribs 15 resting in the openings or gaps 20 between the core members 6 spaced in the slots 4 and 5 of the core 2, and with their angular faces 18 and 19 engaging the angular faces 8 and 9 of the core members 6. The shell sections 11, 12 and 13 when slidably supported, as just described, on the core 2 form as a whole the sectional shell S which rests in concentric relation with the core 2.

Having described in detail the construction of the mandrel M of my invention, I will now describe in detail the means employed for controlling the expansion and collapsing of the mandrel M and the bearing supports B and B′ for rotatably supporting the mandrel M. The spindle shaft 23 which is connected to a suitable driving means extends through a bearing B in the end plate 24 of the winding machine frame, and for a more detailed description of its connection with the driving means and its relation to the entire winding machine, reference may be had to a co-pending application filed by me, Martin B. Grout, and bearing S. N. 683,923. The end 25 of the spindle shaft 23 is provided with an orifice 26 of a size to receive the extending end 27 of the mandrel core 2 and a pin 28 passing through suitable orifices in the spindle shaft 23 and core 2 connects the mandrel core 2 to the spindle shaft 23.

A sleeve member 30 provided with a reduced portion or neck 31 is slipped over the mandrel M after the shell sections 11, 12 and 13 have been placed on the core 2 to be slidably supported thereby to form a cylindrical body and its neck 31 is provided with an orifice 32 of a size to receive the reduced portion 33 of the ferrule, formed by the lugs 14 secured to the shell sections 11, 12 and 13, the body portion of the ferrule resting in the bore 34 of the neck 31 of the sleeve member 30 which bore is slightly larger than the diameter of the ferrule when the sectional shell S is in its collapsed position. The sleeve member 30 is slotted, its slots 35 being spaced 120 degrees apart around the periphery of the sleeve member 30 and extending rearwardly a portion of its length for purposes as will presently be described. The slots 35 in the sleeve member 30 when the same is positioned on the mandrel M, as illustrated in Figs. 4 and 5, are in alignment with the slots 36 formed between adjacent shell sections slidably supported upon the core 2 and screws 37 which pass through suitable orifices 38 in the neck 31 of the sleeve member 30 have screw-threaded engagement with suitable tapped orifices in the lugs 14 on the shell sections 11, 12 and 13. The sleeve member 30 is supported upon the sectional shell member S against lateral movement but may be expanded due to the slots 35, the means for expanding the same and its function will be presently described. A collar 40 provided with a shouldered orifice 41 is of a size to permit it being slipped over the spindle shaft end 23, which is provided with a shoulder 42 against which the collar 40 rests. A helical spring 43 is slipped over the end 25 of the spindle shaft 23 and rests in the bore 44 of the sleeve member 30, and a ring nut 45 having an orifice 46 of a size to permit it being slipped over the shaft end 25 has screw-threaded engagement with the threaded portion of the bore 44 of the sleeve member 30. The helical spring 43 is placed under compression as the ring nut 45 is threaded into the bore 44 of the sleeve 30, one end of the spring 43 bearing against the collar 40 supported on the spindle shaft 23, and its other end bearing against the ring nut 45 and cooperates with the slotted sleeve 30 and the shell sections 11, 12 and 13 linked thereto by means of the screws 37 for purposes as will presently be described. A yoke member 51 pivotally supported between a pair of supporting members 52 and 53 by means of a pivot pin 54, spans the sleeve member 30 and places the yoke 51 in operative relation with the sleeve member 30. The supporting member 52 is in the form of a plate and secured to the front face of the end plate 24 of the winding machine frame by means of the screws 55. The other supporting member 53 is also secured to the end plate 24 and is provided with an extended portion 56 to which the actuating lever 57 is pivotally secured by means of the pivot pin 58. The actuating lever 57 extends forward through a slot 59 in the supporting plate 52, its free end being equipped with a suitable handle. The yoke 51 is provided with an integrally formed extension 60 extending parallel with the supporting plate 52 and this extension 60 of the yoke 51 is provided with an angular portion 61 which cooperates with the actuating lever 57 to rock the yoke 51 about its pivot 54 when the lever is moved to bring about the collapsing of the mandrel M, as will presently be described.

The mandral M is rotatably supported at its other end by means of a slidable support SL as clearly illustrated in Figs. 12–14 inclusive. This support SL may be moved along a suitable supporting shaft so that the end 62 of the mandrel M may be moved free of its supporting bearing 63 to permit a finished tube of electromagnets to be removed from the mandrel M and another tube placed thereon. A sliding arm 64 is provided which is secured to a sleeve member 65 in any suitable manner, as by means of a force fit, and a collar 66 provided with a central orifice 67 is adapted to be slipped on the reduced portion 68 of the sleeve 65 and rotatably supported thereon, and an annular reduced portion 70 of the collar 66 extends into a suitable orifice 71 in the face of the supporting arm 64. The collar 66 is provided with a pair of angular cam faces 73 diametrically opposite and cooperate with a ring shaped member 74 secured to a bracket 76 and which ring 74 is also provided with diametrically opposite angular cam faces 75 whose angle of inclination is opposite that of the angular cam faces 73 of the collar 66 which is rotatably supported on the sleeve 65 for purposes as will presently be described. A suitable shaft 77 supported by the bracket 76 extends through suitable orifices in the ring member 74 and sleeve 65 and supports the slidable arm 64 and its supported parts. The arm 64 supporting the bearing 63 is of the usual ball bearing type, into which the reduced end 62 of the core 2 of the mandrel M extends to rotatably support the mandrel M as a whole between the end plate 24 and the bearing 63 in the slidable arm 64. A helical spring 80 is supported on the sleeve 65 and rests between the arm of the bracket 76, and the annular shoulder 81 on the sleeve 65. The compression of the helical spring 80 is such as to force the sleeve 65 and its supported arm 64 to the left with reference to Fig. 1 and as the collar 66 is also rotatably supported on the sleeve 65, it is also moved with the sleeve 65 to place its angular cam faces 73 into engagement with the angular cam faces 75 of the ring member 74 secured to the leg of the bracket 76, for purposes as will presently be described. I provide a U-shaped member 82 pivoted to the slidable arm 64 by means of a pivot pin 83, which is provided with an integrally formed depending member 84 provided with an arcuate faced toothed rack 85 which meshes with the teeth 86 in the peripheral face of the rotatable collar 66 supported on the sleeve 65. A key way 88 is cut in the bottom face of the slidable arm 64 and a key 89 secured to the bracket 76 rests in the key way 88 for purposes as will presently be described. Handles 90 and 91 secured, respectively, to the slidable arm 64 and the U-shaped pivoted member 82 are provided for operating the slidable handle, as will now be described.

Having described in detail the construction of the expanding mandrel of my invention, and its supporting parts, I will now describe the operation of the same.

The shell sections 11, 12 and 13 of the sectional shell S of the mandrel M are linked to the sleeve member 30 by means of the screws 37 which pass through suitable orifices 38 in the sleeve 30 and have screw-threaded engagement with the shell sections 11, 12 and 13. It is thus readily apparent that any movement of the sleeve 30 along the shaft 23 will produce longitudinal movement of the shell sections 11, 12 and 13 along the core 2 upon which they are slidably supported as before described. The spring 43 which is supported in the bore of the sleeve is under compression so as to force the sleeve 30 and its attached shell sections 11, 12 and 13 to the left with reference to Fig. 4. This movement of the shell sections 11, 12 and 13 to the left causes the angular faces 18 and 19 of the ribs 15 on the shell sections 11, 12 and 13 to ride upon the angular faces 8 and 9 of the core members 6 secured in the slots 3, 4 and 5 of the core 2. Due to the opposite inclination of the faces 18 and 19 of a rib 15 in relation to the angular faces 8 and 9 of its adjacent core members 6 between which each rib 15 rests, the force or pull applied to the sleeve 30 by the spring 43 will cause the sections 11, 12 and 13 to spread or expand which expansion is brought about by the angular faces 18 and 19 of the ribs 15 on the respective shell sections 11, 12 and 13 riding on the angular faces 8 and 9 of the core members 2 secured in the slots 3, 4 and 5 of the core 2. The spreading of the shell sections 11, 12 and 13 upon the core 2 due to their movement to the left under the influence of the helical spring 43, is equal throughout the length of each shell section 11, 12 and 13 and with the type of construction just described it may readily be seen that the diameter of the sectional shell S which comprises shell sections 11, 12 and 13, expands equally throughout its length as to its increased diameter, thus maintaining the contour of the mandrel as to its cylindrical form true throughout its length. The mandrel M of my invention with its expanding sectional shell S provides means for gripping the bore of a tube over its entire inner peripheral bore and length. As the shell sections 11, 12 and 13 are spread or expanded, the peripheral face of the ferrule F formed by the lugs 14 on the end of the shell sections 11, 12 and 13 engages the inner peripheral face of the bore 34 of the reduced neck portion 31 of the sleeve 30 and expands the slotted wall of the sleeve 30, permitting the expansion of the sectional sleeve S.

The mandrel as illustrated in Figs. 1, 2 and 4 is shown in its normal expanded position, in which position a tube is secured thereto against rotation and longitudinal movement. Now to collapse the sectional shell S so that a tube supported on the mandrel may be removed, the lever 57 is grasped by the operator and moved to the right with reference to Fig. 2, causing the beveled edge 95 of the lever 57 to engage the angular face 61 of the yoke extension 60. This causes the extension to tilt upward and causes the yoke 51 to rock about its pivot 54. This movement of the yoke 51 to the right causes the lugs 96 secured to the legs 97 of the yoke 51 to engage the annular shoulder 98 on the sleeve 30 and move the sleeve 30 to the right along the shaft 23. The shaft 23 and the connected core 2 of the mandrel as a whole are held against longitudinal movement by means of the collar 99 secured to the shaft 23 by means of a set screw, and the shoulder 100 formed on the shaft 23 as clearly illustrated in Figs. 4 and 5, and as one end of the helical spring 43 rests against the collar 40 supported on the shaft 23, the movement to the right of the sleeve 30 will place the spring under additional compression. The shell sections 11, 12 and 13 being linked to sleeve 30 by means of the screws 37, causes the shell sections 11, 12 and 13 to slide along the core 2 of the mandrel and due to the opposite inclination of the angular faces 18 and 19 of the ribs 15 and the angular faces 8 and 9 of the core member 6, the force or push applied by the yoke 51 to the sleeve 30 will cause the shell sections 11, 12 and 13 to collapse due to the angular relation of angular faces 18 and 19 of the ribs 15 on the respective shell sections 11, 12 and 13 causing them to ride on the angular faces 8 and 9 of the core members 6 secured in the slots 3, 4 and 5 of the core 2. When the bottom faces 21 of the ribs 15 on the shell sections 11, 12 and 13 engage the bottom 22 of the slots 3, 4 and 5, as illustrated in Fig. 5, the sectional sleeve is fully collapsed so that the tube supported thereby may be removed, that is, after the slidable support SL is moved as will now be described. The slidable support SL is adapted to be moved to the right with reference to Fig. 2 to withdraw the core end 62 from the bearing 63 supported by the arm 64 of the slidable support SL. To accomplish this the lever 91 secured to the pivoted U-shaped member 84 is pressed forward with reference to Fig. 2 and as the arcuate toothed rack 85 is in mesh with the tooth periphery 86 of the collar 66, the said collar 66 is rotated as it is loosely supported on the sleeve 65 secured to the arm 64. Due to the opposite inclination of the angular faces 73 of the rotatable collar 66 and the angular faces 75 of the ring member 74 fixed to the bracket 76, the angular faces 73 of the collar 66 ride on the angular faces 75 of the stationary ring member 74 forcing the arm 64 and its supported parts to the right along the shaft 77 against the normal compression of the spring 80, the arm 64 being guided in its direction to the right by the key 89 in key way 88. The continued movement of the handle 91 forces the arm 64 to the right until it disengages the key way 88, the key 89, and when in this position, the arm 64 and its supported bearing 63 has been moved clear of the core ends 62 permitting the arm 64 and its supported parts to be rocked on the supporting shaft 77 and as the shell S is now in its collapsed position, the tube may be removed from the collapsed mandrel M. After a new tube has been placed on the mandrel M the lever 57 is released and the spring 43 supported in the sleeve 30 having been placed under compression by the movement of the sleeve 30 to the right, now moves the sleeve 30 to the left and as the shell sections 11, 12 and 13 are linked to the sleeve 30, they are also moved to the left to again bring about the expansion of the shell sections 11, 12 and 13 of the sectional shell S to grip the bore of the tube, all of which has been previously described in detail. The movement of the sleeve 30 to the left under the influence of the spring 43 forces the yoke 51 to the left, and causes the angular face 61 of the yoke extension 60 to ride on its beveled edge 95 of the lever 57 and force it into its normal position. To again place the core end 62 in its bearing 63, the arm 64 is again rocked on its supporting shaft 77 until it is in a position to again permit the key 89 to enter the key way 88 and when thus aligned, the spring 80 which was placed under compression by the movement of the sliding arm 64 to the right, forces the sliding arm 64 and its parts to the left permitting the core end 2 to again enter the bearing 63 again placing the angular faces 73 of the collar 66 into engagement with the angular faces 75 of the member 74, and also restore the lever 91, to its normal position.

Referring now to Figs. 8 to 11, inclusive, I illustrate another form of mandrel which is adapted to secure a square tube on the mandrel during the winding operation. The mandrel M′ is of the expanding type and comprises a core 200 cylindrical in shape and is provided with four slots 101, 102, 103 and 104 cut in the peripheral face of the core, each slot being spaced 90 degrees apart. A plurality of core members 105 provided with extending lugs 106 which fit into suitable orifices 107 in the bottom of the slots 101, 102, 103 and 104 by means of a drive fit to secure them in the slots. The core members 105 are spaced equi-distant apart in the slots 101, 102, 103 and 104 with respect to each other throughout the length of the said slots each core member 105 being in alignment with a core member 105 in adjacent slots. The core members 105 are provided with angular faces 108 for purposes as will presently be described.

The expanding members of the mandrel are in the form of ribs 109, 110, 111 and 112, which rest in the slots 101, 102, 103 and 104 in the core 100. The ribs 109, 110, 111 and 112 are slidably supported in the slots 101, 102, 103 and 104 and as each rib is similarly constructed, and slidably supported in its associated slot, a description of one will be typical of the others. The rib 109 is provided with a plurality of toothed notches 113 which notches 113 are spaced along the bottom face 114 of the rib 109 so as to register or align themselves with the core members 105 secured in the slot 101. The toothed notches 113 in the bottom face of the rib 114 have an angular inclination opposite that of the angular faces 108 of the core members 105 secured in the slot 101 and co-operate to allow the rib 109 to expand or collapse as will presently be described.

Having described in detail the construction and method of slidably supporting the rib 109 in its associated slot 101, it is readily apparent from the above description how the ribs 110, 111 and 112 are supported in their associated slots, 102, 103, and 104 and the ribs 109, 110, 111 and 112 when in their fully collapsed position in the slots 101, 102, 103 and 104 rest therein with their bottom faces 114 engaging the bottom of their respective slots 101, 102, 103 and 104.

The core 200 of the mandrel illustrated in Figs. 8 to 11, inclusive, is secured to the spindle shaft 23 in the same manner as described in detail in connection with Figs. 1 to 7, and the sleeve 30 supported thereon and its supported parts which coperate with the ribs 109, 110, 111 and 112 to bring about their expansion and collapsing is the same as previously described, and a further description is not thought necessary only to mention that the sleeve is provided with four slots 120, to permit the slotted sections of the sleeve 30 to cooperate with the said ribs. The ends 109′, 110′, 111′ and 112′ of the ribs 109, 110, 111 and 112 are provided with integrally formed shouldered portions 124 which rest in the bore of the reduced portion 31 of the sleeve 30, and screws 37, passing through suitable orifices 38 in the sleeve 30, and having screw-threaded engagement with tapped orifices in the shouldered portions 124 of the ribs 109, 110, 111 and 112 link the said ribs to the sleeve 30.

The spring 43 supported in the sleeve 30 is under compression so as to hold the mandrel in its expanded position, as the force or pull exerted by the spring 43 causes the sleeve 30 to move to the left with relation to Figs. 7 and 8 and as the ribs 109, 110, 111 and 112 are linked to the sleeve 30 by the screws 37, the said ribs 109, 110, 111 and 112 are also moved to the left in their respective slots 101, 102, 103 and 104 in the core 100. Due to the opposite angular inclination of the core members 105 in the slots 101, 102, 103 and 104 and the toothed notches 113 in the ribs 109, 110, 111, and 112, this movement of the said ribs to the left causes the toothed notches 113 of ribs 109, 110, 111 and 112 to ride upon the angular faces 108 of the core members 105 moving the said ribs outward with relation to the center of the core 200 into their expanded position. The ends $109^2$, $110^2$, $111^2$ and $112^2$ of the ribs 109, 110, 111 and 112 are tapered and a sleeve 130 secured to the core end 200′ by means of a drive fit is provided with a tapered orifice 131 which tapered orifice 131 overlaps the tapered ends $109^2$, $110^2$, $111^2$ and $112^2$ of the ribs 109, 110, 111 and 112. The ends 109′, 110′, 111′ and 112′ of the ribs 109, 110, 111 and 112 are retained in the core of the reduced portion 31 of the sleeve 30 by the shoulder formed thereon and the tapered orifice 131 in the sleeve 130 retains the rib ends $109^2$, $110^2$, $111^2$ and $112^2$ so as to slidably support the ribs 109, 110, 111 and 112 in their respective slots 101, 102, 103 and 104 against displacement.

The means for collapsing the mandrel are the same as described in detail in connection with Figs. 1 to 7, inclusive, and to collapse the mandrel the lever 57 is moved to the right causing the yoke 51 to rock about its pivot 54 to force the sleeve 30 to the right against the normal compression of the spring 43 in the sleeve 30, and due to the screw connection 37 between the sleeve 30 and the ribs 109, 110, 111 and 112 which links them to the sleeve 30, the said ribs are also forced to the right, and due to the opposite angular inclination of the faces 108 of the core members 105 and the toothed notches 113 in the ribs 109, 110, 111 and 112, the said ribs are moved inward with relation to the center of the core 200 until the bottom faces 114 of the said ribs engage the bottom of the slots 101, 102, 103 and 104 and in which position the mandrel is fully collapsed. To permit the mandrel to again expand the lever 57 is released and due to the compression of the spring 43 the sleeve 30 is again forced to the left, and as the ribs 109, 110, 111 and 112 are linked to the sleeve 30, the said ribs are also moved to the left, and due to the opposite angular inclination of the faces 108 of the core members 105 and the toothed notches 113 in the ribs 109, 110, 111 and 112, the said ribs are moved outward with relation to the center of the core 100 to again place the said ribs in their expanded position.

My improved device is particularly adapted for use in multiple winding machines for winding a plurality of electromagnets simultaneously and provides a firm grip between the tube and the mandrel. The expanding manrels as heretofore used required a complication of mechanism, besides necessitating manual adjustment each time a new tube is applied or a finished tube removed. With the improved mandrel of my invention it is only necessary to operate a lever which automatically collapses the mandrel to remove a finished tube, and after a new tube has been applied to release the lever when the mandrel expands automatically to grip the tube equally throughout its length to maintain the tube in its true cylindrical form. It is also to be noted that my improved mandrel is simple in construction, providing for economy of manufacture and the parts are held together through an ingenious arrangement which renders the mandrel practically proof against derangement or getting out of order.

Various modifications might be made in the form and structure of the parts without departing from the spirit and scope of the inventions, and I therefore aim to cover all such changes and modifications as come within the spirit and scope of the appended claims.

What I claim as new and desire to secure by United States Letters Patent, is:

1. In a mandrel of the character described comprising a core and arcuate shaped sectional shell members extending longitudinally thereof, longitudinal slots in said core and means secured to said sectional shell members and in said slots, said means comprising members having inclined faces adapted to engage each other for slidably supporting said sectional shell members on said core to form a unitary cylindrical structure, a spring for maintaining said shell members in their normal positions, and means for placing said spring under compression and thereby sliding said shell members.

2. In a mandrel of the character described comprising a core and arcuate shaped sectional shell members extending longitudinally thereof, longitudinal slots in said core and means secured to said sectional shell members and in said slots, said means comprising members having inclined faces adapted to engage each other for slidably supporting said sectional shell members in concentric relation on said core to form a unitary cylindrical structure in either of their expanded or collapsed positions, a spring for normally expanding said shell members, and means for placing said spring under compression to cause said shell members to assume their collapsed position.

3. In a mandrel of the character described comprising a core and arcuate shaped sectional shell members extending longitudinally thereof, a rotatable shaft connected with said core and a slidable sleeve supported on said shaft, longitudinal slots in said core, means secured to said sectional shell members and in said slots for slidably supporting said sectional shell members in concentric relation on said core to form a unitary cylindrical structure in either their expanded or collapsed position and means controlling the movement of said sleeve to place said sectional sleeve members in either of their expanded or collapsed positions, said last means including a spring for normally expanding said sleeve members, a yoke member, a lever adapted to move said yoke member to place said spring under additional compression and thereby move said sleeve member to cause said shell members to assume their collapsed position.

4. In a mandrel of the character described comprising a core and arcuate shaped sectional shell members extending longitudinally thereof, a rotatable shaft connected with said core, a slidable sleeve supported on said shaft, linked to said sectional shell members, longitudinal slots in said core, means secured to said sectional shell members and in said slots for supporting said sectional shell members in either of their expanded or collaped positions in concentric relation with said core to form a unitary cylindrical structure and means for controlling the movement of said sleeve and its linked sectional shell members to place them in either of their expanded or collapsed positions, said last means including a spring for normally expanding said sleeve members, a yoke member, a lever adapted to move said yoke member to place said spring under additional compression and thereby move said sleeve member to cause said shell members to assume their collapsed position.

5. In a mandrel of the character described comprising a core and arcuate shaped sectional shell members extending longitudinally thereof, rib members having angular end faces spaced along said shell sections, longitudinal slots in said core, ribs having angular end faces spaced in said longitudinal slots, the ribs of said shell sections resting between the spaced core members in said slots and having their angular end faces in engagement at all times with faces of oppo-

site angular inclination, on the said spaced core members to support said shell sections in concentric relation with said core to form a unitary cylindrical structure in either of the expanded or collapsed positions.

6. In a mandrel of the character described comprising a core and arcuate shaped sectional shell members extending longitudinally thereof, longitudinal slots in said core, rib members having angular end faces spaced along said shell sections, core members having angular end faces spaced in said longitudinal slots, said rib members resting between the spaced core members in said slots and having their angular end faces in engagement at all times with faces of opposite angular inclination, on the said spaced core members to support said shell sections in concentric relation with said core to form a unitary cylindrical structure in either of their expanded or collapsed positions and means linked with said shell sections for controlling the movement of said shell members in either their expanded or collapsed positions.

7. In a mandrel of the character described comprising a core provided with longitudinal slots, arcuate shaped sectional shell members extending longitudinally of said core to form a unitary cylindrical structure, ribs having angular end faces spaced along said shell members, core members having angular end faces spaced in said slots, said rib members resting between said core members in said slots, a rotatable shaft connected with said core, a sleeve slidably supported on said shaft and linked to said shell sections, a spring supported in said sleeve under compression so as to place said shell sections in their expanded positions effected by the opposite angular inclination between said rib members and said core members, and means including a lever and a yoke member for placing said spring under additional compression to cause the angular faces of the rib members to cooperate with the faces of the core members to place the shell members in their collapsed positions.

8. In a mandrel of the character described comprising a core provided with longitudinal slots, arcuate shaped sectional shell members extending longitudinally of said core and in concentric relation therewith to form a unitary cylindrical structure, ribs having angular faces spaced along said shell members, core members having angular end faces spaced in said slots, said rib members resting between the spaced core members in said slots and having their angular end faces in engagement at all times with faces of opposite angular inclination, on the said spaced core members, a rotatable shaft connected with said core, a sleeve slidably supported on said shaft and linked to said shell sections, a spring supported in said sleeve tensioned to place said shell sections in their expanded positions effected by the opposite angular inclination between said rib members and said core members and means for moving said sleeve member to cause said linked shell sections to assume their collapsed positions effected by the opposite angular inclination between said rib members and said core members.

9. In a mandrel of the character described comprising a core provided with longitudinal slots, ribs extending longitudinally of said core and resting in said slots, core members spaced in said slots and toothed notches spaced in said ribs, means for slidably securing said ribs in said slots, said core members and said toothed notches cooperating to cause the expanding and collapsing of said ribs, spring means for maintaining said ribs in their expanded position and means including a lever and a yoke member adapted to cooperate with the spring means to cause the same to be placed under additional compression whereby the ribs are placed in their collapsed position.

10. In a mandrel of the character described comprising a core provided with longitudinal slots, ribs extending longitudinally of said core and resting in said slots, core members having angular faces spaced in said slots, toothed notches in said ribs, means for slidably securing said ribs in said slots and spring means for normally maintaining said ribs in their expanded position, means including a lever and a yoke member adapted to place said spring means under additional compression to cause the said ribs to assume their contracted position, said expansion and contraction being effected by the opposite angular inclination of said core members and said toothed notches.

11. In a mandrel of the character described comprising a core provided with longitudinal slots, ribs provided with toothed notches and extending longitudinally of said core and resting in said slots, core members having angular faces spaced in said slots resting in the notches in said ribs, means for slidably securing said ribs in said slots, means including a spring linked to said ribs for normally maintaining said ribs in their expanded position, means including a lever and a yoke member adapted to place said spring means under additional compression to cause the said ribs to assume their contracted position, said expansion and contraction being effected by the opposite angular inclination of said core members and said toothed notches.

12. In a mandrel of the character described comprising a core provided with longitudinal slots, ribs extending longitudinally of said core and resting in said slots, toothed notches in said ribs, core members having angular faces spaced in said slots and rest-

ing in the toothed notches in said ribs, the angular faces of said core members being in engagement at all times with faces of the opposite angular inclination of the said toothed notches, means for slidably securing said ribs in said slots, and means linked to said ribs for maintaining said ribs in their expanded position under the influence of spring means, said expansion of said ribs being effected by the opposite angular inclination of said core members and said toothed notches.

13. A mandrel of the character described including a core slidably supporting a plurality of members forming a unitary device and adapted to be moved radially from the center of the device, and means including sets of rib members on said core having angular end faces, rib members on said plurality of members having angular end faces adapted to be in engagement at all times with faces of the rib members on said core of the opposite angular inclination for so moving said members, said means maintaining said members in their positions.

14. A mandrel of the character described including a core slidably supporting a plurality of members forming a unitary device, and spring means adapted to cooperate with other means including rib members on said core having angular end faces, rib members on said plurality of members having angular end faces adapted to be in engagement at all times with faces of the rib members on said core of the opposite angular inclination for moving said members radially from the center thereof to increase the outer circumference of the device, said spring means for maintaining said members in their expanded positions.

15. A mandrel of the character described including a core slidably supporting a plurality of members forming a unitary device, and spring means adapted to cooperate with other means including rib members on said core having angular end faces, rib members on said plurality of members having angular end faces adapted to be in engagement at all times with faces of the rib members on said core of the opposite angular inclination for moving said members radially from the center thereof to increase the outer circumference of the device and for maintaining them in their expanded position and means for compressing said members.

16. An expansion core comprising a central shaft, an outer shell composed of a plurality of individual strips, an end cap, means connecting said end cap to said strips for connecting the strips for unitary movement, means connected to said end cap for moving the strips longitudinally upon movement of said means, blocks carried by said shaft and arranged in pairs having their facing ends inclined, blocks carried by said strips and having inclined ends slidably engaging the inclined ends of said first named blocks whereby said strips will be moved inwardly towards or outwardly from the shaft upon longitudinal movement of the strips.

17. An expansion core comprising a central shaft, an outer shell composed of a plurality of individual strips, an end cap in engagement with the strips for moving the same longitudinally, blocks carried by said shaft and arranged in pairs having their parallel facing ends inclined, blocks carried by said strips and having inclined ends slidably engaging the inclined ends of said first named blocks whereby said strips will be moved outwardly from the shaft upon longitudinal movement of the strips.

Signed by me at Chicago, in the county of Cook and State of Illinois, this 21st day of February, 1924.

MARTIN B. GROUT.