

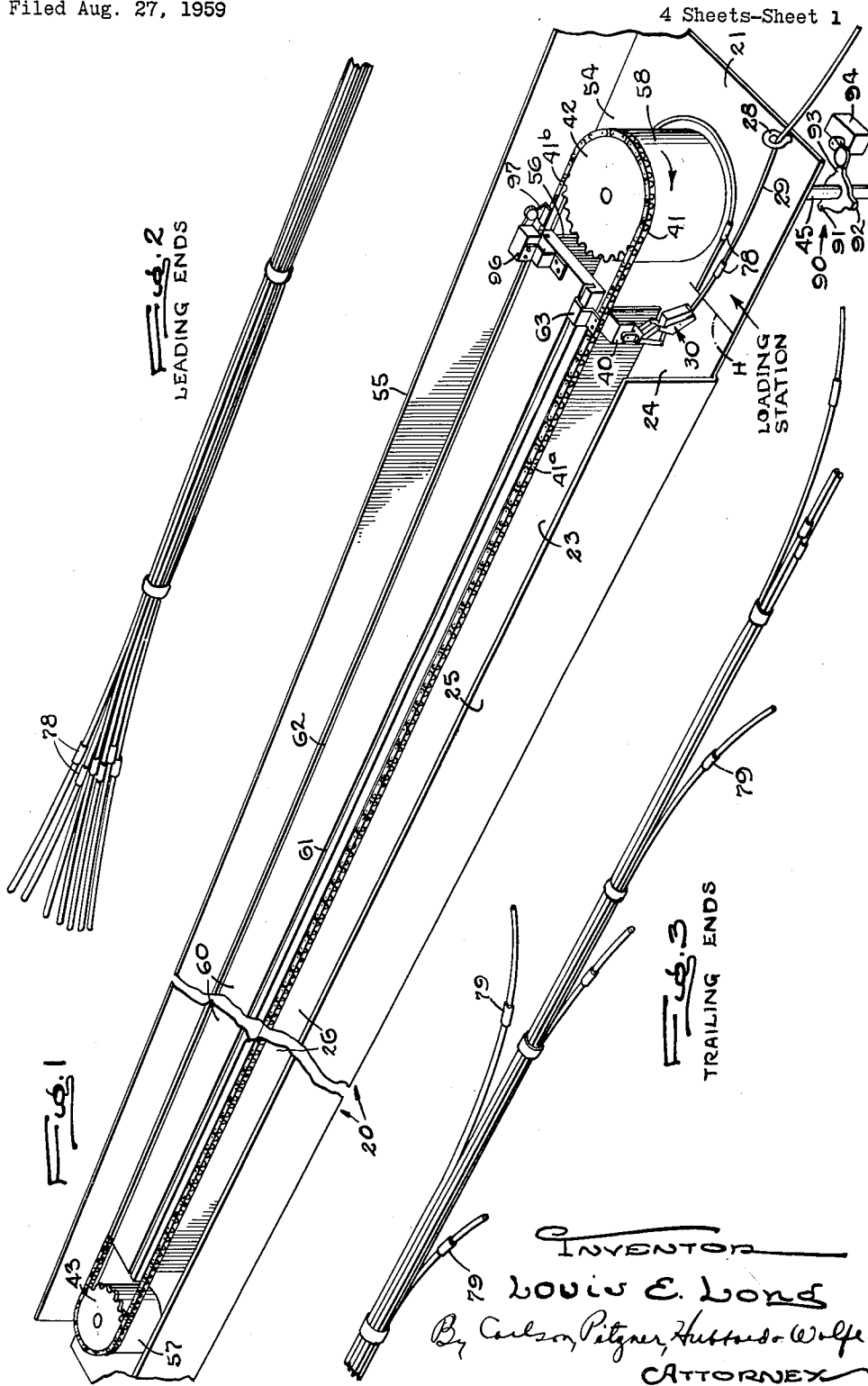
Feb. 6, 1962

L. E. LONG

3,019,915

APPARATUS FOR MAKING A WIRING HARNESS

Filed Aug. 27, 1959



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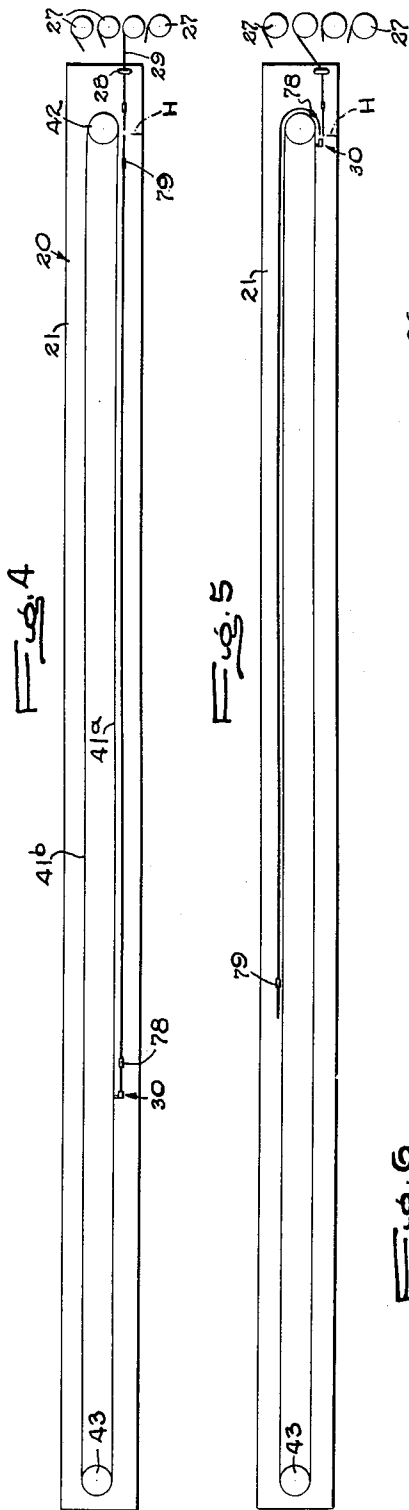
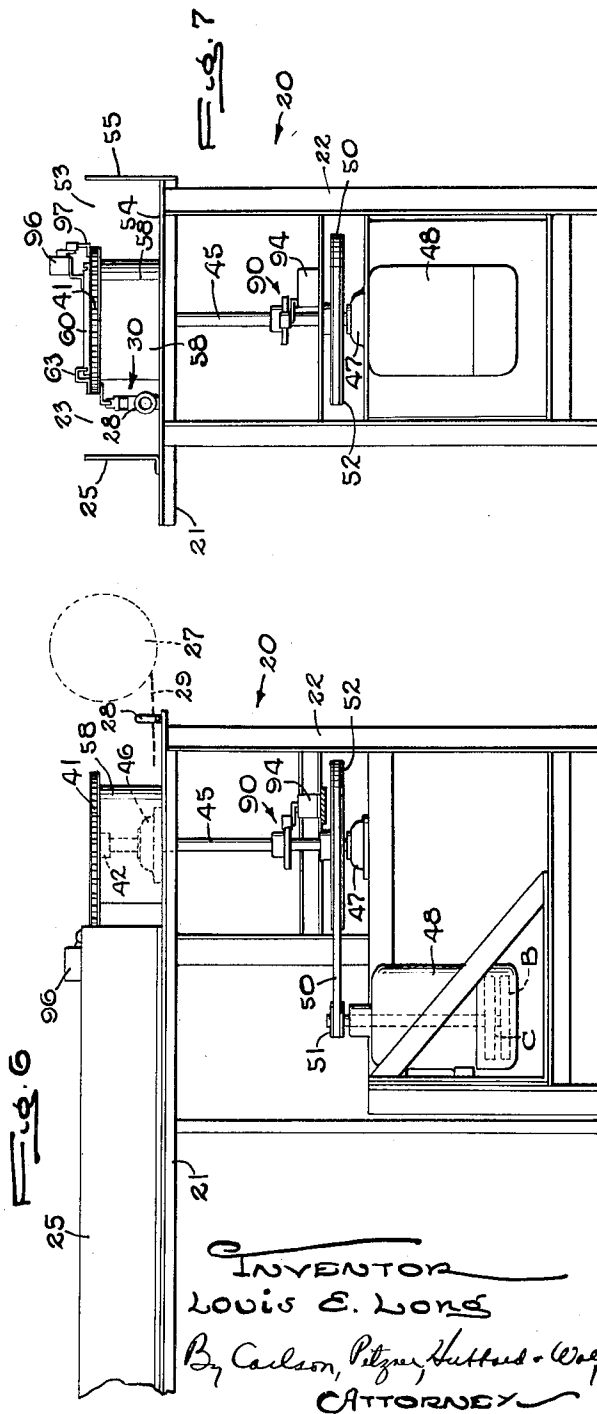
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APPARATUS FOR MAKING A WIRING HARNESS

Filed Aug. 27, 1959

4 Sheets-Sheet 2



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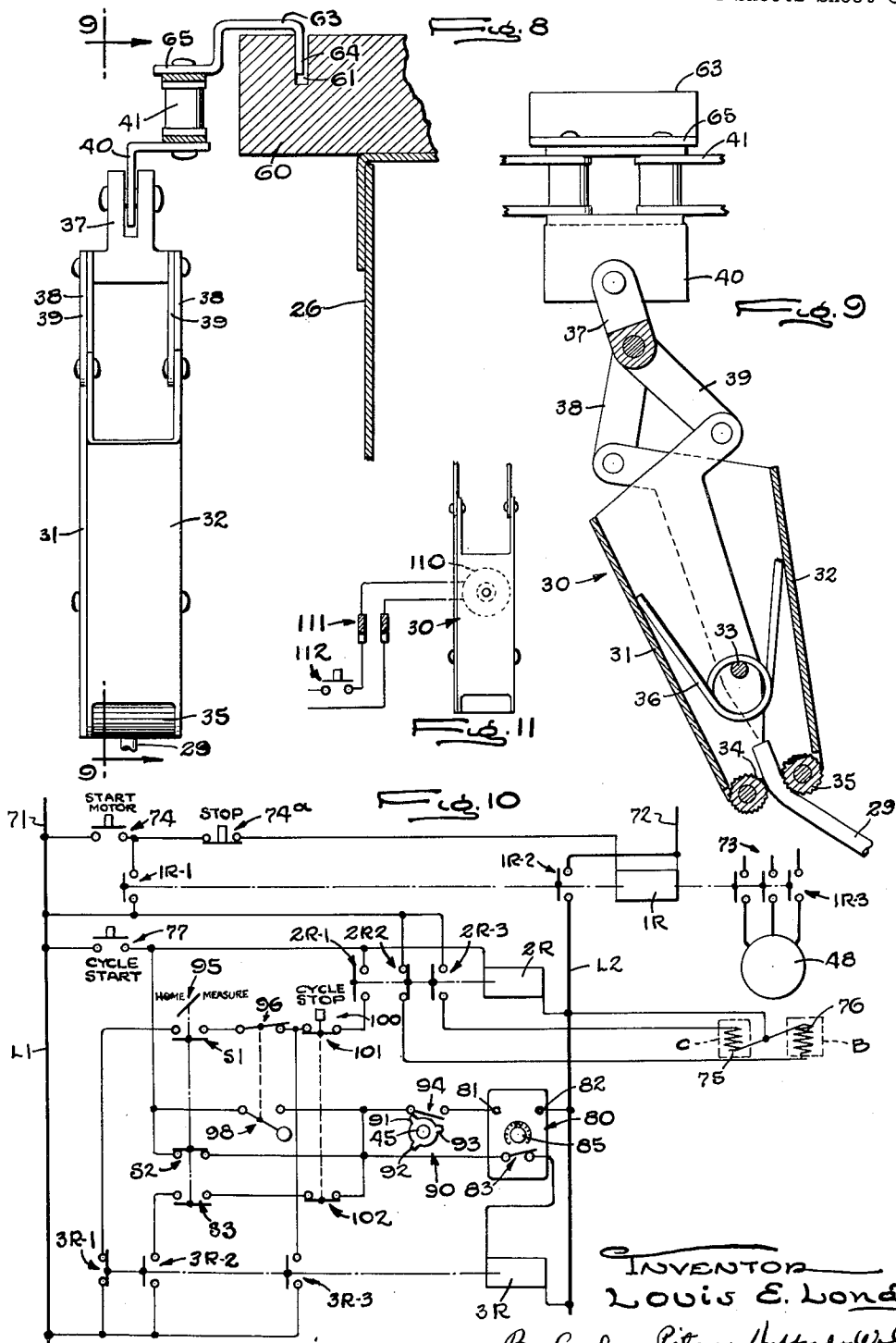
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APPARATUS FOR MAKING A WIRING HARNESS

Filed Aug. 27, 1959

4 Sheets-Sheet 3



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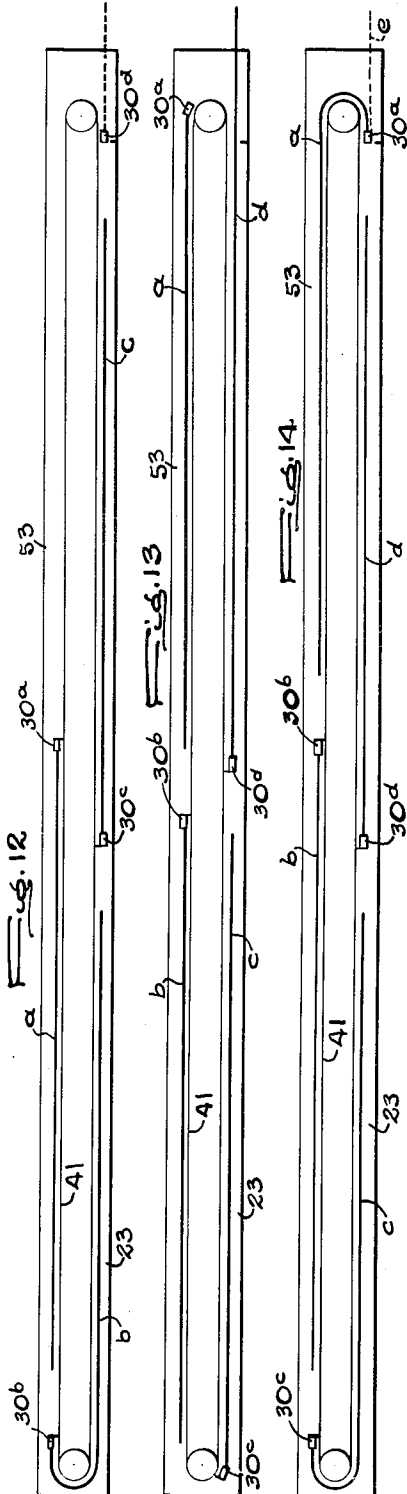
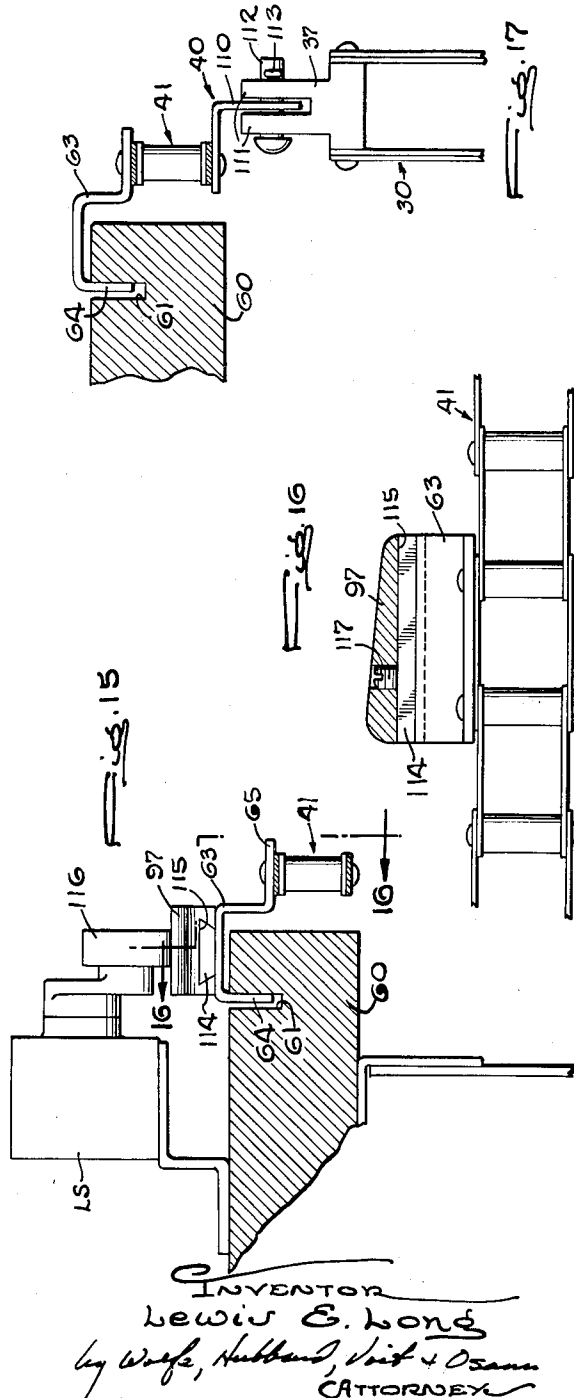
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APPARATUS FOR MAKING A WIRING HARNESS

Filed Aug. 27, 1959

4 Sheets-Sheet 4



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3,019,915

APPARATUS FOR MAKING A WIRING HARNESS
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 Filed Aug. 27, 1959, Ser. No. 836,445
 12 Claims. (Cl. 214-1.1)

The present invention relates to a procedure and apparatus for making wiring harnesses for use in electric control circuits and the like.

In the controlling of machine tools either remotely or semi-remotely from a control station, it is necessary to run a cable of control wires from the control station to relays and other control elements on a centrally located switch board. Conventionally, the cable is made manually in the form of a harness, with the wires, which may be tagged or color coded for identification, being laid out in predetermined lengths and bound or taped together at intervals. When the lengths are long and the number of wires large, this is an operation which is laborious, expensive and time-consuming.

Accordingly, it is an object to provide a novel procedure and apparatus which enables wiring harnesses to be made more economically and rapidly than has been possible in the past. It is another object to provide a harness making machine which may be operated at high speed by an operator without fatigue and with the operations limited to such duties as setting of the controls for causing the wires to be automatically measured, the cutting of the wire after it has been payed out, and the binding of the wires at spaced intervals, so that the complete harness is formed without necessity for the operator's leaving the loading station.

It is an object of the present invention to provide an improved apparatus for making a harness which is compact, requiring only a fraction of the space previously required for this purpose.

In one of its more detailed aspects, it is an object of the present invention to provide a control arrangement in association with a harness making machine which causes the operations to be carried out on a semi-automatic basis requiring a minimum of manipulation and a minimum of decisions on the part of the operator. In the preferred embodiment, it is sufficient for the operator to dial the desired length on the measuring control and to operate push-buttons to initiate the automatic measuring of the wire as well as the automatic homing of the transport mechanism to the start position as required for the pulling of successive wires making up the harness.

Finally, it is an object of the invention to provide a harness making machine which uses readily available, non-precision machine components which may be easily and cheaply constructed, and which requires no maintenance over long periods of time even with constant heavy usage. It is moreover an object to provide a harness making machine in which it is a simple matter to change the length or capacity of the machine from time to time as may be required in the handling of special jobs.

Other objects and advantages of the invention will become apparent upon reading the attached detailed description and upon reference to the drawings in which:

FIGURE 1 is a general perspective view, somewhat foreshortened, showing a harness making machine constructed in accordance with the present invention but omitting the lower frame and drive motor.

FIGS. 2 and 3 show the leading and trailing ends respectively of a harness made in the machine of FIG. 1.

FIG. 4 is a diagrammatic top view of the device shown in FIG. 1 showing the measuring out of a piece of wire and the severance of its trailing end from the supply.

FIG. 5 is a view similar to FIG. 4 showing the piece

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of wire pulled around to "home" position with its leading end at the loading station.

FIG. 6 is an elevation of the right hand portion of the device shown in FIG. 1 including the driving motor.

FIG. 7 is a right hand end view of the device shown in FIGS. 1 and 6.

FIG. 8 is a fragmentary elevation showing the wire gripper.

FIG. 9 is a sectional view taken along the line 9-9 in FIG. 8.

FIG. 10 shows the electric control circuit for the driving motor for effecting automatic measurement and homing at the loading station.

FIG. 11 is a diagram showing a gripper having provision for remote electrical release and suitable for certain specialized uses of the present device.

FIGS. 12, 13 and 14 are schematic plan views of a modified form of the invention.

FIG. 15 is a fragmentary transverse sectional view of the carrier for pulling out the wire as used in the modified form.

FIG. 16 is a fragmentary sectional view taken along the line 16-16 in FIG. 15.

FIG. 17 is a fragmentary transverse sectional view showing the manner of attaching a gripper in the modified form.

While the invention will be described in connection with certain preferred embodiments, it will be understood that I do not intend to be limited to the embodiments shown but intend to cover such other equivalent and alternative constructions as may be included within the spirit and scope of the appended claims.

Turning now to the drawings, and particularly to FIGS. 1, 6 and 7, there is shown a preferred device 20 for carrying out the present invention. It includes a frame having a horizontal portion 21 and a vertical portion 22. Arranged parallel to the forward edge of the horizontal portion of the frame 21 is a receptacle 23 having a bottom surface 24 on which the wire is deposited and an up-standing outer wall 25. This wall is arranged opposite an inner wall 26 so that the two walls and the bottom form a trough or channel. Preferably, the horizontal portion of the frame is securely cantilevered on the vertical portion, extending to the left in the present instance. The right hand end of the machine comprises a loading station having a supply of wire in continuous length wound on one or more reels 27 (FIG. 6) which may be located either remotely or adjacent the machine and supported for unreeling in any convenient way and entering the machine through a suitable guide 28.

For the purpose of pulling the leading end of the wire, indicated at 29, along the receptacle, a spring-engaged gripper 30 is provided having a pair of channel shaped sides 31, 32 centrally pivoted at a pivot 33 and having serrated tips 34, 35, the sides being pressed into gripping position by a spring 36. The gripper 30 is mounted on a carrier 40 by links 37, 38 and 39 as shown, so arranged that the greater the pull the greater is the gripping force. Nevertheless, applying light fingertip pressure to the sides of the gripper spreads the jaws for engagement of the leading end of the wire.

For transporting the gripper 30 down the length of the trough receptacle 23 an endless flexible transport member is provided to which the carrier 40 is secured, such member in the present instance being in the form of a flexible chain 41 having a front pass 41a and a rear pass 41b, the front pass being arranged above the receptacle and parallel to it. The chain 41 is trained about a driving sprocket 42 at its right hand end and an idler sprocket 43 at its left hand end. Turning attention to the driving sprocket 42, it will be noted (FIGS. 1 and 6) that it is

mounted on a shaft 45 journaled in suitable bearings 46, 47. For the purpose of driving the shaft 45, a motor 48 is mounted in the frame parallel to the shaft 45 and connected to it by a step-down driving connection comprising a belt 50 which is trained around a motor pulley 51 and a larger shaft pulley 52. It will be apparent that upon rotation of the motor and drive pulley 42 the gripper 30 draws the leading end 29 of the wire down the receptacle 23.

In accordance with one aspect of the present invention, the receptacle is in the form of a continuous "loop" which starts at the loading station and which returns to it so that the leading end 27 of the wire may be drawn "full circle" for disengagement at the loading station, whereby the leading ends of successive pieces of wire may all be deposited at the loading station in alinement with one another. Thus in the present instance, the elongated wire receptacle which begins along the front edge of the machine as indicated at 23, makes a U-turn at the idler sprocket 43 and continues along the back of the machine as indicated at 53. The portion of the receptacle 53 has a bottom surface 54 and side walls 55, 56 which are parallel to one another and parallel to the rear pass 41b of the chain 41. For guiding the wire "around the corner" a smooth cylindrical guiding surface is used. In the present instance this function is performed by a drum 57 which is integral with the sprocket 43 and which extends down to the bottom of the receptacle, such drum having a diameter which is approximately equal to the spacing between the inner walls 26, 56. A corresponding drum 58 (see FIGS. 1 and 6) is used at the driving sprocket 42.

In order to support and guide the front and back passes 41a, 41b of the chain 41 for prevention of sagging under load, a guide plate 60 is used which has lateral edges which extend parallel to the chain and which are formed with grooves 61, 62 respectively. For the purpose of engaging the grooves, a supporting bracket 63 is used which is of C-shape, having an inner end 64 which rides in the grooves and an outer end 65 which is secured to the chain 41 at the point of attachment of the carrier 40. Thus the weight of the wire pulling on the chain downwardly and backwardly is resisted and the chain is constrained to follow a desired path of movement. Since the guide plate 60 extends substantially the full length of the machine to positions closely adjacent the sprockets at each end, continuous support is assured. Moreover the close spacing between the guide plate and the sprockets insures that the guide 63 is accurately positioned for entering the mouths of the grooves 61, 62.

Further in accordance with the invention, means are provided for continuously measuring the movement of the leading end of the wire from the loading station so that the wire may be cut at the loading station after a predetermined and selected length of wire has been payed out, and for causing the wire to be additionally pulled, after it has been cut off, to a predetermined point in its path of movement. More specifically, the cut piece is drawn around so that its leading end is presented at the loading station, whereupon further driving by the motor is automatically terminated, permitting the gripper to be released for a subsequent cycle of operation, which operation is referred to for convenience herein as "homing."

In order to understand the control arrangement which permits the wire to be cut when of the desired length and which causes the leading end of the wire to be pulled additionally for homing back at the loading station, reference is made to the control circuit shown in FIG. 10. In this figure the supply terminals indicated at 71, 72 are associated with busses L1 and L2. For energizing the motor 48, a first relay 1R is provided having contacts 1R-3 for connecting the motor to a three phase supply line 73. In series with the motor starting relay 1R are start and stop buttons 74, 74a. In order to seal in the relay upon momentarily touching the start button 74,

sealing-in contacts 1R-1 are provided which are in parallel with the contacts of the start button. To energize the control bus L-2 at all times that the motor is running, contacts 1R-2 are used.

For the purpose of securing rapid and positive starting and stopping of the drive from the motor 48, the latter is provided with an integral clutch C and brake B having magnetic windings 75, 76 respectively. Motors employing integral clutches and brakes having separate windings are known in the art, and it will suffice to say that the motor output shaft turns only when the clutch is engaged, with the motor armature continuing to rotate constantly between operating cycles. When the clutch is disengaged, the brake is immediately applied in order to overcome the inertia of the driven system. In the present instance, a clutch-brake relay is provided for insuring that the clutch and brake are applied alternatively. This relay indicated at 2R has a set of clutch contacts 2R-3 and a set of brake contacts 2R-2 connected to the windings 76, 75 as shown. Since the contacts 2R-2 are normally closed, the brake remains engaged until the relay 2R is energized. To begin a cycle of operation, a cycle start button 77 is provided which is in series with the relay 2R. For sealing in the clutch-brake relay 2R while measurement of wire length is taking place, the relay 2R is provided with a set of normally open sealing-in contacts 2R-1. The circuit through which the sealing-in contacts are completed will be apparent as the discussion proceeds.

Prior to discussing the remainder of the control system, reference may be made to the measuring device, here in the form of a counter 80, which is constructed and arranged to be responsive to electrical impulses applied to input terminals 81, 82 for controlling a set of output contacts 83. Counting devices of this type are well known in the art and are sold, for example, under the trade name "Eagle, HN84." It will suffice to say that the unit 80 is provided with a settable control dial 85 which is, in the present instance, calibrated in terms of distance at the rate of one foot per impulse. The arrangement is such that after a predetermined number of impulses has been received at the input terminals 81, 82, the number being set by the control knob 85, the output contacts 83, which are normally closed, momentarily open. Such opening is employed to break the driving connection to the wire transport mechanism or chain so that no further wire is drawn from the supply.

In accordance with one of the more detailed aspects of the invention the counter 80 is made responsive to the length of wire which is payed out from the supply by connecting it to a repetitively operating switch which is closed once for each unit length payed out. In the present instance, this switch is in the form of a cam switch 90 including a cam mounted on the drive shaft 45 and having lobes 91-93 thereon which cooperate with a normally open switch element having contacts 94 arranged in series with the input terminals of the counter, the spacing of the cam lobes being such that the contacts are closed once for each foot of wire which is drawn from the loading station. It will, however, be apparent that where more exact measurement is necessary, additional cam lobes may be provided so that contact is made at more frequent intervals, for example, once for each inch of movement of the wire, and the control 85 may, accordingly, be calibrated in inches if desired. Using the foot as the unit of measurement will, at any rate, suffice to make the operation clear.

Having the operation of the counter 80 and the cam switch which controls it in mind, attention may again be directed to the control system shown in FIG. 10. For the purpose of dropping out the clutch-brake relay 2R after a given length of wire has been payed out, i.e., after a predetermined number of impulses has been received by the counter, a measuring relay 3R is included in the circuit of the counter contacts 83 as shown. Such

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relay includes contacts 3R-3 for holding the relay 2R sealed in, the contacts 3R-3 being arranged in series with the sealing contacts 2R-1 previously referred to.

In carrying out the invention a selector switch 95 referred to as a "measure-home" switch, is provided for conditioning the circuit for the two types of operation. Thus, assuming that the selector switch is in the "measure" position, it will be apparent that both of the relays 2R and 3R will be picked up via the contacts S2 on the switch when the cycle start button 77 is depressed. Moreover, both of the relays will be sealed in by means of their mutually interconnected sealing-in contacts 2R-1 and 3R-3 respectively. Assuming that the leading end 27 of the wire from the supply is gripped by the gripper 30, closure of the relays 2R, 3R initiated by the cycle start button 77 causes engagement of the clutch, disengagement of the brake, and rotation of the shaft 45 to which the cam switch 90 is coupled. The circuit of the contacts 94 of the cam switch are in parallel with the winding of the relay 3R; consequently, impulses are applied to the input terminals of the counter 80, stepping the same forwardly as the wire is payed out. The pay-out continues until impulses are received by the counter 80 to a total number corresponding to the length for which the control knob 85 has been set. When this occurs the output contacts 83 of the counter 80 momentarily open, thereby breaking the circuit to the measuring relay 3R. The sealing-in contacts 3R-3 then open, breaking the circuit to the relay 2R and causing the same to drop out. This serves to deenergize the clutch and energize the brake, terminating movement of the transport mechanism.

The stoppage of movement of the wire and transport mechanism, indicates to the operator that the desired length of wire has been payed out, whereupon the operator cuts the wire at the home reference mark, for example, that indicated at H at the loading station. Such cutting may be accomplished by manual means in the case of light gauge wire or, if desired, a guillotine type cutter, either manual or power operated, may be used.

In carrying out the invention, as previously stated, means are provided in the present device for causing the severed piece of wire to be additionally drawn back to the loading station where the gripper may be conveniently disconnected and reconnected to the leading end of the wire from the supply. Such homing is accomplished using the same mechanism as employed for pulling the wire out to proper length and by utilizing portions of the same control circuit shown in FIG. 10. Referring to such control circuit, means are provided for setting it up so that upon pressing the same cycle start button 77 additional movement of the drive shaft and chain occurs, with automatic shut-off when the homing position is reached. To accomplish this, a limit switch LS is provided having contacts 96 and which is engaged by a dog 97 secured in fixed position to the chain 41. The contacts of the limit switch are arranged in series with the sealing-in contacts of the clutch-brake relay 2R which controls the output of the motor 48.

As will be apparent from FIG. 10, movement of the switch to the "home" position disconnects the counter 80 by opening the contacts S2 and conditions the limit switch 96 for operation through closure of the contacts S1. Movement of the drive shaft, however, does not occur until the cycle start button is depressed, whereupon the relay 2R is energized causing the clutch to be engaged and the brake disengaged and causing the sealing-in contacts on the relay 2R to be closed. Such sealing-in contacts indicated at 2R-1 are completed through the limit switch contacts 96 and contacts S1 on the selector switch. The circuit is completed through normally closed contacts 3R-1 on relay 3R. The drive continues until the limit switch LS produces drop-out.

In sum, the selector switch 95 serves to condition the circuit for two types of operation, measuring and hom-

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ing. When in the "measure" position, the measuring or counting device 80, acting through the measure relay 3R provides a control or drop-out function to stop movement of the drive after the predetermined length of wire has been measured out. When the selector switch is in its opposite or "home" position, the counting device is out of the circuit and, instead, the limit switch contacts 96 are in the circuit so that when the drive is again started by pressing the cycle start button 77 the limit switch is made effective. When such switch is opened incident to the gripper reaching the loading station, relay 2R drops out disconnecting the motor driving connection.

Preferably, the limit switch LS is so arranged with respect to the dog 97 which controls it that the contacts are opened momentarily when engaged by the dog. That is to say, the limit switch is made "sensitive" so that the slight additional coasting movement of the chain upon disconnection of the drive, which may be on the order of a fraction of an inch, is sufficient to cause reclosure of the limit switch contacts 96. Since it is possible that the limit switch contacts may, under some circumstances, remain open when the gripper reaches the home position, auxiliary contacts 98 are provided in the limit switch, which contacts are closed whenever the regular limit switch contacts 96 are open.

Should it be desired to stop the cycle at any point, a stop button 100 is provided having normally closed contacts 101 and 102. The contacts 102 are in the circuit of the relay 3R and breaking of this circuit causes both the relays 3R and 2R to drop out, breaking the driving connection. Operation of the stop button later, during the homing portion of the cycle, causes opening of the contacts 101 serving to break the sealing-in circuit of the relay 2R to interrupt the drive. Regardless of whether the cycle is interrupted by pressing the button 100 during the measuring portion or the homing portion of the cycle, the effect is the same, immediate stoppage, and the cycle may be resumed at will simply by again pressing the cycle start button 77.

When it is desired to turn off the motor completely, as contrasted with simply controlling the output thereof through the clutch 75, the stop button 74a is pressed which breaks the sealing-in circuit of the relay 1R thereby opening the contacts 1R-2 and removing voltage from the bus L2.

For ready understanding, the device has been described above in terms of structure and function required to complete a single operating cycle in which the gripper 30 is transported from the loading station, stopped in an intermediate point in its path of movement, and then advanced or "homed" back to the loading station. As one of its aspects, the invention contemplates a novel method of forming a harness which may be practiced on the present machine but which is by no means limited to the present machine in the carrying out of the method steps. Briefly stated, in accordance with the invention, the method comprises the steps of gripping the leading end of a wire at its source, pulling the wire around a predetermined endless path until a selected length has been payed out, cutting the wire, and then continuing the pulling movement until the leading end of the severed piece of wire is brought to a predetermined point along the endless path, such predetermined point being, in the present instance, the loading station, where the grip is released, the steps being repeated for successive pieces of wire until a bundle is formed. Following this, the bundle is bound at spaced points without disturbing the relative positions of the component wires. In a narrower aspect it is a final step of the method to pull the entire bundle of wire intact about the endless path in order to facilitate binding the bundle at intervals without leaving the loading station.

The above method steps will be more fully appreciated by considering a typical operating cycle, reference

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being made to the diagrammatic FIGURES 4 and 5. It is assumed at the outset that the start button 74 has been depressed so that the motor is running idly, that the selector switch is in its "measure" position, and that the desired length has been "dialed in" on the setting knob 85. As a first step, the gripper 30 is connected to the leading end 27 of the wire from the supply. The wire may be fed from any one of a number of conveniently located reels 27 which carry wires of different color in continuous length and may be tagged for identification as indicated at 78. The cycle start button 77 is depressed which energizes the clutch 75 and conditions the counter 80 for operation. As the wire is payed out, "length" impulses are transmitted from the cam switch 90 to the counter 80, and after an amount of wire is payed out for which the counter is set, the output switch of the counter momentarily opens thereby dropping out relays 2R and 3R, which de-energizes the clutch and stops the transport mechanism with the piece of wire in the position shown in FIG. 4. At this point, the wire is cut at the source by any suitable means and the trailing end is tagged for identification as indicated at 79. The selector switch 95 is then moved to the "home" position which conditions the circuit for response to the limit switch LS. Pressing the cycle start button 77 causes the clutch C to be engaged so that the piece of wire, now separated from the source, is pulled additionally down the trough 23, and up the trough 53 until the gripper 30 is again at the loading station. Operation of the limit switch at this point causes the gripper to be stopped abruptly and accurately. The wire is then disconnected from the gripper and the gripper is attached to the tagged leading end of the wire from the source. The counter 80 is set for the second length of wire to be measured by turning its setting knob 85. The selector switch is restored to its "measure" position, following which the cycle start button 77 is depressed. After the measuring portion of the cycle is completed and the tail end of the wire is tagged, the selector switch 95 is again turned to the "home" position and the cycle start button 77 is again pressed to bring the leading end of the second piece of wire to the home position with its leading end deposited in alinement with the first piece. The cycle is completed for successive pieces of wire until the entire bundle is formed, with all of the leading ends being alined with one another. At this point the leading ends are bound or taped together, the selector switch is appropriately set, and the counting device is set for a length of, say, three feet. The gripper is applied to the leading end of the harness and when the cycle start button is pressed, the entire harness is drawn forwardly three feet. Thereupon the operator may apply the tape to the harness at the three foot position without having to leave the loading station. With the control on the counter set for three feet, the cycle start button is again pressed so that the harness is drawn forwardly an additional step where it is stopped automatically for the next application of tape. This process is repeated until the entire harness has been taped.

It will be apparent from the above that the device is extremely simple to operate, the making of the complete harness requiring only the manipulation of three simple controls and the cutting of the wire at the end of the measuring interval, without any necessity for operator to leave the loading station. Consequently, physical effort is greatly reduced. Moreover, the speed of the driving motor may be made just as fast as desired so that the time required for pulling out the wire may be reduced to a small fraction of that ordinarily required.

The length of the "closed loop" troughs may be made sufficiently great as to accommodate the longest piece of wire to be used. Where required for a special job, the capacity of the machine may be appropriately increased simply by putting extenders on the troughs, adding links to the chain, and moving the sprocket 43 farther out-

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board. However, an occasional length longer than the total loop can also be obtained by simply setting the counter to the proper length and operating as before, and even though the ends of the wire will overlap, the proper end is cut and the other end is then pulled to home position as before.

The invention has been described above in connection with a wiring harness in which the wires are all alined with one another at one end since most commercial harnesses are of this type. Indeed, accurate alinement is one of the features of the present device. It will be apparent, however, to one skilled in the art that the device is readily adaptable to the production of harnesses in which the wires are non-alined or staggered at each end. This may be accomplished by the simple expedient of employing two measuring cycles, the first to determine the length of the piece of wire and the second to determine the point within the closed loop receptacle at which the leading end of the piece is deposited. For example, a 6 foot length of wire might have its leading end deposited at a point 9 feet "down stream" from the loading station. This would require the setting of the counter 80 first for 6 feet and then for an additional 3 feet, the gripper then being disconnected prior to homing of the gripper to the loading station. To carry the example one step further, a second piece of wire may be measured for a length of 6 feet and the counter subsequently set for an additional 2 foot measuring cycle causing the leading end of the wire to be deposited at the 8 foot position. This would, in this simple example, cause the two pieces of wire to be offset 1 foot at both the leading and trailing ends and, using the same procedure, additional wires could be added and the bundle taped together into harness without disturbing the relative axial positions of the wires.

Using the machine to produce a harness of the above type would require the operator to leave his control station for releasing the gripper from the leading end of a wire deposited at some "down stream" point in the troughs 23, 53. In this connection, access to both of the troughs is easy because of the narrow and compact construction of the machine. Obviously, it would not constitute a departure from the present invention to provide for remote operation of the gripper as, for example, by providing a manual gripper with suitable solenoid actuator 110, with a trolley electrical connection 111 under the control of a push button 112 at the loading station as shown diagrammatically in FIG. 11. It is emphasized, however, that under normal conditions, and for maximum simplicity, resort to a remotely released gripper is not necessary.

When making wire harnesses where the individual wires are comparatively short, the efficiency of the machine can be improved by using a plurality of grippers 30. Such an arrangement is shown in FIGS. 12 through 17 in which four such grippers, 30a, 30b, 30c and 30d are used and are spaced equally along the chain 41. In this case, several lengths of wire are disposed at different positions along the receptacles or troughs 23 and 53.

FIGS. 12, 13 and 14 illustrate the manner in which a plurality of grippers 30 may be used. In FIG. 12, three lengths of wire a, b and c already have been cut and are held in the troughs 23 and 53 by grippers 30a, 30b and 30c while the fourth gripper 30d is at the "homing" position. At this time, the carrier 40 is dwelling and the operator attaches the end of the wire on the supply reel to the gripper 30d. Then the counter 80 is set for the length of the fourth wire, the switch 95 is set to the "measure" position and the cycle start button 77 is depressed. As in the preferred embodiment, this causes the carrier 41 to pull out the desired length of wire after which the carrier stops and the operator cuts the wire leaving a fourth wire piece d held by the gripper 30d.

Next, the switch 95 is set to the "homing" position and the button 77 is depressed again. Instead of bringing the

gripper 30d all the way around to the homing position as was the case with a single gripper, this brings the following gripper 30a to the homing position and merely advances the gripper 30d and the wire d is short way down the trough 23. At this point, the wire a is removed from the gripper 30a which then receives the end of the supply wire for the next wire length e and the cycle is repeated. With this arrangement, the idle time required to home is reduced materially, particularly where short wire lengths are being measured.

In order to permit the grippers to be used in different combinations and at different spacings, the grippers are arranged to be mounted detachably on the chain 41 so that they may be placed on the chain at intervals which are correlated to the lengths of wire to be measured. To this end, the link 37 (FIG. 17) connecting the gripper to the carrier 40 is bifurcated and receives an angle bracket 110 between the resulting legs 111. A beaded pin 112 projects through the legs and the bracket and is held in place by a cotter pin 113.

Where more than one gripper is employed, a dog 97 (FIG. 15) is associated with each gripper and its position along the chain 41 is correlated with the position of the corresponding gripper so as to trip the limit switch LS at the proper time to cause the gripper to stop at the homing position. The dogs, like the grippers, are detachably mounted on the chain so that both the grippers and the dogs may be positioned selectively on the chain. To this end, selected ones of the brackets 63 are formed with upwardly projecting dovetail slides 114 which receive the mating groove 115 on the underside of the dog 97. The latter engages the actuator 116 of the limit switch LS to stop the chain. A set screw 117 (FIG. 16) is threaded through the side of the block 116 and bears against the slide 114 to hold the dog in place.

This application is a continuation-in-part of my copending application Serial No. 654,930, filed April 24, 1957, now abandoned.

I claim as my invention:

1. A machine for forming a wire harness which comprises an endless flexible drawing member, means for supporting said flexible drawing member for movement about an endless path, controllable means for driving said drawing member intermittently along said path in steps of selectively variable length, a loading station adjacent said endless path, a wire receptacle extending along said endless path, a source of wire at said loading station, means coupled to said drawing means for gripping the leading end of a wire fed from said source, means for measuring the amount of wire payed out from said source, presettable means coupled to said driving means for automatically stopping said leading end at a predetermined point in its path of movement so that it may be cut at said loading station to form a first piece of wire having a predetermined length, and means for causing the leading end of the first piece of wire to be drawn additionally along said path of movement and deposited at said loading station so that when successive pieces have been cut off they lie side by side in said receptacle for binding together into a harness.

2. In a machine for making a wiring harness, the combination comprising a loop receptacle for wire and having a loading station, pulling means arranged parallel to the loop receptacle and having means for gripping the leading end of a length of wire for pulling the same around said loop receptacle, driving means coupled to said pulling means, means including a measuring device coupled to said pulling means for measuring the length of wire pulled from the loading station and having a provision for conditioning the wire for cutting when a predetermined amount of wire has been measured, means including a limit switch for stopping said driving means upon arrival of the gripping means at the loading station, and means including a selector switch for selectively energizing the measuring means or the limit switch means.

3. In a machine for making a wiring harness, the combination comprising a loop receptacle for wiring and having a loading station, pulling means arranged parallel to the loop receptacle and having a gripper for gripping the leading end of a length of wire for pulling the same around said loop receptacle, driving means coupled to said pulling means, means including a measuring device coupled to said pulling means for measuring the length of wire pulled from the loading station by said gripper and having provision for stopping the driving means when a predetermined amount of wire has been measured, means including a limit switch for stopping said pulling means upon arrival of the gripper at the loading station, and means including a selector switch for energizing the measuring means when the gripper is at the loading station and for energizing the limit switch means after the measuring means has completed its function.

4. In a machine for making a wiring harness, the combination comprising a loop receptacle for wire and having a loading station, pulling means including a gripper for pulling a length of wire from said loading station around said loop receptacle, driving means for said pulling means, a settable counting device having input terminals and an output switch and so arranged that the output switch is actuated upon receipt by said counting device of a predetermined number of electrical impulses at said input terminals, means coupled to said driving means for sending electrical impulses to said counting device in direct proportion to the amount of movement of the gripper from the loading station, and means actuated by the output switch of said counting device for disabling said driving means so that the pulling means and the gripper thereon is stopped automatically incident to the pulling out of a predetermined length of wire from said loading station.

5. The combination of, an endless carrier, means supporting said carrier in the form of an elongated loop, a gripper on said carrier for engaging and holding the leading end of a wire and drawing the same from a source of supply during the travel of said carrier, a receptacle for supporting a length of wire behind said gripper, a power operator for driving said carrier intermittently in steps of selectively variable length, means for initiating operation of said operator selectively in measuring and homing cycles, a measuring device driven in unison with said carrier and selectively adjustable for different lengths of wire, said device operating to stop said operator after the selected length of wire has been drawn from the supply in said measuring cycle, and means operable during a homing cycle to stop said operator when said gripper, after traveling around said loop, has returned the leading wire end to a predetermined position.

6. The combination of, an endless carrier, means supporting said carrier in the form of an elongated loop, a gripper on said carrier for engaging and holding the leading end of a wire and drawing the same from a source of supply during turning movement of said carrier, a receptacle for supporting a length of wire behind said gripper, a power operator for driving said carrier intermittently in steps of selectively variable length, means for initiating operation of said operator in successive measuring and homing cycles, a measuring device driven in unison with said carrier and selectively adjustable for different lengths of travel of the carrier, said device operating to stop said operator after a preselected length of wire has been drawn from the supply in said measuring cycle, and means coacting with said device for stopping said operator to terminate said homing cycle when said gripper, after traveling around said loop, has returned the leading wire end to a position predetermined by the setting of said device.

7. The combination of, an endless carrier, means supporting said carrier in the form of an elongated loop between and above said shelves, a gripper on said carrier for engaging and holding the leading end of a wire and

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drawing the same from a source of supply during turning movement of said carrier, a receptacle for supporting a length of wire behind said gripper, a power operator for driving said carrier intermittently in steps of selectively variable length, two control members selectively operable to initiate operation of said operator in successive measuring and homing cycles, a device driven in unison with said carrier and selectively adjustable for different lengths of wire, said device operating to stop said operator after the selected length of wire has been drawn from the supply in a cycle initiated by one of said control members, and means controlled by said other control member for initiating a homing cycle of said operator and terminating such cycle when said gripper, after traveling around said loop, has returned the leading wire end to a predetermined position.

8. The combination of, two laterally spaced horizontal shelves, an endless carrier, means supporting said carrier in the form of an elongated loop between and above said shelves, one of said shelves defining a loading station and the other forming a storage receptacle, a gripper on said carrier for engaging and holding the leading end of a wire and drawing the same from a source of supply and along said shelves during movement of the carrier, a power operator for driving said carrier intermittently in steps of selectively variable length, first and second control members each operable when actuated to start said operator, a measuring device actuated in unison with said carrier and selectively adjustable for different lengths of wire said device operating to stop said operator after the selected length of wire has been drawn from the supply in response to operation of said first control member, and means operable in response to starting of said operator by said second control member to stop the operator when said gripper, after traveling around said loop, has returned the leading wire end to said loading station.

9. The combination of, two laterally spaced horizontal shelves, an endless carrier, sprockets rotatable about spaced upright axes and supporting said carrier in the form of an elongated loop between and above said shelves, one of said shelves defining a loading station and the other forming a storage receptacle, a gripper for engaging and holding the leading end of a wire and drawing the same from a source of supply and along said shelves during turning of said sprockets, a power operator for driving said carrier, first and second control members each operable when actuated to start said operator, a device driven in unison with said carrier and selectively adjustable for different lengths of wire, said device operating to stop said operator after the selected length of wire has been drawn from the supply in response to operation of said first control member, and means operable in response to starting of said operator by said second control member to stop the operator when said gripper, after traveling around said loop, has returned the leading wire end to a predetermined position.

10. The combination of, an endless carrier, means supporting said carrier in the form of an elongated loop, a plurality of grippers carried by and spaced around said carrier to be advanced successively away from a predetermined homing position, the gripper at said homing position being operable to engage and hold the leading end of a wire and draw the same from a source of supply

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during travel of said carrier, a power operator for driving said carrier, means for initiating operation of said operator selectively in measuring and homing cycles, a measuring device driven in unison with said carrier and selectively adjustable for different lengths of wire, said device operating during a measuring cycle to stop said operator after the selected length of wire has been drawn from said supply, and means operable during a homing cycle to stop said operator when the succeeding gripper reaches said homing position.

11. The combination of, an endless carrier, means supporting said carrier in the form of an elongated loop, a plurality of grippers carried by and spaced around said carrier to be advanced successively away from a predetermined homing position, the gripper at said homing position being operable to engage and hold the leading end of a wire and draw the same from a source of supply during travel of said carrier, a power operator for driving said carrier, means for initiating operation of said operator selectively in measuring and homing cycles, a measuring device driven in unison with said carrier and selectively adjustable for different lengths of wire, said device operating during a measuring cycle to stop said operator after the selected length of wire has been drawn from said supply, a controller having a stationary part disposed along the path of said carrier and operable when actuated to terminate the homing cycle of said operator, and a plurality of members, one for each of said grippers and each mounted on said carrier to engage said part and actuate said controller, each of said members being positioned on said carrier to stop the carrier with the corresponding gripper at said homing position.

12. The combination of, an endless carrier, means supporting said carrier in the form of an elongated loop, a plurality of grippers carried by and spaced around said carrier to be advanced successively away from a predetermined homing position, the gripper at said homing position being operable to engage and hold the leading end of a wire and draw the same from a source of supply during travel of said carrier, a power operator for driving said carrier, means for initiating operation of said operator selectively in measuring and homing cycles, a measuring device driven in unison with said carrier and selectively adjustable for different lengths of wire, said device operating during a measuring cycle to stop said operator after the selected length of wire has been drawn from said supply, a controller having a stationary part disposed along the path of said carrier and operable when actuated to terminate the homing cycle of said operator, a plurality of members, one for each of said grippers and each mounted on said carrier to engage said part and actuate said controller, each of said members being positioned on said carrier to stop the carrier with the corresponding gripper at said homing position, and means detachably supporting said grippers and said members on said carrier whereby selected numbers of each may be used and spaced apart selected distances to accommodate wires of different lengths.

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