Oct. 22, 1946. E. R. WORKMAN 2,409,652

BANDING MACHINE

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Fig. 20.

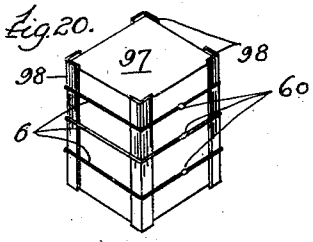


Fig. 1.

Fig. 2.

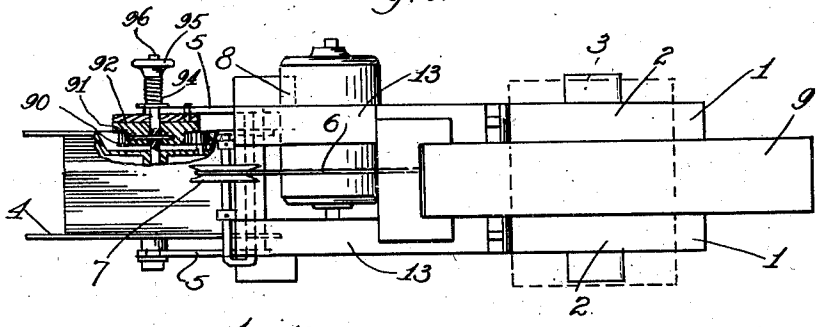


Fig. 17.

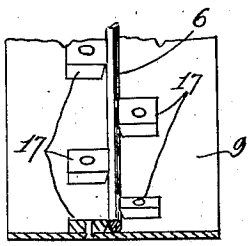
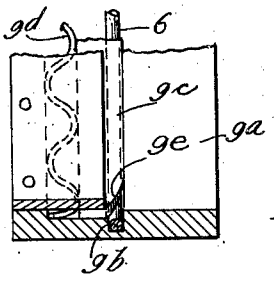


Fig. 18.



Witness

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BANDING MACHINE

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Fig. 3.

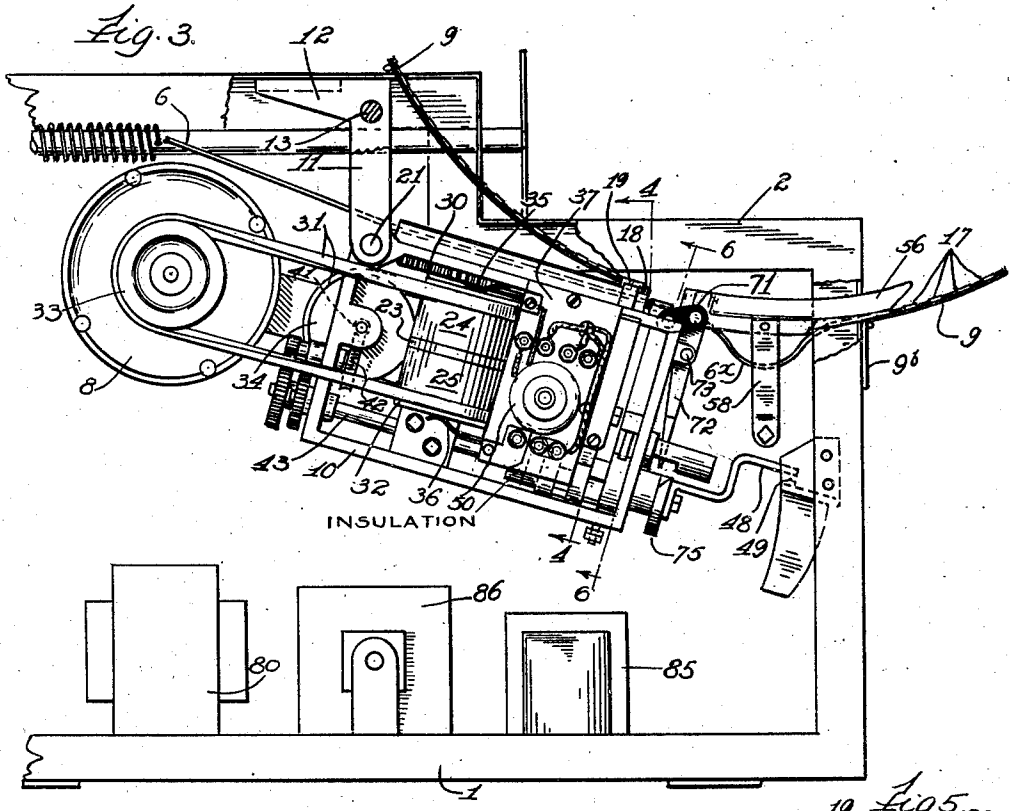

Fig. 4.

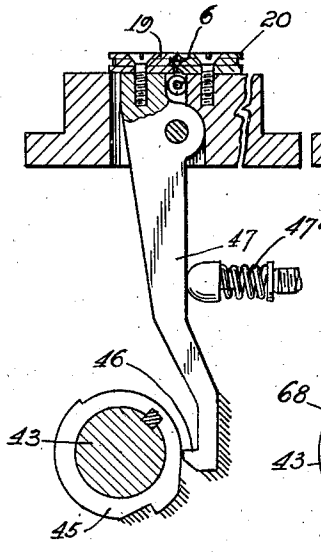

Fig. 6.

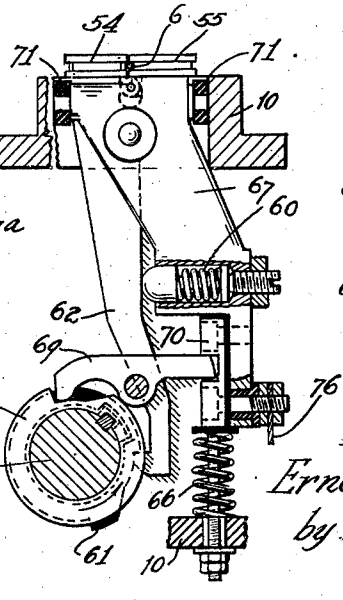

Fig. 5.

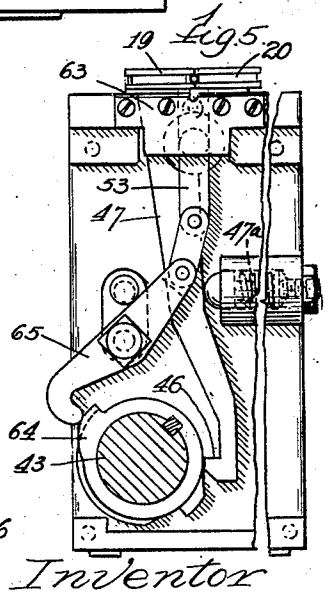

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Fig. 7

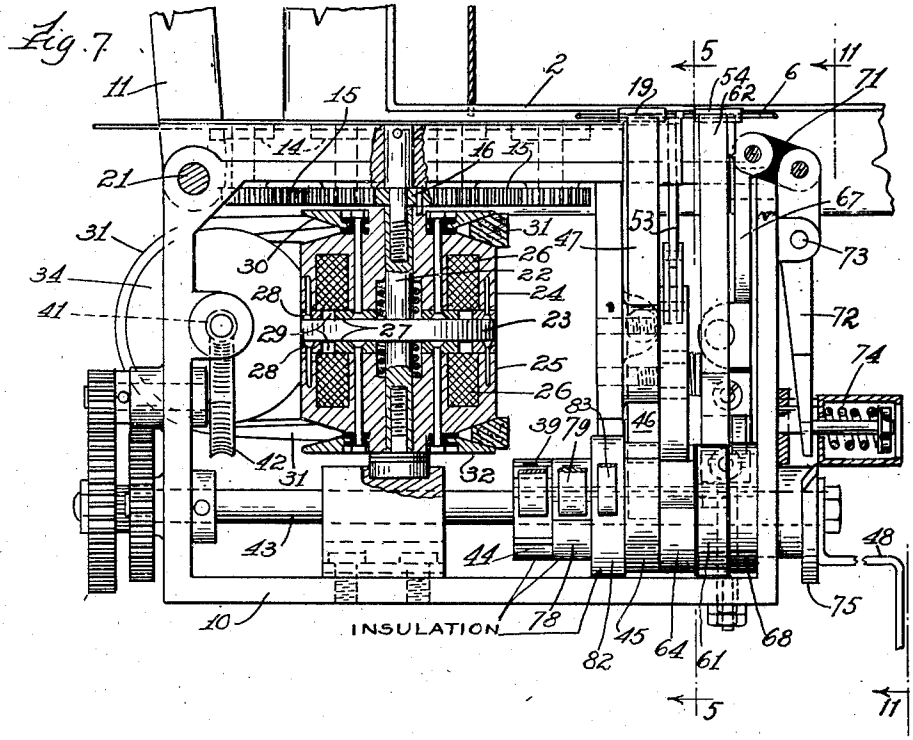

Fig 8

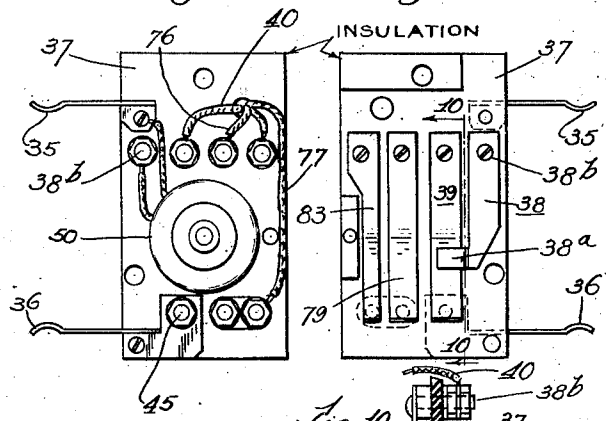

Fig 9

Fig. 10.

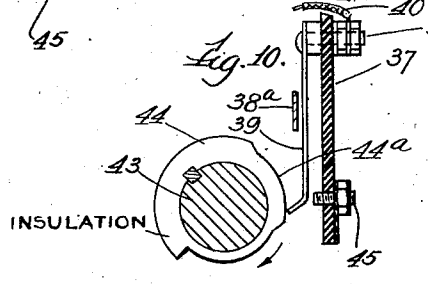

Fig 11.

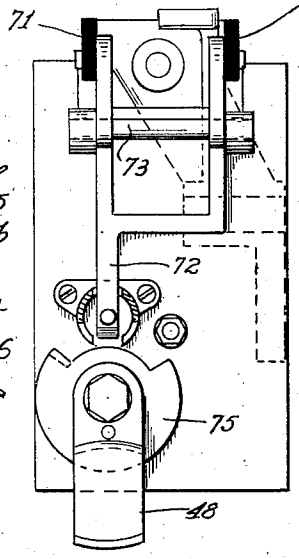

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Fig 12.

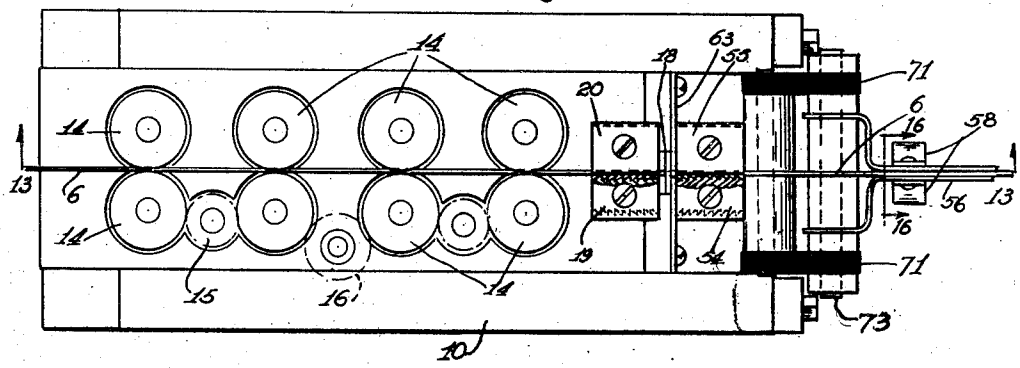


Fig 13.

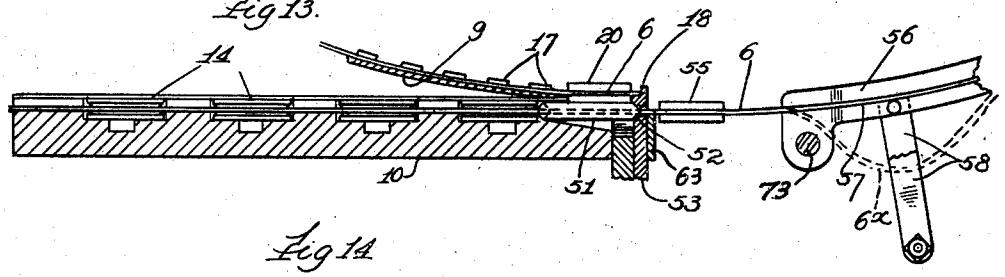


Fig 14

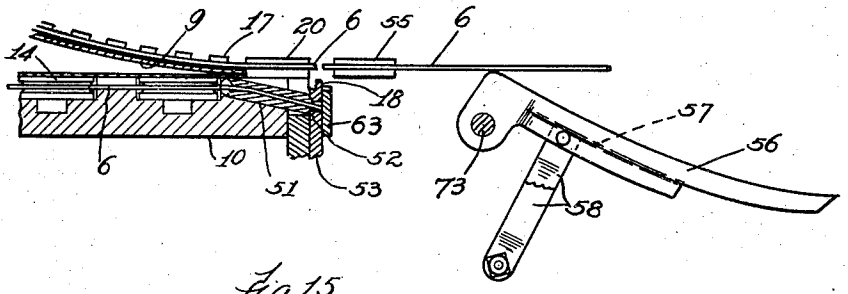


Fig 15.

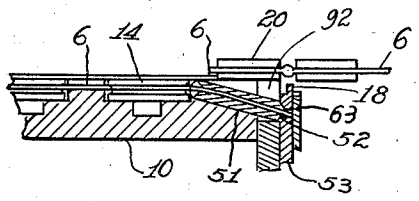


Fig. 16.

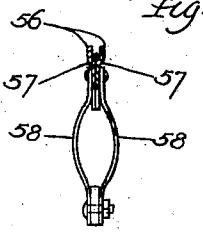
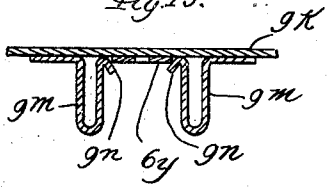


Fig 19.



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BANDING MACHINE

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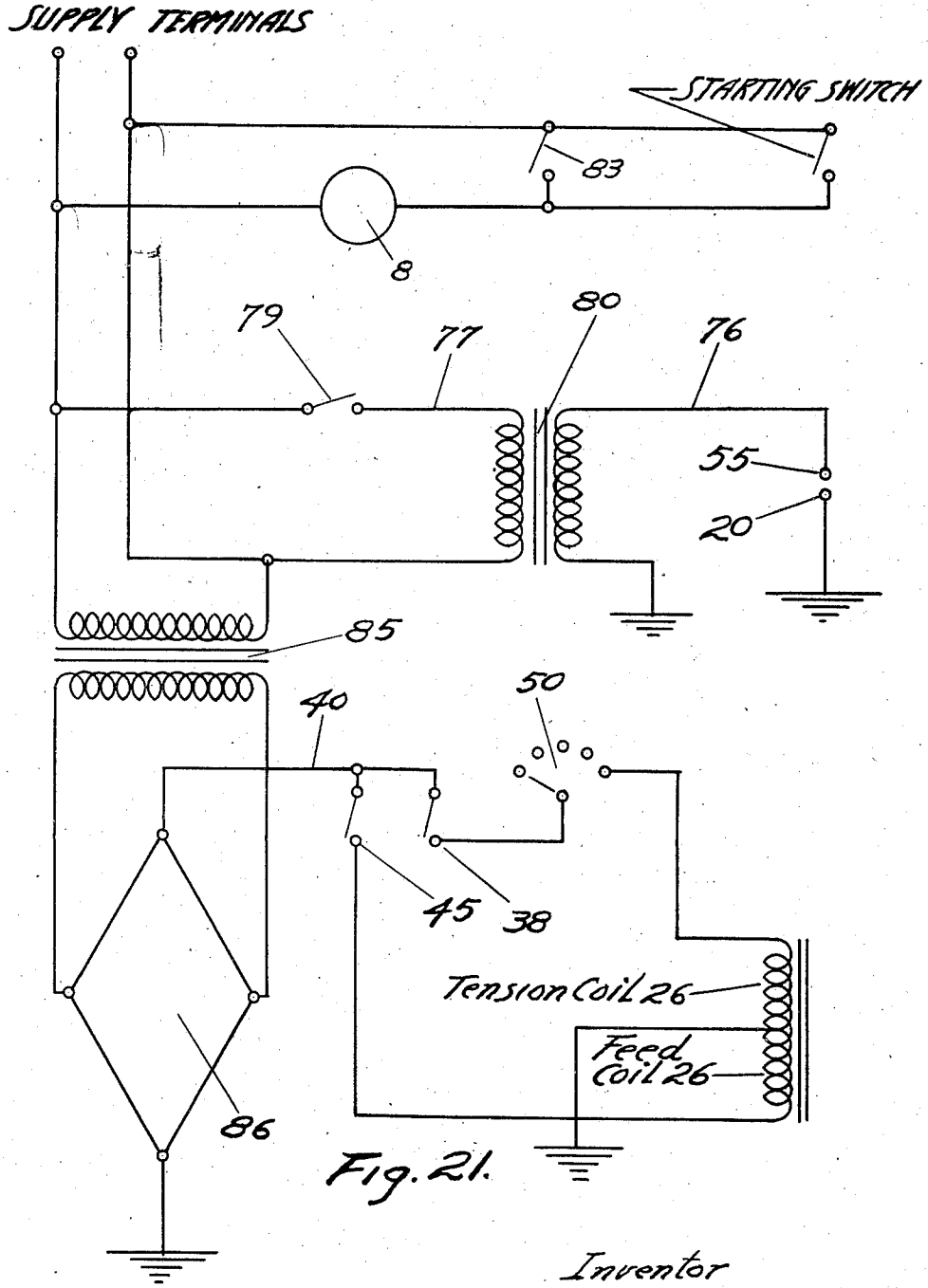

Fig. 21.

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UNITED STATES PATENT OFFICE

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BANDING MACHINE

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Application May 3, 1939, Serial No. 271,435

81 Claims. (Cl. 100—31)

1

This invention relates to a machine for applying and securing a tight metallic band around an object or group of objects either as a package reinforcement or tie, or as a structural element. One object of the invention is to complete the application and securement of such a band in a shorter period of time than is possible with present mechanisms. Another object is to produce a smoother connection of the band than has been accomplished heretofore. More particularly, it is an object of the invention to tension a metallic band from both its ends around an object or group of objects with the said ends of the band abutting each other and then to weld said ends together. Another object of the invention is to provide a machine that will continue to run automatically after each welding operation until it has formed a banding loop and comes to rest, holding said loop in readiness to be applied at the beginning of a succeeding operation. And it is a further object of the invention to provide a machine adapted to perform automatically the complete necessary cycle of operations involving the application of the band, the tensioning of the same, the cutting of the material from a supply and the welding of the cut ends. The invention consists in various features and elements of construction in combination, as hereinafter shown and described, as indicated in the claims.

In the drawings:

Fig. 1 is a side elevation of a banding machine embodying this invention.

Fig. 2 is a top plan view of the same.

Fig. 3 is a partial side elevation on a larger scale with a portion of the raceway omitted, but showing the control mechanism in its assembled operative relation.

Fig. 4 is a detail section at line 4—4 on Fig. 3, showing the cam mechanism for actuating one pair of gripper jaws.

Fig. 5 is a detail section taken as indicated at line 5—5 on Fig. 7, showing the shearing blade and its actuating cam.

Fig. 6 is a detail section taken as indicated at line 6—6 on Fig. 3, showing the cam mechanism for actuating the other pair of gripper jaws.

Fig. 7 is a side elevation showing the control mechanism on a still larger scale than in Fig. 3, with the magnetic drive clutches shown in section.

Fig. 8 is a detail side elevation of the electrical control panel.

Fig. 9 is an elevation showing the reverse side of the panel and contact fingers mounted thereon,

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Fig. 10 is a detail section taken as indicated at line 10—10 on Fig. 9.

Fig. 11 is an end elevation of the control unit showing the cam action for tensioning the band, taken substantially as indicated at line 11—11 on Fig. 7.

Fig. 12 is a top plan view of the control unit showing the wire feeding rolls and the gripping and welding jaws.

Fig. 13 is a detail section taken as indicated at line 13—13 on Fig. 12, showing the initial relation of the control unit to the raceway in forming a loop thereon.

Fig. 14 is a similar section showing the relative position of the ends of the loop after the shearing operation and before welding.

Fig. 15 is also a detail section at the same plane as Fig. 13 showing the ends of the loop after welding.

Fig. 16 is a detail cross-section of the yielding portion of the raceway which provides an escape for the excess wire, as indicated at line 16—16 on Fig. 12.

Fig. 17 is a detail section of the raceway showing a fragment of the inner face in elevation, as indicated at line 17—17 on Fig. 1.

Fig. 18 is a section similar to Fig. 17, but showing a modified form of raceway.

Fig. 19 is a transverse section of another form of raceway adapted for use with a flat band instead of wire for forming the loop.

Fig. 20 is a perspective view showing one type of package to which the banding method of this invention is applicable.

Fig. 21 is a diagram of the electrical circuits involved in the operation of the machine herein shown and described.

Heretofore, banding loops for use on boxes, bundles and other packages have been made of wire, and, in some cases, of flat metallic bands, and have been closed by means of clips embracing the lapped ends of the bands, or by twisting the wire ends together, and, in some cases, by welding lapped portions of the banding material; but mechanisms for accomplishing these forms of securement have nearly always required the insertion of a part or element between the band and the object or bundle to which it was being applied. Such methods have prevented the application of a thoroughly tight band, and have usually left rough and sharp projections at the connected portions, involving a series liability of damage to persons and property during handling of the banded objects. The present invention eliminates these objectionable features by pro-

viding means for making a smooth, electrically welded butt joint in a band which is tensioned around the object without the use of any mechanism or part operating between the band and the object.

Referring to the drawings, Fig. 1 illustrates a machine embodying the invention and comprising a main frame 1, which includes a supporting platform 2, on which an object such as a box, indicated in broken outline at 3, may rest while the metallic band is applied to it by the machine. The drawings illustrate the banding material as consisting of round wire, but it may be understood that other forms of band may be employed, as, for example, flat metallic ribbon, involving only slight alterations in the mechanism. Fig. 1 shows a reel 4, which may be understood as containing a supply of the banding wire, and which is rotatably supported on bracket arms 5 extending from the main frame 1 of the machine. From the reel the wire seen at 6 passes over an idler pulley 7 to and through a suitable feed mechanism driven by a motor 8. The feeding means advances the wire around a circular track or raceway 9 which, as seen in Fig. 1, encompasses the box or package 3 which is to be banded. The main portion of this raceway is secured to the frame by two brackets 9^a and 9^b, as shown in Fig. 1, and extends in a vertical plane, but an initial portion 56 of the raceway is pivotally connected to a movable sub-frame 10 at 73 (see Fig. 3 and Fig. 12) and the opposite end of this pivoted portion 56 rests on the fixed end of the main portion which is supported by the bracket 9^b so that it can slide along this main portion of the raceway to accommodate itself to movements of the subframe 10, as hereinafter more fully described. The main portion of the raceway includes a flexible part extending from the bracket 9^a to the sub-frame 10 to which it is anchored, and the flexibility of this part renders it somewhat deformable in response to limited movement of the sub-frame. The feed mechanism, together with the gripping and welding jaws and the controlling cams which time the various steps in the operation, are mounted in and carried by the sub-frame 10, which is suspended from the main frame 1 by links 11 whose upper ends include stop arms 12 which limit the swinging movement of the links in one direction. The main frame 1 is shown as constructed of angle iron, and the links 11 are pivoted to the vertical webs of the angle frame members at 13, while the stop arms 12 engage the horizontal flanges of these members, as seen in Fig. 3.

Journaled in the upper portion of the frame 10 is a series of feed rollers 14, shown geared together in pairs and connected by idler gears 15, with a final drive connection by a pinion 16 so that the simultaneous rotation of the rollers 14, engaging both sides of the wire 6, operates to feed the wire from the supply reel 4 to the curved raceway 9 for one full circuit thereof in preparation for the banding operation. The frame 1 comprises two similar side frames which are spaced apart to provide a path for the wire between them, and the lower portion of the raceway 9 also fits between these side members. Thus, when the box or other article indicated at 3 is placed on the platform portions 2, 2 of the side frames, the raceway 9 supports the wire 6 in a loop which extends under and over the object 3. The raceway 9 is constructed of a flat band bent to circular form, and having its inner surface fitted with a series of guide studs 17 which serve to position the wire along the center line of the band. Successive studs of the series are disposed at opposite sides of the wire, and the studs are of slightly flared cross-section so that they overhang the circular cross-section of the wire to retain it in the raceway. However, the studs are spaced apart by such distances that the spring of the wire between successive guide studs is sufficient to permit it to be pulled away from their overhanging engagement and toward the center of the raceway when the wire is to be contracted about the object or package disposed at 3 within the circle of the raceway 9. The wire is first fed around the raceway until its free end is arrested by an upstanding stop 18; this end portion of the wire is then firmly gripped by jaws 19 and 20 and the direction of rotation of the feed rolls 14 is reversed, thus pulling back the excess length of wire in the raceway 9 and drawing the wire out of the raceway until it is pulled tightly around the object 3. The final portion of the raceway leading toward the stop 18 is flexible so that, although it is anchored to the top of the sub-frame 10, it will permit the sub-frame to be swung about its pivotal support 21 to a substantially horizontal position directly under the object 3 and just below the plane of the platform members 2. This permits the wire to be drawn tightly around the object 3, as just described, and Fig. 1 shows the wire in dotted outline in the process of being so tensioned.

The reversible drive of the feed rolls 14 may be accomplished in various ways, but a very effective mechanism for this purpose is illustrated in Fig. 7. It consists of a pair of magnetic clutches which may be alternately energized, and which are simultaneously driven in opposite directions so that either one may be caused to pick up the drive of the feed rolls by the mere throwing of a switch. The drive gear 16 is carried by a shaft 22 having fixed thereon a disk or flange 23 of magnetic metal such as steel. Adjacent opposite faces of the disk 23 there are loosely journaled on the shaft 22 the electro-magnets 24 and 25, respectively, each having a hollow, annular space containing a winding 26, with annular retaining plates 27 and 28, which are spaced apart radially to form an annular magnetic gap 29 directly adjacent the disk 23. When either of the coils 26 is energized, the part 23 thus becomes a magnetic armature and is magnetically attracted and rotated by the magnet whose coil is energized.

The upper end of the magnet 24 is beveled and has secured to it in electrically insulated relation an oppositely beveled ring 30, which may be of copper or other electrically conductive material so as to serve as a contact ring in circuit with the coil 26 of the magnet 24. The opposing beveled surfaces of the magnet 24 and the ring 30 form a grooved pulley for a drive belt 31. The lower end of the magnet 25 is likewise beveled and has affixed to it in insulated relation an electrically conductive ring 32, which is electrically connected with the coil 26 of the magnet 25. The drive belt 31, which extends from a pulley 33 on the shaft of the driving motor 8, passes around the pulley portions of the clutches 24 and 25 and thence around a pulley 34 journaled on the subframe 10. The upper and lower plies of the belt 31, traveling in opposite directions, thus rotate the clutch members 24 and 25 in opposite directions respectively, and the flange 23 and shaft 22 will be driven by one or the other of said clutch members, depending on which clutch has its coil 26 electrically energized.

Contact brushes 35 and 36 engage respectively the flat surfaces of the conductor rings 30 and 32 and extend from a panel 37 of insulating material. A contact finger 38 on the inner face of the panel, leads from the brush 35 and includes a laterally offset portion 38a, which overlaps and normally contacts an adjacent finger 39 on the panel 37. A lead wire 40 connected with a source of current supply thus normally energizes the upper clutch 24 by way of contact members 39, 38 and brush 35.

The pulley 34 drives a worm 41, meshing with a worm gear 42 which, through an intermediate set of gears mounted on the outer end of the frame 10, drives a cam shaft 43 by which the various movements and operations of the banding cycle are controlled. A cam 44 on the shaft 43 engages the contact finger 39 and for a proper portion of its revolution forces the finger out of contact with the overlapping lug 38a and into contact with a terminal screw 45 which is electrically connected with the brush 36. When this occurs the circuit in the coil of the magnetic clutch 24 is opened, but the coil of the clutch 25 is energized for driving the flange 23 and its shaft 22 in the opposite direction. As shown, the clutch 25 thus operates rolls 14 to advance the wire 6 around the raceway 9, in position to encircle the box or package at 3, and the other clutch 24 serves to retract the wire for tightening it around the object before its ends are permanently joined.

The cam shaft 43 includes a cam 45 with which there is associated a follower 46 on a lever 47, which carries at its upper end the movable jaw 19 cooperating with the fixed jaw 20 to engage the free end of the wire 6. Pressure between the jaws is maintained by a spring 47a acting against the arm 47, as seen in Fig. 4. After the wire has been fed around the raceway 9 and its end has been arrested by the stop 18, the cam 45 allows the spring 47a to close the jaws 19, 20 upon the end portion of the wire; the feed can then be reversed for the tensioning operation.

But, preferably, the cycle is interrupted at this point; if a package is then placed on the platform 2 the first operation will be the fitting and tensioning of the wire. This involves pulling the wire out of control of the studs 17 on the raceway, as indicated in Fig. 1, until it is drawn snugly about the object 3. While this fitting of the wire loop around the object 3 is taking place, a crank 48 on the end of the control shaft 43 is rotated against a fixed shoulder 49, so as to swing the frame 10 about its pivotal mounting at 21 into a substantially horizontal position, and the final pull of the tensioning operation will result in moving the sub-frame 10 and its motor 8 bodily in horizontal direction, as permitted by the swinging links 11, which support these parts. This brings the gripping jaws 19, 20 up close to the bottom of the box or package 3 at the plane of the platform frame members 2; and when the tensioning operation is completed the magnetic clutch 24 may continue to turn until its current supply is cut off at a predetermined point in the cycle, but the fact that its connection with the flange 23 and shaft 22 is wholly magnetic permits the clutch to "slip" after the wire has been drawn tight. The final pull exerted on the wire is thus determined by the strength of the magnetic pull, and this may be regulated to a nicety by means of an adjustable rheostat 50 mounted on the panel board 37 and connected between the binding post 38b of the finger 38 and the brush 35,

through which the current is supplied to the clutch 24.

As seen in Fig. 13, the wire supply 6 is fed from the rollers 14 through a guide sleeve or thimble 51, which has one end fitted into a countersunk recess 52 in a plate 53, which is mounted for limited vertical reciprocation in the sub-frame 10. Through a small hole in the plate 53 which registers with the bore of the guide sleeve 51 the wire passes between a second pair of jaws 54, 55 and thence to the raceway. The initial portion of the raceway consists of a pair of plates 56 offset to form shoulders 57, which provide a track for the wire when the members 56 are held closely together. The members 56 thus form a bridge leading to the raceway proper at 9, and when the end of the wire 6 has traversed the raceway it is arrested by the upstanding stop portion 18, formed at the upper end of the plate 53, as seen in Fig. 13. I have found that, particularly when the wire is fed at a considerable speed by the rolls 14, it is rather difficult to arrest this movement instantly upon arrival of the end of the wire against the stop shoulder 18; therefore, the plates 56 forming the initial bridge portion of the raceway are held together by spring arms 58, so that they may yield laterally to provide an escape for the excess length of wire, allowing it to pass between the shoulders 57, forming a downwardly deflected loop at 6^x which remains until the reverse movement of the rolls 14 for tensioning the wire takes up this slack.

When the reverse rotation of the feed rolls 14 is completed, and the wire is drawn tight about the object 3, the second pair of jaws 54, 55 is caused to grip the wire through the action of a spring 60 and cam 61 operating a lever 62 which carries the jaw 54 and controls it in the same manner that the lever 47 controls the jaw 19.

Under the control of the cam shaft 43 the plate 53 is now drawn downward to the position shown in Fig. 14, carrying with it the movably mounted sleeve or thimble 51 and the portion of the wire contained within it, but carrying this portion of the wire past a shear plate 63 which cuts it free of the loop encircling the object 3. This movement of the plate 53 is controlled by cam 64 on the shaft 43, operating through the medium of a rocker 65. The downward movement of the plate 53, incidentally, withdraws the stop shoulder 18 from the end portion of the wire just beyond the gripping jaws 19, 20. The sheared end of the wire gripped by jaws 54, 55 is now shifted upward into alignment with the other end by the force of a lift spring 66 which, as shown in Fig. 6, serves to elevate the insulated jaw-supporting carriage 67 on which the lever 62 is fulcrumed. This lift is timed by the operation of a cam 68 on the shaft 43, actuating a rocker 69. A bolt fixed to the lower end of the carriage 67 extends through a spring 66, as seen in Fig. 6, and fits loosely in an opening in the sub-frame 10. A pair of adjusting nuts are threaded on the lower end of the bolt to limit upward movement of the carriage 67 under stress of the spring 66. The said bolt positions the lower end of the carriage, and limited movement of the bolt in the loose fitting opening of the sub-frame 10 permits limited horizontal movement of the upper end of the carriage 67. Movement of the upper end of the carriage in a transverse direction is prevented by the links 71 of insulating material which are disposed slidably between the carriage and upstanding vertical surfaces of the sub-frame, as indicated in Fig. 12, these links serving to shift

the carriage and its jaws 54, 55 horizontally, as will be presently explained. The carriage 67 is held suspended in a floating position by means of the spring 66 and the links 71, so that its upper end shall be subject to movement in a horizontal direction under control of said links by lever 72 and cam 75, and in a vertical direction under control of the lever 69 and the cam 68.

As the final preparation for the welding of the two ends of the wire, the jaws 54, 55 are moved toward the jaws 19, 20, so as to bring the severed ends of the wire into actual contact with some pressure. The lower end of the carriage 67, on which these jaws are mounted, is supported upon, but insulated from, the spring 66 and is movable vertically under control of the rocker lever 69, engaging a notched block 70 which is secured to, but insulated from, the carriage 67. The position of the upper end of this carriage is further controlled horizontally by links 71 of insulating material, extending from the upper portion of the carriage to a lever 72, which is fulcrumed on the sub-frame 10 at 73. The lower end of the lever is controlled by a spring 74 and a face cam 75, the cam being mounted on the end of the shaft 43 so that actuation of the lever and corresponding movement of the jaws 54, 55 is timed and controlled by the rotation of the shaft 43. When the wire 6 has been sheared by downward movement of the plate 53 the cams on the shaft 43 are so timed as to operate the jaws 54, 55 for gripping the severed end of the wire and to operate the rocker 69 so as to permit the jaws 54, 55 to rise and align the end of the wire with the opposite end which is already held by the jaws 19, 20. A lead wire 76 carries the welding current to the insulated carriage 67 and jaws 54, 55 carried upon it, the other side of the welding circuit being grounded through the frame of the machine and thus extending to the other gripping jaws 19, 20. Thus, with the opposite ends of the wire loop in alignment, as shown in Fig. 14, it is only necessary to move these ends into abutting relation and to allow the force of the spring 74 to press them together in order to effect the welding operation. For this purpose the feed wire 76 is momentarily energized through the operation of a cam 78 on the shaft 43, and a contact finger 79 supported on the panel board 37 and actuated by the cam 78. A feed wire 77, seen on the panel board in Fig. 8, may be understood as extending from a suitable transformer 80, which furnishes the welding current at the desired voltage. The finished weld is indicated in Fig. 15.

As soon as the weld has been formed, the welding current is cut off by operation of the cam 78, but the motor 8 continues to drive the cam shaft 43 for actuating the crank 48 and lowering the swinging frame 10 back to its initial inclined position; simultaneously, the cams 45 and 61 operate to release the gripper jaws so that the tensioned and welded band is left on the box or package 3, while the feeding and welding mechanism withdraws downwardly from it. The motor 8 continues to run until its current supply is cut off by operation of a cam 82 on the shaft 43, actuating a contact finger 83 on the panel board 37.

Preferably, the control cams on the shaft 43 are arranged so that the cycle of operation terminates with the feeding of a length of wire around the raceway 9 to the stop 18 under control of the magnetic clutch 25, as already described. If this is made the last step of the cycle it can take place while the banded package at 3 is being removed from the machine and while another box or package is being shifted onto the platform 2. Then, immediately after the new package is in position, the cycle of operations can be repeated and will commence with the contracting of the wire onto the object at 3, without any delay which would otherwise be occasioned if the raceway 9 were not filled with a loop of wire until after the object was placed on the platform. This arrangement of the cycle thus secures extremely efficient operation in that the time consumed by the operator in removing a banded box and replacing it with one to be banded, is utilized by the machine itself in refilling the raceway with wire.

It may be understood that any suitable manually operable switch may be connected in the motor circuit for temporarily bridging the gap which occurs when the contact finger 83 is moved to open circuit position by its control cam 82; and this cam 82 may be so shaped that it will maintain the motor circuit through all but a few degrees of its revolution so that promptly after the manually operable starting switch (not shown) is actuated, the motor circuit will be reestablished by the contact finger 83. Then the motor will continue to run until the completion of the step of the cycle which consists in filling the raceway 9 with wire, and will be arrested substantially at the moment when the circuit is shifted from the magnet clutch 25 to clutch 24. Thus when the motor circuit is manually reestablished, the clutch 24 will commence the operation of driving the feed rolls in their reverse direction for contracting the loop of wire 6 onto the object at 3. Following this step, both magnetic clutches will be de-energized so as to avoid any movement of the wire during the severing and welding operations. This is accomplished by providing the cam 44 with a delay surface 44a with which the finger 39 is shown in contact in Fig. 10, so that it is held out of contact with the terminal 45 and also out of engagement with the part 38a. In the drawings a transformer 85 and a rectifier 86 are shown, which may be understood as serving to provide direct current at the proper voltage for operation of the clutches 24 and 25. However, for the sake of clarity, the conductors connecting these elements and also conductors from the welding transformer 80 and for the motor 8 are omitted from most of the views but are indicated in Fig. 21, which is a wiring diagram of electrical connections for the machine.

When the wire 6 is drawn from the reel 4 in initially filling the raceway 9, the rotation of the reel operates to tension a spiral spring 90 having one end anchored to the reel, as seen in Fig. 2, and having its opposite end attached to a hub or disk 91, which is mounted rotatably and co-axially within the reel. One face of the disk 91 engages frictionally with a fixed disk 92, which is anchored to the suppporting frame 5. When the feed rolls are reversed for contracting the wire 6 about the object 3 the wire is thus fed beck toward the reel 4, but when this occurs the friction between the parts 91 and 92 tends to hold the part 91 stationary, and thus temporarily anchor the end of the spring 90 which is attached to it. The tensioned spring then operates to drive the reel 4 in reverse direction for taking up the extra length of wire not required for banding the object at 3. As shown in Fig. 2, a compression spring 94 reacting between the frame member 5 and an adjustable nut 95 on the reel

spindle 96 may be provided to supply pressure for producing the proper friction between the parts 91 and 92.

As a substitute construction for the raceway shown in Fig. 1, and in detail in Fig. 17, Fig. 18 illustrates a raceway 9^a, having a groove or channel at 9^b for the wire 6. A laterally slidable cover member 9^c normally closes this channel to retain the wire in the raceway, and the cover is held yieldingly in closed position by a sepentine spring 9^d. The end of the cover 9^c is beveled at 9^e, so that upon reversal of the wire feeding means for contracting the wire about a box or package on the platform 2 the tension on the wire will cause it to engage the beveled end 9^e and force the slidable cover 9^c back against the spring 9^d at one end of the raceway. As the tension continues, and the wire is drawn out of the slot 9^b it will continue to crowd the cover 9^c out of the way, and this action will serve to release the wire from the raceway as it is needed for banding the object at 3. Fig. 19 illustrates a further modification of the raceway which is adapted for use when a flat strip 6^y is employed instead of a round wire as the banding material. In this construction the circular floor of the raceway 9^k has secured to it a pair of sheet metal flanges 9^m, which are doubled upon themselves and formed with inclined terminal portions 9^n for engaging the edges of the strip 6^y. The doubled formation of the flanges 9^m permits them to yield laterally at their inclined terminals 9^n sufficiently to allow the band 6^y to be withdrawn as needed for tensioning around an object on the platform. With any of the forms of raceway herein described it will be understood that some resistance to extraction of the wire from the raceway is of advantage in that it provides tension to insure that the wire will be led around and laid onto the object or package in proper alignment. In the form shown in Fig. 17 the stiffness of the wire offers the desired resistance to its extraction from the hold of the studs 17; in the form of Fig. 18, the serpentine spring 9^d and friction of the wire against the edge of the cover 9^c offers the proper resistance; and with the track form of Fig. 19, the spring flanges 9^m furnish the yielding opposition which keeps the band under control. The tensioned and welded bands or wires produced by the machine will have a wide variety of uses, including the securement of bales and boxes of various shapes and sizes. As an example, Fig. 20 illustrates a rectangular object 97 which might be a sheet metal cabinet or filing case which is protected for shipment by the application of angular corner strips 98 of wood or fiber or heavy corrugated paper board, and these are easily and quickly secured by a few bands of wire 6, each welded at 60 by the process performed in accordance with this invention. The tension in the bands 6 may be such that they will impress themselves slightly into the angle strips 98 at their exposed edges, thus preventing slippage of the bands 6 and securing the parts firmly to the object 97.

As seen in Fig. 12, the jaws 19 and 54 are made serrated for gripping the wire effectively, but their cooperating jaws 20 and 55 are formed with smooth pressure surfaces to engage the side of the wire. This avoids the tendency of the wire to weld to the jaws, which is observable when all the gripping surfaces are made serrated, with the result that the welding current is too strongly concentrated in the teeth of the gripping faces. With my construction the smooth surfaces effectively conduct a sufficient current to the ends of the wire loop, so that the welding effect is concentrated at the ends of the wire to form an extremely strong bond having at least the tensile strength of the wire itself.

While there is shown and described herein certain specific structure embodying the invention, it will be manifest to those skilled in the art that various modifications and re-arrangements of the parts may be made without departing from the spirit and scope of the invention, and that the same is not limited to the particular form herein shown and described, except in so far as indicated by the appended claims.

I claim:

1. In a banding machine, means to feed a wire, means to guide the wire into the form of a loop, means for contracting the loop onto an object, means for guiding the contracting loop in a definite plane, including means to maintain the wire continuously under tension during contraction, grippers for engaging the loop adjacent its terminals, power driven means arranged to move the grippers to tension the loop and press its terminals into abutting relation, and means supplying an electric welding current to the terminal portions of the loop for butt-welding the ends together.

2. In a banding machine, platform means to support an object to be banded, grippers positioned to hold a wire substantially at the plane of the platform, and a motor-driven mechanism for controlling the automatic actuation in timed sequence of instrumentalities including means for positioning a loop of wire to band an object on the platform with opposite end portions of the loop held by separate grippers, means by which one of said grippers is moved toward the other for pressing the end surfaces of the gripped ends of the loop into abutting relation, and switching means for supplying a predetermined welding current to the wire to secure its ends together.

3. In a banding machine, a support for an object to be banded, a raceway to encircle the object on said support, feeding means for advancing a wire around the raceway, a stop engageable by the advancing end of the wire upon completion of its circuit, said raceway having a portion arranged to yield to provide an escape for excess wire moving into said raceway after the end of the wire encounters the stop, and means for then reversing the feeding means to take up said excess and contract the wire around the object.

4. In the combination defined in claim 3, said yielding portion of the raceway comprising a pair of shouldered members pressed yieldingly together with their shoulders cooperating to form a track for the wire, and separable to provide the escape slot for the excess wire.

5. In a banding machine, a raceway to encircle an object to be banded, feeding means for advancing a wire around the raceway, and a stop engageable by the advancing end of the wire upon completion of its circuit, said raceway having a portion arranged to yield to provide an escape for excess wire moving into said raceway after said end of the wire encounters the stop.

6. In a banding machine, a raceway to encircle an object to be banded, feeding means for advancing a wire around the raceway, and a stop engageable by the advancing end of the wire upon completion of its circuit, said raceway having an end portion including parts separable by an excess of wire to form a gap.

7. In a banding machine, a raceway to encircle

an object to be banded, feeding means for advancing a wire around the raceway, and a stop engageable by the advancing end of the wire upon completion of its circuit, said raceway including means movable to provide a gap for the escape of excess wire moving into said raceway after the end of the wire encounters the stop.

8. In combination, a raceway, feeding means for advancing a wire around the raceway to form a loop, and a stop engageable by the advancing end of the wire upon completion of its circuit, said raceway including a portion through which an excess of wire may escape when the end of the wire encounters the stop.

9. In a banding machine, means to feed and guide a wire into the form of a loop, the guiding means comprising a circular raceway into which the wire is fed from a straight guideway substantially tangent to said circular raceway, a stop to arrest the end of the wire when it has traversed the circular raceway, said raceway including means for yieldingly engaging the wire to retain it, means for gripping the wire adjacent the said stop, a platform to support an object within the circle of the raceway, and means for reversing the feed of the wire to withdraw it progressively from the yielding retaining means under tension and contract it about the object.

10. In a banding machine, means to feed and guide a wire into the form of a loop, the guiding means including a substantially circular raceway, a platform to support an object within the circle of the raceway, said raceway having a terminal portion extending below the platform in spaced relation thereto, gripping means associated with said terminal portion for engaging the end portion of the wire below an object on the platform, means for contracting the loop about the object by withdrawing the other end portion of the wire from the raceway, the said terminal portion of the raceway being flexible, and means for moving said flexible portion and the associated gripper upward adjacent the plane of the platform to facilitate fitting the wire tightly about the object.

11. In a banding machine, a platform to support an object to be banded, and mechanism including means to feed a wire into the form of a loop with means to tension the wire about an object on the platform, and means to join the ends of the loop, said mechanism being mounted for bodily movement upwardly to bring a portion of the loop adjacent the plane of the platform during the tensioning and joining operations.

12. In a banding machine, a support for an object to be banded, a raceway to encircle the object on said support, feeding means for advancing a wire around the raceway, gripping means engageable with the end portion of the wire after it has traversed the raceway, a supply reel containing the wire to be fed to the machine, means for reversing the feeding means to draw the wire from the raceway and fit it closely around the object on the support, movable gripping means engageable with the wire between the feeding means and the raceway, means operable to sever said portion of the wire and means moving said gripping means to align the severed end with the first mentioned end.

13. In a banding machine, a motor-driven mechanism effecting the automatic actuation in timed sequence of instrumentalities including means to feed and guide a wire into the form of a loop, means for contracting the loop onto an object, grippers for engaging the loop adjacent its terminals, means for shifting at least one set of grippers to bring the terminals of the wire into direct alignment, means for further shifting at least one set of grippers to press the end surfaces of the wire into abutting relation, and means for supplying an electric welding current to the terminal portions of the loop for permanently uniting the abutting ends.

14. In a banding machine, a fixed frame including a platform to support an object to be banded, means to guide a wire into the form of a loop to be spaced around an object on said platform, said means including a track of substantially circular form, a sub-frame movably carried by the fixed frame, said track having a flexible portion attached to the sub-frame, and the sub-frame supporting wire-feeding means arranged in tangent relation to the circular track, whereby the wire is fed from the sub-frame around the track, means for reversing the feeding means to contract the wire about the object, gripping means carried by the sub-frame to engage the free end of the wire during such contraction, and means for shifting the sub-frame and said flexible track portion substantially to the plane of the platform to facilitate fitting the wire tightly about the object.

15. In the combination defined in claim 14, a member projecting from the sub-frame within the main frame and geared to operate in timed relation with the feeding means on the sub-frame, together with a fixed abutment on the main frame engageable with said member whereby operation of the member serves to shift the sub-frame toward the platform.

16. In a banding machine, a curved raceway to guide a wire into the form of a loop, studs upstanding from said raceway in staggered relation with successive studs of the series at opposite sides of the path of the wire, said studs having faces for engaging the sides of the wire, the faces of successive studs being slightly inclined in opposite directions to overhang the wire for resisting extraction thereof toward the central area within the loop, gripping means to hold one end of the loop, and means to exert a pull on the other end whereby the wire is caused to yield laterally past the overhanging inclined surfaces of the studs for removal from the raceway and contraction about an object within the loop.

17. In a banding machine, a curved raceway to guide a band into the form of a loop, said raceway including continuous retaining means extending parallel to the raceway to yieldingly resist extraction of the band toward the central area within the loop, gripping means to hold one end of the loop, and means to exert a pull on the other end for extracting the band from the yielding engagement of said retaining means and contracting it about an object within the loop.

18. In a banding machine, a curved raceway to guide a wire into the form of a loop, said raceway including a groove for the wire and a cover for said groove slidable laterally thereover with yielding means holding the cover in closed position to resist extraction of the wire toward the central area within the loop, gripping means to hold one end of the loop, and means to exert a pull on the other end, said cover having an inclined edge engageable by the wire under such tension for shifting the cover to open position as the wire is extracted from the groove of the raceway and contracted about an object within the loop.

19. In a banding machine, a curved raceway to guide a wire into the form of a loop, a retractible

stop to engage one end of the wire after it has traversed the raceway, and gripping electrodes to engage the end portions of the loop, together with means extending continuously along the raceway and arranged to yield the wire progressively under tension from the raceway.

20. In a banding machine, means to form a banding loop, means to contract the band about an object supported in the central area within the loop, including means for gripping the terminal portions of the loop, and means for moving said gripping means toward and adjacent the object to facilitate fitting the band tightly thereon.

21. In a banding machine, means to feed and guide a wire from a source of supply into the form of a loop, and means to sever the loop from the supply comprising a blade having a passage through which the wire is fed, a shear member, and means for reciprocating the blade to move its passage past the edge of said shear member, said blade having a portion positioned to serve as a stop for the end of the wire upon completion of the loop form, whereby said stop is withdrawn when the other end of the loop is severed from the supply, and gripping means engageable with both end portions of the loop and movable for aligning the ends for connection.

22. In a banding machine, mechanism for controlling the automatic actuation in timed sequence of instrumentalities to sever a band from a supply of wire and fit it about an object, to align the ends of the band in abutting relation and to butt-weld the aligned ends together.

23. In a machine which includes mechanism for fitting a band of wire about an object, mechanism automatically operable in a predetermined cycle and including means for severing the band from a supply of wire, aligning the ends of the band in abutting relation and butt-welding the aligned ends together.

24. In a machine which includes mechanism to sever a band from a supply of wire and mechanism to butt-weld the band about an object, means for moving the severed end of the supply and the severed end of the band from each other prior to the welding operation.

25. In a machine which includes mechanism to sever a band from a supply of wire and weld it about an object, means for deflecting the severed end of the supply from the position at which it is severed.

26. In a machine as defined in claim 23, means to move the severed end of the band away from the severing mechanism.

27. In a machine which includes mechanism arranged for feeding wire from a supply into a raceway and extracting the wire therefrom, means movably mounted for guiding the moving wire between the feeding means and the raceway and frictional means to continuously resist such extraction of the wire from the raceway.

28. In a machine which includes rolls to draw wire from a supply and feed it into a raceway, and means to reverse the rolls for extracting the wire from the raceway, a spring-closed cover for the raceway tapered at one end to progressively and continuously resist extraction of the wire from the raceway.

29. In a machine which includes mechanism to draw wire from a coil and feed it into a raceway against a stop, means of escape for the excess wire fed into the raceway after the fed end of the wire encounters the stop.

30. In a machine which includes a raceway and mechanism to draw wire from a coil and feed it into the raceway against a stop, a portion of the raceway being yieldable in response to the action of excess wire fed into the raceway after the end of said wire encounters the stop.

31. In a machine which includes means to feed wire from a coil into a raceway, means to sever the wire in the raceway from the coil, said severing means having a shear member which includes a movable stop for positioning the end of the wire fed into the raceway.

32. In a machine which includes a raceway for wire, a stop to position an end of the wire fed into the raceway from a supply, means to sever the wire in the raceway from the supply, means to weld said wire into a band about an object and means to deflect the severed end of the supply from the band during the welding operation.

33. In a machine for forming a loop on the end of a wire fed from a supply, automatically operable means to feed and contract the wire about an object, to maintain the loop in a definite plane under tension during said contraction thereof, to sever the tensioned loop from the supply and to butt-weld the ends of the tensioned wire together.

34. In a machine which includes a support for an object and mechanism to connect a band about the object, a sub-frame carrying the connecting means and mounted for movement upwardly into a position closely adjacent the object on the support.

35. In a machine which includes means for tensioning a band about an object, a support for the object and mechanism including means yieldably mounted on the support for movement in response to the tension and arranged for exerting tension in the band from both its ends.

36. In a banding machine, a support for an object, and means operable automatically in sequence for applying a loop of metallic banding material around the object, tightening said loop, severing the loop from the supply, aligning the loop ends and butt-welding said ends together in their aligned relation.

37. In a banding machine, means to secure a loop of metallic banding material around an object, including a gripper engaging one end of the loop, a second gripper to hold the banding material out of alignment with the end held by the first gripper, cutting means to sever a band from the material at a plane between said grippers, and means for shifting said second gripper to move the severed end of the loop away from the cutting means and into abutting alignment with the other end, together with means automatically controlling the action of the grippers in accordance with a predetermined cycle and supplying an electric current to the end portions of the loop to butt-weld them together.

38. In a banding machine, means to form a metallic loop extending around an object, including a stop for engaging one end of the loop, a gripper for engaging the end portion of the loop adjacent said stop, a second gripper spaced from the first, cutting means operable to sever said material at a plane between said grippers, means for actuating the cutting means and withdrawing the stop, mechanism operating to shift the severed end of the loop away from the cutting means and align said severed end with the other end of said loop, means for causing the second gripper to engage the loop, means for causing approach of said grippers to press the aligned ends of the loop together, and means automatically controlling the action of the grippers in accordance with a predetermined cycle and sup-

plying a welding current to the loop to butt-weld the aligned ends.

39. In a banding machine, a mechanism to feed and guide a band into the form of a loop around an object and including rotary feed rolls engaging the band, a driving member with connections therefrom to the rolls for driving them in a direction to advance the band in forming the loop, gripping means engaging the end portion of the loop, an electro-magnetic clutch operable to drive the rolls in reverse direction for contracting the loop and tensioning it about the object, a source of electric current for the clutch, and means for varying the strength of said current to control the tension applied to the loop.

40. In a banding machine, a main frame including a platform to support an object, a sub-frame movable relatively to the platform, means to feed and guide a strand of banding material into the form of a loop to encircle an object supported by the platform, mechanism carried by the sub-frame including means to grip one end of the loop at a position initially spaced from the supporting plane of the platform, means to contract the loop around the object, means to sever the loop from a supply of banding material and means to grip the severed end of the loop, together with means operating during contraction of the loop to shift the sub-frame and bring the gripped ends of the loop into alignment substantially at the said plane of the platform close to the surface of the object, and means to join the aligned ends of the loop.

41. In a banding machine, a main frame including a platform to support an object and a sub-frame movable relatively to the platform, mechanism carried by the sub-frame for feeding a strand of banding material into the form of a loop to encircle an object supported by the platform, said mechanism including feed rolls engaging the strand, a motor for said rolls with reversible drive connections between the motor and the rolls whereby the loop may be contracted around the object, means to grip one end of the loop during such contraction, means to grip the other end of the loop after it is fitted to the object, a cutter to sever the loop from a supply of banding material, said gripping means on the sub-frame being initially spaced from the supporting plane of the platform, and means operating during the contraction of the loop to shift the sub-frame and bring the gripped ends of the loop substantially into the plane of the platform and close to the surface of the object; together with means to join the ends of the loop together, and a timing shaft journaled in the sub-frame and driven by said motor on the sub-frame, said shaft carrying control devices for changing the direction of the feed rolls, operating the gripping means, actuating the cutter, shifting the sub-frame and energizing the means for joining the ends of the loop, all in automatic sequence.

42. In a banding machine, a raceway curved to guide a band into the form of a loop, said raceway including means formed and positioned to frictionally engage opposite sides of the band so as to deflect successive portions of the band in opposite directions to resist extraction when one end of the loop is held fixed and tension is applied to the other end for contracting the loop.

43. In a banding machine, a support for an object, a sub-frame carrying mechanism to place and secure a band on the object in accordance with a predetermined cycle, said sub-frame being mounted for movement to and from the object, and means automatically operative for effecting said movement as a step in said cycle of operation.

44. A machine for banding an object, including a support for the object, a raceway to guide a wire into the form of a loop, a sub-frame mounted for movement relative to the support with mechanism carried by the sub-frame operative to sever the loop from a supply of wire and to connect its ends together, and means automatically operative for moving the sub-frame to and from the object.

45. A machine for banding an object, including a support for the object, a raceway to guide a wire into the form of a loop, a sub-frame mounted for movement relative to the support with mechanism carried by the sub-frame operative to sever the loop from a supply of wire and to connect its ends together, and automatically operative means for moving the sub-frame to and from the object in timed relation to the operation of said mechanism, the raceway being connected to the support and to the sub-frame and being deformable to permit said movement of the sub-frame.

46. A machine as defined in claim 43, wherein the sub-frame is also movable in a direction parallel to the plane of the support.

47. A machine for banding an object, including a support for the object, a raceway to guide a wire into the form of a loop, a sub-frame mounted for movement relative to the support with mechanism carried by the sub-frame operative to sever the loop from a supply of wire, to tension the loop about the object and to connect its ends, the sub-frame being mounted for movement in more than one direction.

48. A machine for banding an object, including a support for the object, a raceway connected to the support and formed to guide a wire into the form of a loop about the object, a sub-frame mounted on the support for movement relative thereto with mechanism carried by the sub-frame operative to sever the loop from a supply of wire and to connect its ends together, and means for causing said relative movement of the sub-frame automatically as a part of each banding cycle in the operation of the machine.

49. In a machine as defined in claim 43, said mechanism on the sub-frame including means to butt-weld the ends of the band together.

50. In a banding machine which includes means to form a loop on an end fed from a supply of wire, means to contract the loop about an object, means to sever the contracted loop from the supply, means to move the ends of the severed loop into abutting alignment, means to butt-weld said ends together, and a common source of power actuating said several means in a definite predetermined cycle.

51. In a machine which includes a raceway to form a loop on an end fed from a supply of wire and reversible rolls to feed the wire and contract the loop about an object, mechanism to sever the loop from the supply including a movable member and a guide for the wire extending substantially from the rolls to said member and movable with said member.

52. In a machine which includes a raceway and means to sever a loop from a supply of wire and to connect its ends about an object, rolls to feed the wire from the supply into the raceway, a magnetic clutch to drive the rolls, and power-driven switching means which energizes the

clutch and controls the rotation of the rolls intermittently in cycles.

53. In a banding machine which includes a raceway formed to guide an end of a supply of wire into a loop, electrically driven rolls to feed the wire into the raceway and reversible for contracting the loop, a retaining cover for the raceway mounted for movement in response to movement of the wire in the contracting loop and automatically operative switching means effecting the rotation and reversal of said rolls intermittently in cycles.

54. In a machine which includes mechanism arranged for feeding wire from a supply into a raceway curved to form the wire into a loop, means for extracting the wire from the raceway toward the space enclosed by it, and slidably mounted retaining means for resisting such extraction substantially continuously to maintain the wire under tension and contract the loop in a definite plane.

55. In combination, a raceway shaped to form a loop on the end of a wire, electrically driven rolls to feed the wire into the raceway and reversible to contract the loop by retracting a portion of the fed wire, and automatically operative switching means for effecting the forward rotation and reversal of the rolls intermittently in cycles.

56. In the combination defined in claim 55, means to sever the loop from the supply and means to butt-weld the ends of the loop together, the actuation of said severing means and butt-welding means being also controlled by said switching means.

57. In the combination defined in claim 55, means to sever the loop from the supply and means to butt-weld the ends of the loop together, wherein said switching means controls the duration of the welding operation.

58. In a machine as defined in claim 55, and which includes mechanism to sever a band from a supply and mechanism to butt-weld the band about an object, means for moving the severed end of the supply and the severed end of the band away from each other prior to the welding operation.

59. In a machine as defined in claim 55 which includes mechanism to sever a band from a supply of wire and butt-weld it about an object, means to move the severed end of the band away from the severing mechanism prior to the welding operation.

60. In a machine as defined in claim 50, means for deflecting the severed end of the supply away from the severed end of the loop prior to the welding operation.

61. In a machine which includes mechanism to sever a loop from a supply of wire and butt weld its ends together, means for moving the severed end of the loop into alignment with the other end and moving the severed end of the supply away from the severed end of the loop prior to the welding operation.

62. A machine for banding an object, including a support for the object, a raceway mounted to the support for guiding the end of a fed wire into loop form, and a sub-frame with means carried thereon adapted to connect the ends of the loop, said sub-frame being mounted to the support for movement to and from the object.

63. In a machine as defined by claim 36, means for deflecting one of the severed ends of the band from the other severed end to prevent a short circuit during the welding operation.

64. In a banding machine, a frame including a platform to support an object to be banded, and mechanism including means to feed a wire into the form of a loop with grippers engaging the loop adjacent its terminals and relatively movable to tension the loop about the object and align its terminals in abutting relation, and means for butt-welding the aligned terminals, together with a sub-frame which carries said mechanism and which is guided for bodily movement on the frame to bring a portion of the loop adjacent the plane of the platform during the tensioning and welding operations.

65. In a machine which includes a raceway and means to sever a loop from a supply of wire and to connect its ends together, rolls to feed the wire from the supply into the raceway, means to guide the wire between the rolls and the severing means, a magnetic clutch to drive the rolls, and power-driven switching means which energizes the clutch and controls the rotation of the rolls intermittently in cycles.

66. In combination, a raceway curved to form a loop on the end of a fed strand of wire, a support for an object, said raceway being fixedly mounted upon said support, a sub-frame mounted upon the support for movement relative thereto, and means carried by the sub-frame operative to tension and secure the loop about an object, a portion of the raceway being connected directly to said movable sub-frame.

67. The combination defined by claim 66, wherein the raceway includes a flexible portion to permit the movement of the sub-frame relative to the support.

68. The combination defined by claim 66, wherein the raceway includes a pivoted portion to permit the movement of the sub-frame relative to the support.

69. The combination defined by claim 66, wherein the raceway includes a portion slidably engaging the adjacent portion of the raceway to permit the movement of the sub-frame relative to the support.

70. The combination defined by claim 66, wherein the raceway is deformable to permit the movement of the sub-frame relative to the support.

71. In a banding machine, means to feed a wire, means to guide the wire into loop form, means for contracting the loop in a definite plane, grippers to engage the loop adjacent its ends, means to move the grippers to tension the loop and align its ends in abutting relation, means to butt-weld the aligned ends together, and power driven means to effect the actuation of all said means and the grippers as part of an automatic banding cycle.

72. In a banding machine, means to feed and guide a wire into loop form, means to sever the loop from a supply, and butt-welding means including two pairs of jaws wherein one of each pair has teeth to indent the wire and the other of each pair is smooth to form an electrical conducting contact with the wire, together with power driven means for effecting the actuation of the wire feeding means and the wire severing means and the energization of the butt-welding means as part of an automatic banding cycle.

73. In a banding machine, means to feed and guide a wire into loop form, means to sever the loop from the supply, and butt-welding means including two pairs of jaws to engage the wire adjacent its ends wherein each pair comprises a toothed jaw to indent the wire and a smooth

jaw to form an electrical conducting contact with the wire, together with electrically driven power means and automatic switching means operated thereby to control the actuation of the wire feeding means, the wire severing means and said butt-welding means to join the ends of the loop.

74. In a machine for tensioning a band about an object, a support for the object and tensioning mechanism yieldably mounted on the support for movement in response to tension applied to the band.

75. The machine defined by claim 74 wherein the yieldably mounted mechanism includes means anchoring one end of the band for equalizing the applied tension in both ends of the band.

76. The machine defined by claim 74 wherein the yieldably mounted mechanism includes gripping means engaging one end of the band and movement of the mechanism is opposed by tension exerted in the opposite end of the band.

77. In a machine which includes a raceway for guiding an end fed from a supply of wire, a cover for the raceway slidable transversely thereof and normally closed to retain the fed wire in said raceway, said cover being adapted to yield in engagement with the wire and thus serving to resist extraction of said wire from the raceway.

78. In a banding machine, a support for an

object, a sub-frame, means carried thereby to tension and connect a band about the object, and means mounting the sub-frame on the support which permits relative movement between the object and the sub-frame during tensioning of the band.

79. In combination, means to fit a band on an object, means to weld the ends of the fitted band together, and automatic electric switching means to control said fitting and welding means as part of a banding cycle.

80. In combination, rolls to feed a band from a supply source, means to sever the fed band from the supply, means to fit the severed band on an object, means to weld the fitted band about the object, means to grip and hold the fitted band during the welding thereof, said gripping and welding means being mounted for movement to and from the object as steps in the cycle of operation to facilitate the application of a tight fitting band.

81. In combination, means to support an object, means to fit a band about the supported object, and means to weld the ends of the fitted band together, said welding means being mounted for movement to and from the object as steps in the application of the band.

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