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MACHINE FOR WINDING STRIP MATERIAL INTO TUBULAR FORM

Original Filed Feb. 17, 1925

4 Sheets-Sheet 1

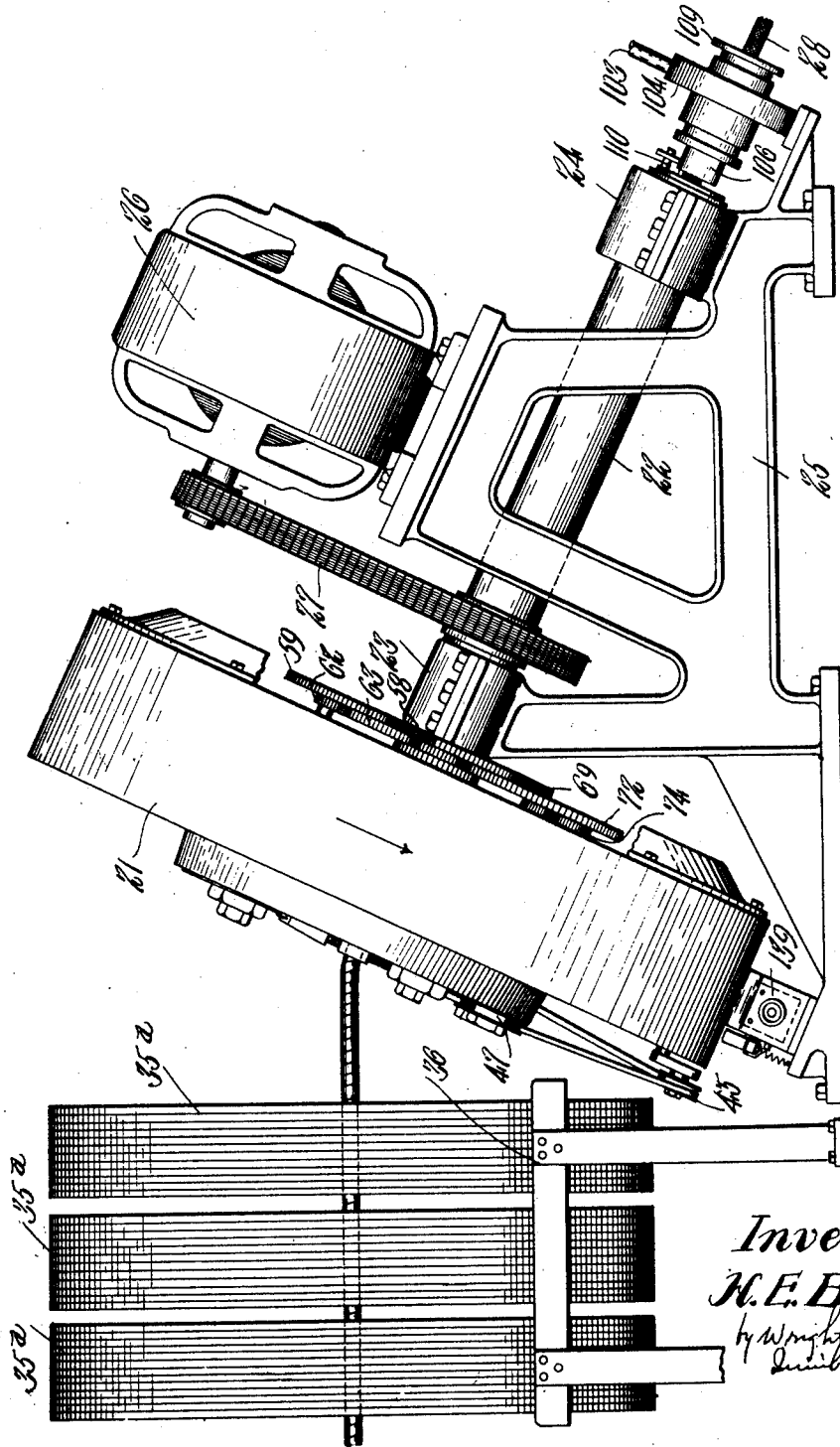


Fig. 1

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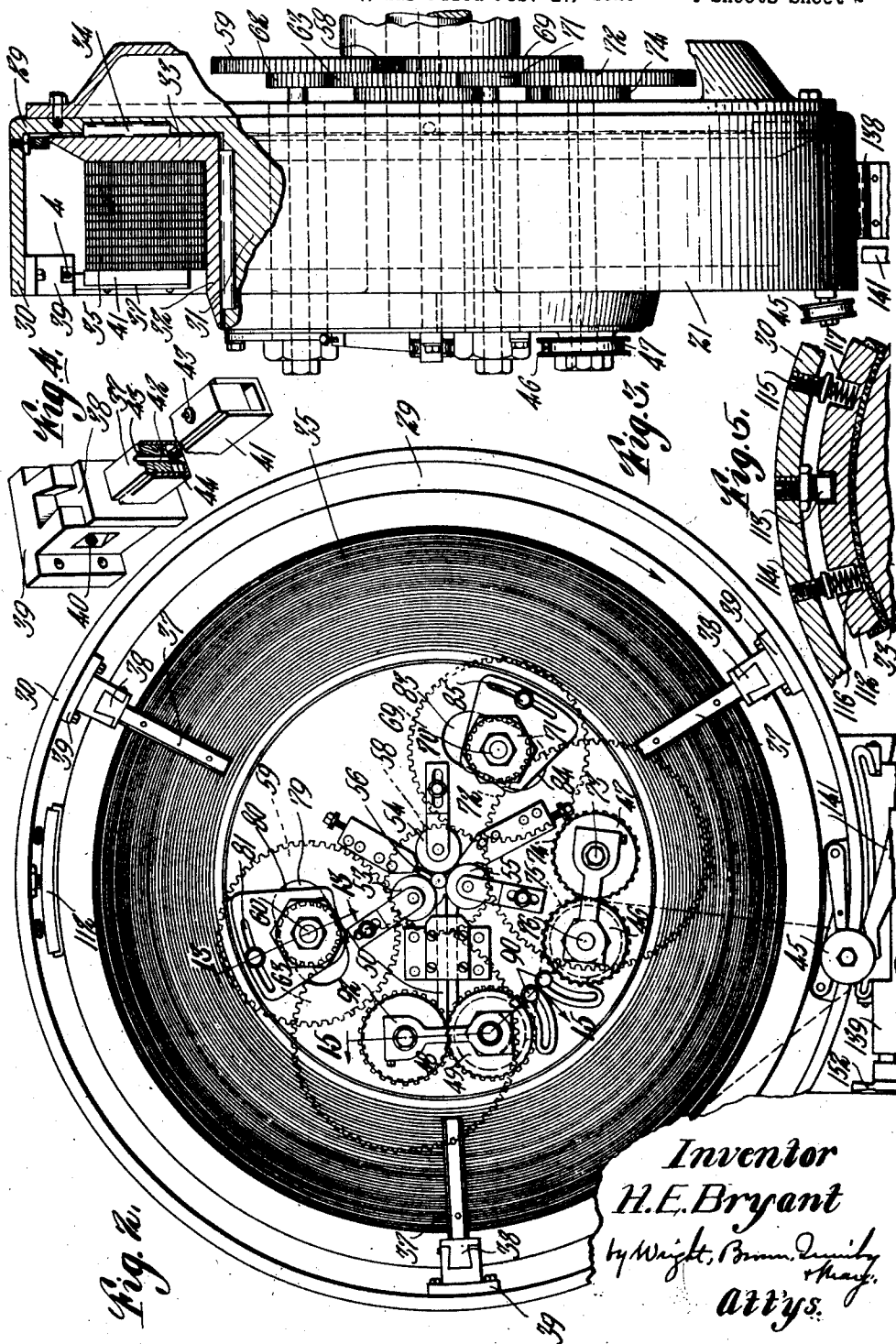
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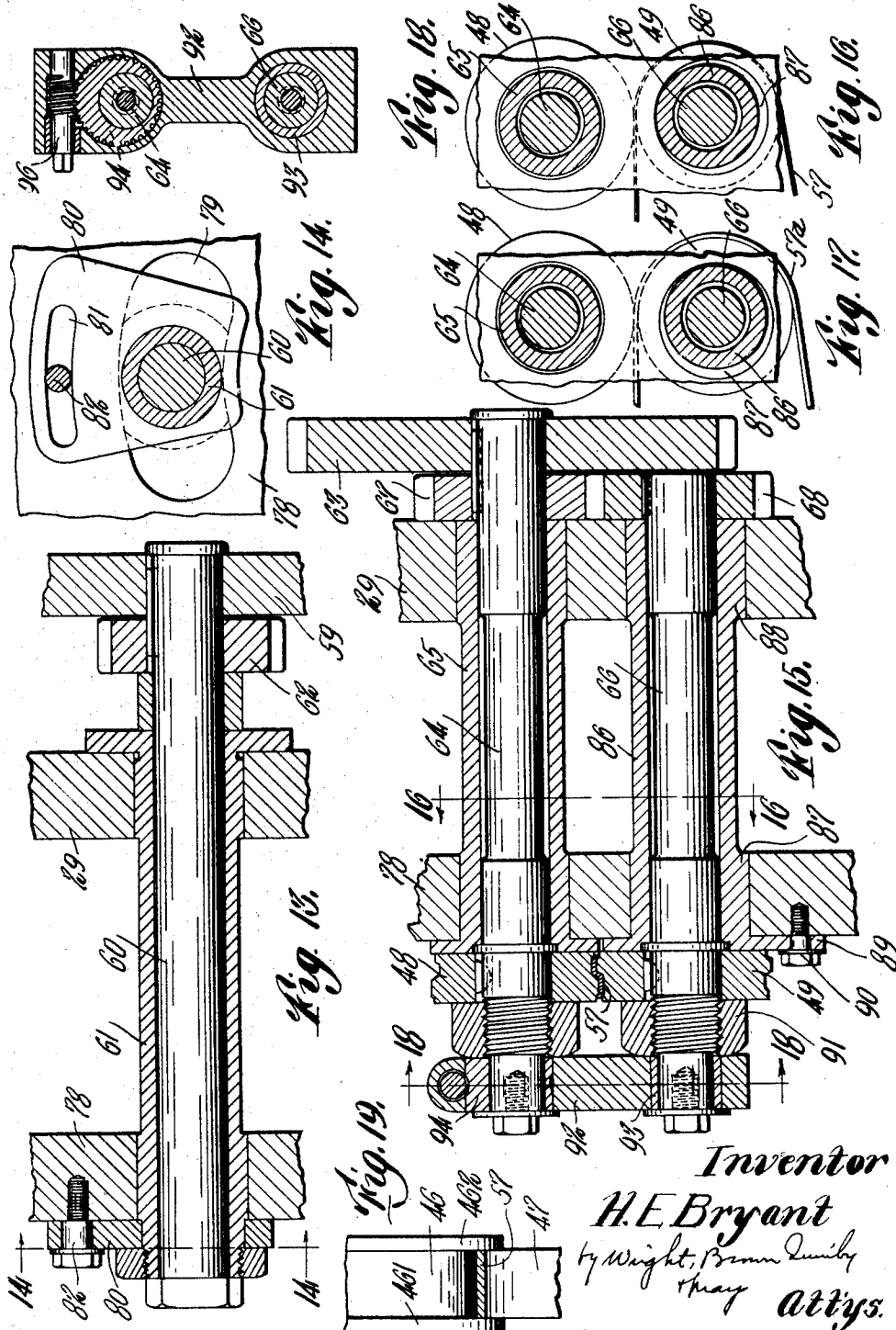
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MACHINE FOR WINDING STRIP MATERIAL INTO TUBULAR FORM

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4 Sheets-Sheet 4



UNITED STATES PATENT OFFICE.

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MACHINE FOR WINDING STRIP MATERIAL INTO TUBULAR FORM.

Application filed February 17, 1925, Serial No. 9,782. Renewed March 5, 1928.

The present invention relates to machines adapted to wind strip metal and similar material into helical form, either around a core or as an open tube, and is particularly concerned with machines of this character which operate on a flat strip, forming flanges on the edges of the strip, and so winding it that adjacent turns of the strip overlap and are interlocked by the flanges, making a flexible, puncture-resisting, fireproof tube, the coils of which cannot be separated by a pulling stress lengthwise of the tube. Tubing of this character, when made of iron, or other hard and puncture-resisting material, is commonly used as armor for electrical conductors, and as conduit adapted to be used for the electrical wiring of buildings, to provide a channel into which the electrical conductors may be drawn. In the first case the strip material is wound into tubular form about the conductor as a core, and in the second case it is wound without a core, or possibly upon a mandrel from which the tubing is removed as fast as it is formed, although such a mandrel is not required for making open tubing with machines according to this invention. The machines in which I have embodied the present invention are adapted to form flexible metallic tubing of this character and of either class, but for the purpose of illustration in the present specification, I have shown one such as used to enclose an electrical conductor or cable in a flexible armor. Having this purpose more particularly in mind, I will in the following specification generally refer to the machine, for convenience simply, as a "cable armoring machine"; but this descriptive title is not to be construed as indicating any limitation in the use of the machine or in the protection which I claim; for the same machine and equivalent machines are equally applicable to making conduit with an open interior, and the generic protection of the appended claims is intended to include other machines for analogous purposes, operating with other metallic filaments (wire, for instance) than a flat, wide, and thin strip, or with filaments of other materials.

The objects which I have accomplished by the present invention include the following:—

To provide a machine capable of being loaded with such a large quantity of strip material that it may continue in operation for a long time without interruption for re-loading, and may then be quickly loaded with a new supply of the strip material, in the form in which such material is provided by the makers, and without requiring the material to be rewound upon bobbins or the like.

To provide simple and efficient means for lubricating the metal strip in its course through the winding or coiling members.

To provide improved means for feeding and forming the strip, capable of feeding it at a rate exactly proportioned to the requirements of an armor or conduit of a given diameter with provisions for varying such diameter, and adapted also to trim and reduce the strip to a predetermined even width and thickness, and adjustable for variation of thickness.

To provide means for stopping the machine in case either the strip should break or it should fail to be delivered freely and rapidly enough from the supply to the feeding and forming rolls.

To provide other and minor improvements of construction and design, the nature of which, as well as of the preferred means for accomplishing the precedently stated objects, is fully explained in the following specification.

In the drawings:—

Fig. 1 is a side elevation of a complete machine embodying, in their preferred form, all the principles of the present invention;

Fig. 2 is an end view of the winding head of the machine, as seen from the left of Fig. 1 and in line with the axis of the head;

Fig. 3 is a side view and partial section of the winding head;

Fig. 4 is a perspective view, partly broken away, of one of the retainers for the strip material;

Fig. 5 is a sectional detail view illustrating a friction brake adapted to prevent lagging when the machine is started up, or overrunning when the machine is stopped, of the spool which carries the supply of strip material;

Fig. 6 is a partial longitudinal sectional

view of the machine illustrating particularly the provisions for lubricating the strip material;

Fig. 7 is a detail cross section taken on line 7—7 of Fig. 6;

Fig. 8 is a partial end view of the winding head and its stopping means, showing the latter in inoperative position;

Fig. 9 is a view similar to Fig. 8 showing the stopping means in position for stopping the machine;

Fig. 10 is a plan view of the mechanism by which the strip is guided and the arresting device is tripped;

Figs. 11 and 12 are detail views of part of the last named mechanism;

Fig. 13 is a fragmentary sectional view taken on line 13—13 of Fig. 2 showing one of the shafts in the driving train for the feeding and forming rolls, and the means for mounting said shaft;

Fig. 14 is a cross-section and end view of the same taken on line 14—14 of Fig. 13;

Fig. 15 is a fragmentary sectional view taken on line 15—15 of Fig. 2 showing the pair of forming rolls and the means for mounting and driving them;

Fig. 16 is a cross section of the shafts and bearings for these forming rolls, taken on line 16—16 of Fig. 15;

Fig. 17 is a view similar to Fig. 16 but showing the forming rolls in a different position of adjustment;

Fig. 18 is a section on line 18—18 of Fig. 15 showing the connecting bar in detail; and

Fig. 19 is a fragmentary view showing the pair of rolls which feed the strip and trim and compress it to the required dimension.

Like reference characters designate the same parts wherever they occur in all the figures.

I call by the term "winding head" that part of the machine which carries the instruments for forming the strip with interlocking edges and for winding it into the form of a tubular armor or conduit. Such winding head is designated 21 in the drawings. It is secured on the end of a shaft 22 and is held in an inclined position, with its outer end facing somewhat upwardly, by means of suitably arranged bearings 23 and 24 on the base or frame 25, substantially as shown in Fig. 1. Such head may be driven by any suitable means, and I have illustrated as the preferred means an electric motor 26 mounted on the frame 25 and connected with the shaft 22 by means of a link belt or chain 27 passing around sprockets on said shaft 22 and on the armature shaft of the motor respectively. Provided the frame is designed to hold the winding head and its shaft in the manner indicated and preferably also to support the motor 26, it may be made of any form and with any structural character-

istics desired within the skill and knowledge of the machine designer.

The shaft 22 is tubular and provides a continuous bore through which, and through the head, the wire or cable 28 to be armored may pass. The machine may be made according to these principles, but designed only to produce open conduit, without such continuous passageway.

The winding head is cylindrical in form, having an end wall 29, an outer lateral wall 30 and an inner structure which provides an external cylindrical bearing 31 for the annular strip-carrying spool, later described, and interior bearings for the shafts supporting, and forming parts of the driving trains for the strip-forming rolls. Between the bearing 31 and the surrounding wall 30, there is an annular space in the winding head, which is open at the forward side and in which is contained a spool or reel for holding the supply of strip material. Such spool has a tubular hub 32 surrounding the bearing 31, and a flange or base 33, bearing on the end wall 29 of the head, or against roller bearings mounted in said end wall. I prefer to mount bearing rollers 34 in recesses in said wall 29, which rollers project just far enough to engage the base of the spool and hold the latter clear of the wall 29. The rollers are arranged with their axes radial to the spool and provided in sufficient numbers and in proper spacing to give whatever character of antifriction support for the spool and its load of strip material may be desired. The inclination of the winding head causes the spool to rest by gravity against this end bearing; and such inclination is of a character and degree such that gravity will effectually overcome any tendency of the spool to be displaced while rotating at high speed. Such inclination also secures important advantages in the running of the machine by distributing the weight of the shaft, the winding head and the parts carried by the winding head, between the bearings, and avoiding the concentration of weight on the bearing next to the head which would be occasioned if the axis of the rotating parts were horizontal. The greatest part by far of the total weight of the machine is contained in the winding head and the parts carried thereby, and this component of weight is located outside of the bearings. The inclined arrangement not only divides this weight between the two bearings, but it also reduces the tendency of the head when in rapid rotation to cause vibration, and reduces the wear on the bearings.

The space bounded by the hub and base of the spool and the outer wall of the winding head receives a coil 35 of strip material. Such material is furnished by the makers in prescribed lengths and wound into a coil

of standard dimensions as to both inner and outer circumference, and width; and the winding head and spool are made with the necessary dimensions to receive such a standard coil of strip material, the hub of the spool being enough smaller than the inner diameter of the coil to receive the latter easily. Thus the coils of material as furnished by the makers may be easily placed in the machine. As an adjunct to the machine, to facilitate loading, I provide a rack or frame 36 near the front or open end of the winding head on which are placed a number of coils 35^a of the strip material, providing a reserve supply sufficient to feed the machine for a given period of time. The armored cable, or conduit, as finished by the winding head, is led away through the reserve coils to the machine by which it is itself wound up into coils of prescribed length. The rack 36 is so near the winding head and at so nearly the same level that, when the supply of strip material in the head becomes exhausted, the nearest reserve coil may be slipped directly from the rack into the winding head, where it will seek its proper position on the spool by the force of gravity. The reserve coils are placed on the rack at times when the armored cable or conduit has been cut off and a short end is left protruding from the machine. Sufficient opportunities exist for thus placing the reserve coils because the completed tubing is cut off from time to time in prescribed lengths, and more than enough of the strip material can be provided in the reserve supply to make such prescribed lengths of completed tubing, and prevent any loosened turn of the coil from flying out and causing injury to the product, the machine, or persons in the vicinity.

Retaining arms 37 are provided to insure retention of the coil of strip material in the winding head. Figures 2 and 3 show three of such arms, and Figure 4 shows a detail view of one of the arms. Each of the arms has a base 38 formed of a dove-tailed rib which fits in a complementary guideway 39 secured to the inside of the outer wall of the winding head. A set screw 40 is mounted in the guide to secure said base. These arms may thus be readily removed and replaced when a new coil or strip is mounted in the machine. When in place the arms lie close to the outer surface of the coil, and they are furnished with spring-pressed shoes or bearing pieces 41 which press yieldingly against the coil to prevent the outer turns of the strip from slipping off from the coil and becoming tangled up. These spring-pressed shoes embrace the arms and slide transversely thereon, being retained by freely fitting pins 42 and nuts 43, and being pressed outward by springs 44.

The strip from the supply is led around

a guide roll 45, as shown in dotted lines in Figure 2, to a pair of feeding and sizing rolls 46, 47, thence to a pair of forming rolls 48, 49, and finally through a guide 50 to the winding point, where it is wrapped about the cable, or wound into an open tube, and the adjacent turns of the strip are interlocked by means of their edge flanges. The windings are brought down to finished size and curvature by follower rolls 53, 54 and 55, which are held by brackets mounted adjustably on the outer face of the central part of the head, by bolts and slots, as clearly shown in Figure 2. These final or compacting rolls are suitably inclined to follow the helix of the strip being wound, in a manner well understood in this art. There may also be pressers 56, in addition to the compacting rolls, arranged to rub over the coiled strip and assist the compacting rolls in bringing it to final prescribed size. As this invention is not concerned in any improvement in such rolls or presser, the same need not be described in any further detail.

The pair of rolls 46 and 47 are designed to compress and trim the strip material to the required thickness and width, and also to draw off the strip from the supply at the required rate, proportioned to the diameter of the finished armor and the rotational speed of the winding head. This strip material is soft iron, galvanized, and it is apt to vary somewhat in both width and thickness, due partly to uneven thickness in the zinc coating and partly to variations in the dimensions of the strip itself. The roll 46 is cylindrical with flanges 461 and 462 at opposite ends, separated by a space equal to the required width of the strip. The complementary roll 47 is a plain cylinder of a width exactly equal to the space between the said flanges. Both rolls are of hard material, preferably hardened steel, and the edges of the roll 47 and the adjacent edges of the flanges 461 and 462 are made as cutting edges. Furthermore the rolls are adjustable relatively toward and away from one another to the exact prescribed thickness of the strip. Thus these rolls, as they are positively driven by mechanism, later described, grip the strip with sufficient pressure to draw it from the supply, and at the same time they roll it down to a uniform thickness and trim off all excess width at the edges of the strip by their shearing action.

The second pair of rolls, 48, 49, are formed peripherally with profiles corresponding to the required form of the strip. They also are positively driven, at the same rate of speed as the first pair of rolls, and are pressed forcibly against the opposite sides of the strip. Their form is such that, under this pressure, they offset zones of the strip at opposite sides of an approximately cen-

tral longitudinal line, in opposite directions, and at the same time turn back flanges along the edges of the strip, approximately as shown in Figure 5, where the strip is indicated in section at 57 between the rolls. In passing from the first pair of rolls to the second pair, the strip is carried partly around the roll 46, and then partly around the roll 49. Both pairs of rolls exert traction upon the strip by their gripping action and positive rotation. Both pairs then are equally feeding rolls. The first pair in addition are trimming and sizing rolls; and the second pair are forming rolls.

Rotation is imparted to the forming rolls by the following means. A stationary sun gear 58 is secured to the frame and surrounds the shaft 22. A planet gear 59 meshes with the sun gear 58 and is secured to a shaft 60 which rotates in a bushing 61 mounted in the central part of the winding head (Figures 2 and 13). The shaft 60 carries a pinion 62 in mesh with a large gear 63 secured to a shaft 64 arranged to turn in a bushing 65 also mounted in the central part of the winding head (Figures 2 and 15). Shaft 64 also carries the roll 48. A parallel shaft 66 carries the roll 49 and is geared to rotate oppositely but at an equal speed with the shaft 64 by means of pinions 67 and 68, of equal diameters, on the respective shafts. All these gears, and the rolls, are secured by keys to their shafts.

The trimming and sizing rolls 46 and 47 are driven by an exactly similar gear train consisting of a planet gear 69 on shaft 70 and meshing with gear 58, a pinion 71 on shaft 70 meshing with a gear 72 on the shaft 73 to which also the roll 47 is connected, and a pair of equal gears 74 and 75 on the shafts 73 and 76, the latter shaft carrying roll 46.

The shaft 60 with its gears 59 and 62 is adjustable in an arc around the center of the winding head in order to permit substitution of different gear pairs 62, 63, having different speed ratios. Similarly the shaft 70 is adjustable to permit substitution of different gear pairs 71 and 72. By changing these pairs of gears the sizing, feeding and forming rolls may be driven at different speeds in proportion to the speed of the winding head, and the strip thereby fed to the winding point at different rates as required for making larger or smaller tubes. Thus tubular armor or conduit of any desired diameter may be made.

Figure 13 shows in detail the mode of mounting the shaft 60. The bushing 61 is supported in the rear wall 29 of the winding head, and also in a front wall 78 which lies in the central part of the winding head within the area surrounded by the supply spool, and spaced from the rear wall by intermediate structural members of suitable

character. This entire winding head frame structure may be made as a single casting, with the rear wall 29, the outer wall 30, the central front wall 78 and intermediate web or spacing structure, all integral. The walls 29 and 78 are formed with arcuate slots 79, concentric with the axis of the winding head, and there is fitted on the end of the bushing in front of the wall 78 a plate 80 having a slot 81 through which a clamping bolt 82 passes into the wall 78. A similar slotted plate and clamping bolt may be arranged at the rear side of the rear wall 29, in order to hold the shaft more rigidly and securely in its adjustments, if desired.

The shaft 70 is similarly mounted in arcuate slots 83 and is provided with a like slotted plate 84 adjustably clamped by a bolt 85.

The shafts 64 and 66 carrying the forming rolls turn in rotatable bushings which are mounted in the winding head in an essentially similar manner except that they are not adjustable in the same way. Provision is made however for adjusting the distance between the rolls, and this is effected in the design here shown by making the bushing 86 for the shaft 66 with eccentric journals 87 and 88 rotatably mounted in bearings in the walls 29 and 78. A slotted plate 89 is made fast to the bushing 86 and serves as means for rotating the bushing so as to move the rolls nearer together or farther apart. A bolt 90 passed through the arcuate slot of this plate into the adjacent fixed wall serves to secure these adjustments. Figures 15 and 16 show the adjustment when the rolls are at the least distance apart and the strip 57 acted upon is a relatively thin one; while Figure 17 shows a different adjustment effected by turning the bushing 86 through an angle of 90 degrees, thus setting the rolls to engage a thicker strip 57.

The rolls are made fast on their shafts by nuts 91, and on the protruding ends of the shafts there is mounted a tie bar 92 which is an important adjunct in stiffening the shafts and preventing them from being at all sprung apart by the interposed strip and also in aiding to secure a most accurate adjustment of the distance between the rolls and to prevent this adjustment being disturbed by the pressure of the strip material, vibration, or from other cause. This tie bar is formed near its ends with holes in which are placed bushings 93 and 94 surrounding the respective shafts. One of the bushings, here shown as the bushing 94 which surrounds the shaft 64 (but it might as well be the other bushing) is eccentric and is adapted to be rotated and rocked by means of a worm 96 fitted in the tie bar in a suitable arrangement to mesh with a series of teeth on the circumference of this

bushing. As the bushing 86 is turned to alter the distance between the rolls the bushing 94 is also turned to change the distance between the end bearings of the shaft in the same manner and degree. Since both adjusting means are rotatable members with eccentric circular bearing surfaces, no difficulty in making these adjustments is caused by the fact that the adjustable shaft is moved to one side as well as toward or away from the other shaft. This type of adjusting means is preferred to others because of the extreme fineness and accuracy with which adjustments can be made, and its simplicity and ruggedness. However I may use other types of adjusting means known in the art of machine tools, and therefore do not limit my claim to protection wholly to this particular means.

The shafts 73 and 76 that carry the sizing rolls 46 and 47 are mounted and adjustable in exactly the same way and by exactly the same means as the forming rolls, in the machine here illustrated; wherefore the foregoing description, together with the reservation of protection for equivalent adjusting means, applies equally to the sizing rolls.

The guideway 52 through which the strip passes to the winding point after leaving the forming rolls, is essentially a bar having a passageway in the same form, in cross section, as the formed strip. Preferably it is made in two parts, for convenience of manufacture, each containing half of the passageway. Said guide is mounted in a bracket 98 secured to the outer face of the winding head, that is to the wall 78, and provision is made for supplying a lubricant to the guideway, the means for so doing being shown in Figure 6. The holder or bracket 98 and the guide are provided with registering ports 99 and 100 leading into the passageway, and opening from a tube 101 which is secured on or in the face of the winding head and is connected with a tube 102 leading through the shaft 22. Of course the connections between the guide, its holder 98, and the tube 101 are made sufficiently leakage tight to prevent any objectionable escape or discharge of the lubricant. The lubricant is supplied from a reservoir or any other suitable source of supply by means of a pipe 103 to a stationary casing 104, with the interior of which the pipe 102 communicates. To prevent leakage at this point, the connection between pipe 102 and casing 104 is made by means of a disk 105 having a hub 106, concentric with the shaft 22, into which the end of pipe 102, protruding from the rear end of shaft 22, enters, and in which it is made tight. A deep annular space 107 is formed in the disk 105 in position to receive the liquid flowing from pipe 103, and

a passage 107 leads from this annular space to the pipe 102. Stuffing boxes 108 and 109, of any common or other suitable character, form parts of the casing 104 at opposite sides of the disk 105 and pack the hub 106 of the disk so that no leakage can occur. Said hub 106 and the stuffing boxes have a central passageway to admit the cable 28 when, as is the case here, the machine is designed to wind armor upon cable. A coupling consisting of a pin 110 projecting from a shaft 22 and entering a notch 111 in a ring 112 which is fixed to the hub 106, causes said hub and the disk of which it is a part to rotate with the winding head, and relieves the tube 102 of bending and shearing stresses.

It will be apparent from what has gone before that, as the winding head is rotated, the sizing rolls, forming rolls, winding or compressing rolls, and the supply of strip material are all revolved about the winding point, and that the strip feeding rolls are given an independent rotation about their own axes at the proper speed to draw the strip from the supply at the rate needed to wind it into a helix of the prescribed diameter. The said rolls thus feed the strip positively and propel it to the winding point, while at the same time they reduce it to the required dimensions, in places where the strip may be too thick or too wide, and shape it into the form in cross section which will cause interlocking of the overlapped edges of the strip. Their action in thus propelling the strip relieves the cable or other core which may be provided, of any duty in drawing off the strip or maintaining the diameter of the helix. The duty of bringing the helix to exact size is performed by the winding rolls 53, 54, 55, and/or the follower 56 when such a follower is provided; and said rolls are mounted on the winding head with such an inclination and in such sequence as will properly conform with the helix angle of the complete tubing or armor. Such helix angle is a function of the width of the strip, the amount of overlapping of its edges on successive turns, and the diameter of the tubing or armor. Although the drawings here do not particularly show the helical inclination and arrangement of the winding rolls, such inclination and the necessary provisions for giving it are well understood in the art, and it is to be understood that this machine is to be so equipped. Said winding rolls also propel the finished tubing or armor lengthwise away from the machine as fast as it is formed; and when the armor is wound upon cable, the cable is drawn through the machine at the same time owing to the grip which the armor is caused to take on the cable in course of winding. At the same time the strip is lubricated, if desired, and such lubrication facilitates its passage through the guide 52 and past the winding

rolls, aiding the latter to bend the strip with the sharp curvature needed to make tubing of this character.

With the drawing off of the strip, the
 5 spool carrying the supply of material is rotated relatively to the winding head, as well as rotated with it. Depending on the direction of winding of the strip material in the supply, this relative rotation is either in the
 10 same direction or the opposite direction to that of the winding head. In order to prevent the spool with its load of strip material from lagging behind the winding head when the latter is started up from a position
 15 of rest, and so putting too great a tension on the strip, as well as to oppose overrunning of the spool when the winding head is suddenly stopped, and so either imposing too much tension on the strip unwinding the
 20 strip with consequent liability of tangling and snarling, I have provided a frictional drag member 112, similar to a brake shoe, which bears on the periphery of the base part 33 of the supply spool, and is connected loosely with the revolving head by
 25 means of a stud 113 secured to the wall 30 of the latter and entering a socket in the friction shoe. Other studs 114—115 are secured to the wall 30 in line with the stud
 30 113 and they hold springs 116 and 117 which enter sockets in the friction shoe and serve both to aline the latter and to press it against the spool. The friction of this shoe, while great enough largely to overcome the
 35 momentum and inertia of the spool with its load of strip material, is not severe enough to add appreciably to the work of the sizing, feeding and forming rolls.

The tension of the strip in passing around
 40 the guide roll 45 controls a brake for stopping the winding head quickly in case either the strip should break or that it should fail to be drawn freely enough from the supply coil. Attention is now called particularly
 45 to Figures 8 to 12. The guide roll 45 is freely mounted on the end of an arm 118 secured to a shaft 119 which is mounted rotatably in bars 120 and 121 forming part
 50 of a frame which is secured to the inside of the wall 30 in such a position that the strip may pass properly from the roll 45 to the sizing rolls. A second shaft 122 is similarly mounted in the bars 120 and 121, and to it is secured an arm 123. The latter arm
 55 is connected to the arm 118 by a pin 124 on the latter projecting into slot 125 in the arm 123. Springs 126 and 127 coiled around the shafts 119 and 122 respectively are connected to said shafts and react on the frame in
 60 which they are mounted, with tendency to throw the roll 45 outwardly, that is from the position shown in Figure 8 to that shown in Figure 9. These springs also resist pull
 65 exerted inwardly on the roll 45 by the strip material; and said inward pull is further

resisted by a cam or wedge member 128 shown in Figure 11, which is secured to a rod 129 having an endwise movement in guideways formed in the bars 120 and 121.
 70 A spring 130 confined between the bar 120 and an abutment 131 on the rod, formed as a nut adjustably threaded on said rod, resists movement of the bar in one direction, and the force of its resistance may be regulated by adjusting the nut 131. Under the
 75 pull of the strip, the roll 45 is drawn toward the axis of the head until the arm 123 comes to bear against the inclined outer face of the cam 128. Further movement in the same
 80 direction of the roll can take place only with displacement of the cam 128, which is resisted by spring 130. The inclination of the cam face and the resistance of the spring are fixed and adjusted, with respect to the
 85 stiffness of the strip material, so that when the material is being drawn off under normal tension, the guide roll 45 will occupy approximately a certain position, for instance that shown in Figures 2 and 8. But
 90 with a great increase in the tension of the strip, due to some condition which might cause harm if not remedied, the roll 45 will be drawn further inward against the resistance of the cam, until it passes beyond
 95 the influence of the latter. Conversely, if the strip should break, the roll 45 is thrown outward by the springs 126 and 127. In either case a substantial angle of rotation is given to the shaft 119.

On said shaft 119 is mounted a double cam
 100 132, and adjacent to said cam and bearing upon it is the arm 133 of a trip lever 134 which is pivoted at 135 to a bracket on the winding head, and is provided with a finger
 136 extending through a hole in the outer
 105 wall of the winding head. A spring 137 bears on said trip lever, with tendency to withdraw said finger 136 and hold the arm 133 against the cam 132.

Beside the outer surface of the wall 30
 110 there is arranged a brake member 138 having a frictional face complementary to the wall 30, and this brake is arranged to slide in a guideway formed in a block 139 which is secured to a stationary structure 140,
 115 forming part of the main frame 25, or otherwise secured in a stationary manner near some part of the revolving head. It does not matter at what point about the circumference of the head its brake may be located,
 120 provided only that it is so placed that the brake may be brought into proper contact with the head. The guideway in block 149 is inclined at a small angle to the tangent at
 125 the middle part of the braking surface of the brake shoe to the end that when said shoe is engaged with the winding head the frictional drag of the latter will cause the brake shoe to ride on its inclined guideway and thereby be forced into ever tighter en-
 130

gagement with the head. Normally the brake is retracted so as just to clear the winding head, this position being shown in a somewhat exaggerated way in Figure 8. It is held in this position by a latch dog or lever 141 pivoted at 142 and having a shoulder which engages a projection 143 on the brake. A spring 144 is connected to the latch, substantially as shown in the drawings, and a spring 145 is confined between the brake and an adjustable abutment in a bracket 146 on the frame. Thus spring 145 tends to move the brake into engagement with the winding head, but such movement is blocked by the latch 141. Said latch has an arm 147 extending near to the path in which the trip finger 136 rotates when retracted, and across the path in which said finger rotates when projected.

When the machine is running properly with the strip under prescribed tension, the trip controlling cam 132 is in what may be called its neutral position, that is the position, shown in Figure 8, where neither projection acts on the trip lever and the finger 136 of the latter is retracted. Now if the roll 45 should be displaced, from either of the causes above mentioned, farther than the displacement caused by permissible variations in tension of the strip, the double cam 132 will be turned one way or the other, depending on whether the strip tension is greatly increased or greatly diminished, and whichever way it turns, it causes the finger 136 to protrude and in its next passage by the latch dog, to strike the arm 147 of said dog and release the brake shoe. The brake shoe then is moved by the spring 145 into contact with the winding head, and is immediately forced into tight engagement therewith owing to the frictional drag imposed by the head, so that the head quickly comes to rest. While the head is thus suddenly coming to rest, the brake shoe 112 prevents the supply spool from running ahead and unwinding the strip material from the coil.

At the same time a switch in the power or control circuit of the driving motor is opened by the setting of the brake. A typical or illustrative form of switch is shown in Figures 8 and 9 as consisting of complementary contacts 148 and 149 connected to the conductors 150 and 151 in the motor control circuit but otherwise electrically insulated. The contact 149 is carried by, or is mechanically a part of, a lever 152 which stands in the way of a projection 153 of the brake shoe in such fashion that when the brake shoe is brought into engagement with the winding head the switch is opened. It is to be understood that although I have thus illustrated and described an operative means for breaking the motor circuit, I am not limited to the par-

ticular means so disclosed, but may use any equivalent means for the purpose, operated by or in connection with any part of the brake or its tripping or setting means. In a broader sense the switch here referred to represents and typifies any means for intermitting the driving effort from a prime mover to the machine, whether such prime mover is an electric motor or a power shaft driven by steam or other power, and whether the intermission of power is caused by stopping the prime mover itself or by disconnecting the transmission means between the prime mover and the machine.

By means of the invention embodied in the machine here described, I have made it possible to wind metallic strip material into cable armor or flexible conduit rapidly, continuously, and economically; with substantially perfect uniformity in the character of the product, and with the minimum number and duration of delays in the operation of the machine caused by exhaustion of the supply of strip material. The machine itself is relatively simple in construction, and can be assembled in running order at lower cost than machines heretofore made.

It is to be understood that various modifications in form, construction and arrangement of the machine and its several parts may be made, within the scope of the protection which I claim for the invention, and that the principles of the invention as here claimed may be embodied in winding machines for other purposes of a generally similar nature. With this understanding, the term "strip material" as used in such of the following claims as do not, by their context, require such material to be oblong in cross section, is to be construed as including strips or filaments of any shape in cross-section.

What I claim and desire to secure by Letters Patent is:

1. A winding machine of the character set forth having a rotatable winding head, and a spool adapted to receive a previously prepared coil of the material to be wound, said winding head and spool being arranged on an inclined axis and at the upper end of such axis, whereby placing of such coil on said spool is facilitated.

2. A winding machine of the character described comprising a rotatably mounted winding head having a central structure, winding instrumentalities mounted on said central structure, and a spool surrounding said central structure, said spool being constructed and open at its outer end to receive a previously prepared coil of the material to be wound.

3. A winding machine of the character described comprising a rotatably mounted winding head having a central structure, winding instrumentalities mounted on said

central structure, and a spool surrounding said central structure, said spool being constructed to receive a ready formed coil of the material to be wound, and displaceable retaining means mounted on said head and arranged to project over the coil-receiving space of the spool to prevent dislodgment thereof from said spool.

4. The combination with a winding machine of the character described having a winding head, said winding head being rotatably mounted upon an inclined axis, a spool rotatably mounted on the head about the same axis and being open at one end to receive a coil of material to be wound, and a rack adjacent to the said open end of the spool adapted to support a reserve supply of coils in position to be placed upon said spool.

5. A winding machine of the character described comprising a stationary frame, a winding head rotatably supported by said frame, a spool rotatably mounted on said head coaxially therewith, said spool being formed to receive and hold a commercial coil of the material which said machine is designed to wind.

6. A winding machine of the character set forth comprising a frame, a rotatable shaft mounted in said frame, a winding head on said frame having a central structure coaxial with the shaft; a coaxial outer wall connected to said central structure, there being between said wall and said central structure an annular space, a spool rotatably mounted upon said central structure in said annular space, and there being between the spool and said outer wall a space open at the end of the head for the reception of a coil of the material to be operated on by the machine.

7. In a winding machine of the character described a winding head having a central structure, an end wall, and an outer enveloping wall concentric with said central structure and separated therefrom by an annular space, and a spool located in said annular space and having a hub which surrounds and bears on the central structure, and a flange lying adjacent to said end wall.

8. In a winding machine of the character described a winding head having a central structure, an end wall, and an outer enveloping wall concentric with said central structure and separated therefrom by an annular space, and a spool located in said annular space and having a hub which surrounds and bears on the central structure, and a flange lying adjacent to said end wall, the winding head being mounted at an inclination such that the spool is impelled by gravity toward said end wall.

9. A winding machine of the character set forth comprising a shaft, a winding head mounted on said shaft, and separate bear-

ings, both at the same side of the winding head in and by which said shaft is held rotatably, said bearings being arranged to hold the shaft at an inclination.

10. A winding machine of the character set forth comprising a frame having separate alined shaft bearings arranged at an inclination to the horizontal, a shaft mounted rotatably in said bearings and protruding at one end from the upper bearing, and a winding head secured to the protruding end of said shaft outside of said upper bearing.

11. In a winding machine of the character described a winding head having a central structure, an end wall, and an outer enveloping wall concentric with said central structure and separated therefrom by an annular space, and a spool located in said annular space and having a hub which surrounds and bears on the central structure, said spool having also a flange lying adjacent to said end wall, and a coil retainer secured to said outer wall in position to extend over the aforesaid annular space adjacent to the side thereof opposite to the said end wall.

12. In a winding machine of the character described a winding head having a central structure, an end wall, and an outer enveloping wall concentric with said central structure and separated therefrom by an annular space, and a spool located in said annular space and having a hub which surrounds and bears on the central structure, said spool having also a flange lying adjacent to said end wall, and a coil retainer secured to said outer wall in position to extend over the aforesaid annular space adjacent to the side thereof opposite to the said end wall, said retainer comprising a bar and a guideway secured to the outer wall of the head in which said bar is adjustable in a direction generally axial with respect to the head.

13. The combination of a winding head having a coaxial annular space adapted to receive a coil of material to be wound, and a coil retainer comprising a guide member secured in the outer wall of said head extending axially thereof, and a bar extending radially of the head and having an adjustable and removable engagement with said guide.

14. In a winding machine of the character described a rotatable winding head having a central structure, an outer enveloping wall separated from said central structure by an annular space, and an intermediate end wall, combined with a spool having a hub rotatably surrounding said central structure and a base adjacent to said end wall, and a friction device interposed between said spool and the head, connected to travel with one of them and being frictionally engaged with the other.

15. In a winding machine of the character described a rotatable winding head having

a central structure, an outer enveloping wall separated from said central structure by an annular space, and an intermediate end wall, combined with a spool having a hub rotatably surrounding said central structure and a base adjacent to said end wall, and a friction device bearing on the periphery of said spool base and being connected with the winding head.

16. In a winding machine adapted to form a flexible tubular structure from strip material, a rotatable winding head, a pair of rolls cooperatively formed to grip, trim the edges of, and feed the strip material, a second pair of rolls cooperatively formed to offset the strip with longitudinally extending locking flanges and zones, and means for driving said rolls positively in the course of the rotation of the winding head as a whole.

17. In a winding machine adapted to form a flexible tubular structure from strip material, a rotatable winding head, a pair of rolls cooperatively formed to grip, trim the edges of and feed the strip material, a second pair of rolls cooperatively formed to offset the strip with longitudinally extending locking flanges and zones, and means for driving said rolls positively, comprising a stationary sun gear coaxial with the winding head and planetary gear trains leading from said sun gear to the respective pairs of rolls.

18. A machine for winding strip material helically into flexible tubing with the edges of successive turns of the strip overlapping and interlocked, comprising a frame, a winding head rotatably mounted on said frame, strip sizing, forming and feeding rolls rotatably mounted in said head, a spool mounted rotatably and coaxially upon said head and arranged to carry a coil of strip material surrounding the orbit in which said rolls revolve about the axis of the head, the strip material being led directly from said coil to the first pair of said rolls, a sun gear mounted on the frame concentric with the winding head, and gear trains carried by the winding head and extending from the sun gear to each pair of rolls.

19. In a winding machine of the character described a rotatable winding head, a pair of strip feeding rolls mounted to rotate cooperatively in said head at one side of the rotational axis of the latter, a stationary sun gear concentric with the head, a gear train for driving said rolls comprising a gear connected to the shaft of one of the rolls, a planetary gear in mesh with said sun gear, and a pinion in mesh with the previously named gear, said planetary gear and pinion being connected together coaxially and mounted with provision for adjustment about the axis of the sun gear, whereby to

permit changing the value of the gear train by substitution of other intermeshing gears and pinions.

20. A winding machine of the character described comprising a winding head rotatably mounted, a pair of complementary rolls rotatably mounted in said head on one side of the axis thereof, said rolls having surfaces adapted to roll strip material to uniform thickness and having the complementary shearing edges arranged to trim the material to a prescribed maximum width, a second pair of complementary rolls rotatably mounted on the head eccentric to the axis thereof, said rolls being peripherally shaped to roll strip material with offset longitudinal zones and locking flanges at its edges, means for driving said rolls positively as the head rotates, and means for supporting a coil of strip material surrounding that part of the head in which said rolls are mounted and in position for the strip material to be led directly to the first named pair of rolls.

21. A winding machine of the character set forth comprising a winding head mounted to rotate about a central axis, positively driven means for feeding toward the winding point the material to be wound, said means being carried by the head, and a holder for a supply of the said material also carried by said head and mounted with provision for independent rotation relatively thereto about the same axis.

22. A winding machine of the character described comprising a rotatable winding head, a spool adapted to hold a supply of the material to be wound mounted coaxially on said head with provision for independent rotation relatively thereto, and positively driven feeding rolls mounted upon the head and arranged to receive and grip and draw the material from the spool and propel said material toward the axis about which the head rotates.

23. In a machine of the character described, a rotatable winding head, parallel shafts rotatably mounted in said head, complementary strip gripping and feeding rolls mounted on the respective shafts, and distance means connected to the protruding ends of said shafts beyond said rolls, said distance means being adjustable to vary the distance of said protruding shaft ends from one another.

24. In a machine of the character described, a winding head, parallel shafts rotatably mounted in said head, complementary strip engaging rolls mounted on the respective shafts, a tie bar having bearings fitting upon said protruding shaft ends, one of said bearings being an eccentric bushing mounted in the tie bar, and means for securing said bushing in different positions of rotation.

25. In a machine of the character described, a pair of complementary strip engaging rolls and means for driving said rolls and adjusting the distance between them, comprising parallel shafts on which the rolls are respectively mounted, a bushing for one of said shafts having a rotatable bearing in the head eccentric to the shaft, means for securing said bushing in various positions of angular adjustment and a tie bar applied on the protruding ends of said shafts at the side of the rolls away from the head, said tie bar having a rotatable, adjustable eccentric bushing surrounding one of said shafts.

26. In a winding machine of the character described, a rotatable winding head, a pair of complementary strip engaging rolls mounted rotatably in said head eccentrically of the axis thereof, intermeshing gears connected respectively with the rolls of said pair, a drive gear connected with one of said rolls, a transmission gear in mesh with said drive gear, a shaft on which said transmission gear is mounted, and a gear couple for driving said shaft, one of the gears of said couple being concentric with the shaft and the shaft being adjustable about the axis of the other gear of said couple.

27. In a winding machine of the character described, a rotatable winding head, a pair of complementary strip engaging rolls mounted rotatably in said head eccentrically of the axis thereof, intermeshing gears connected respectively with the rolls of said pair, a drive gear connected with one of said rolls, a transmission gear in mesh with said drive gear, a shaft on which said transmission gear is mounted, a bushing in which said shaft has a rotatable bearing, a gear couple for driving said shaft, one of the gears of said couple being fast to the shaft, the winding head having an opening concentric with the other gear of said couple in which said bushing is adjustably received, and a slotted plate connected with said bushing and adapted to be clamped to the head so as to secure the bushing in various positions.

28. In a winding machine of the character described, a winding head having a central cylindrical structure with forward and rear end walls, strip engaging rolls, driving gears for such rolls, and shafts holding said rolls and driving gears mounted and supported rotatably in the front and rear walls of said central structure, the rear wall of the head being extended beyond the periphery of said central structure and the head having an encircling outer wall extending from said rear wall, and a carrier adapted to hold a coil of the material to be wound by the machine mounted within the annular space between said outer wall and said central structure and being independently rotatable about the central structure.

29. In a winding machine of the character set forth, a rotatable winding head having a guide for the material to be wound by the machine, and means for lubricating the guide including a conduit extending through said winding head and having a port opening in the guide, a stationary supply tube for lubricant, and a rotatable fluid conducting connection between said conduit and the rotating winding head.

30. In a winding machine of the character set forth, a rotatable winding head having a guide for the material to be wound by the machine, and means for lubricating the guide including a conduit extending through said winding head and having a port opening in the guide, a stationary supply tube for lubricant, and a rotatable fluid conducting connection between said conduit and the rotating winding head, said connection comprising a casing into which said supply tube opens, a disk rotatably contained in said casing and having a passage for the lubricant which communicates with the passage in the winding head, said disk being rotatable with the winding head, and means for packing the casing to prevent leakage therefrom of the lubricant.

31. In a winding machine of the character set forth, a rotatable winding head having a guide for the material to be wound by the machine, and means for lubricating the guide including a conduit extending through said winding head and having a port opening in the guide, a stationary supply tube for lubricant, and a rotatable fluid conducting connection between said conduit and the rotating winding head, said connection comprising a casing into which said supply tube opens, a disk rotatably contained in said casing and having a passage for the lubricant which communicates with the passage in the winding head, said disk being rotatable with the winding head, and leakage preventing packings mounted in said casing to surround the central or hub portion of the disk at opposite sides thereof.

32. In a winding machine of the character described, a rotatable winding head, a brake adjacent to said head normally out of contact therewith but adapted to be brought into frictional engagement therewith, and a trip device controlled by the tension of the material being wound and arranged to cause setting of said brake when an abnormal condition of tension occurs.

33. A winding machine of the character described comprising a winding head having winding instrumentalities and carrying a supply of the material to be wound, a guide carried by said head and about which the said material passes on its way to the winding instrumentalities, said guide being displaceable from normal position in consequence of an abnormal condition of tension

in the material, a brake for the winding head normally placed inoperatively and a trip arranged to be operated for setting said brake in consequence of the aforesaid displacement of said guide.

34. In a winding machine, a rotatable winding head having winding instrumentalities and carrying a supply of strip material, a guide member around which the strip material passes on its way to the winding instrumentalities, means tending to displace the guide against the pull exerted upon it by the strip material and resisting movement of the guide under such pull, a brake for the winding head normally inoperatively placed, a trip device for causing said brake to be applied, and means operated by displacement of said guide for actuating said trip.

35. In a winding machine of the character described, a rotatable winding head, a brake for said head under an impulse tending to apply it to the head, a latch normally restraining said brake from application, a trip carried by the head and arranged to occupy different positions, in one of which it passes clear of said latch and in another of which it is adapted to engage and release the latch, and means controlled by the tension of the material being wound to place such trip in one or the other of such positions.

36. In a winding machine of the character described, a rotatable winding head, a driver for imparting rotation to said head, a brake for stopping rotation of the head, and means controlled by the tension of the material being wound for simultaneously causing said brake to be set and causing the driving effort of said driver to be stopped when an abnormal condition of the tension of said material occurs.

37. In a winding machine of the character described, a winding head, a brake for said head arranged to be automatically brought into engagement with the head, a displaceable guide carried by the head and so arranged that the material being wound passes around it in its course to the winding point, and a trip device operated by movement of said guide in consequence of breakage of said material, arranged to cause application of the brake.

38. In a winding machine of the character described, a rotatable carrier for the strip material to be wound, a guide around which said strip material is caused to pass on its way to the winding point, a pivoted arm

by which said guide is carried, a spring tending to move said arm oppositely to the direction of force application thereon by the strip material, a cam connected and movable by said arm, and a trip device operable by said cam.

39. In a winding machine of the character described, a rotatable carrier for the strip material to be wound, a guide around which said strip material is caused to pass on its way to the winding point, a pivoted arm by which said guide is carried, resilient means opposing displacement of said arm under the pull applied to said guide by the strip material, a cam connected with said arm and movable thereby under such displacement, and a trip device operable by said cam.

40. In a winding machine of the character described, a rotatable carrier for the strip material to be wound, a guide about which said strip material is passed on its way to the winding point, an arm carrying said guide, a rock shaft to which said arm is secured, a second rock shaft, a second arm connected to the second rock shaft and having engagement with the first arm, springs acting on said shafts with cumulative tendency to move the guide in the opposite direction to the pull exerted upon it by the strip, a displaceable cam member against which one of said arms is forced by the pull of the strip, and a spring arranged to resist displacement of said cam member.

41. A winding machine of the character described, comprising a supporting structure, a head rotatably supported by said structure and having coaxial bearing means, winding instrumentalities carried by said head, and a spool or holder for the material to be operated upon by said machine mounted for rotation on said bearing means and open at the forward side of the head for reception of a coil of such material.

42. In a winding machine of the character described, a rotatable winding head having coiling means adapted to form strip material into a tube, said head having bearing means open at the forward side of the head for reception of a spool or holder, and a spool or holder for the material to be so wound mounted and freely rotatable on said bearing means and open at the front side of the head for reception of a coil of such material.

In testimony whereof I have affixed my signature.

HENRY E. BRYANT.