May 22, 1962 W. D. BOHANNON, JR 3,035,395

WIRE WRAPPING MACHINE

Filed Dec. 30, 1959

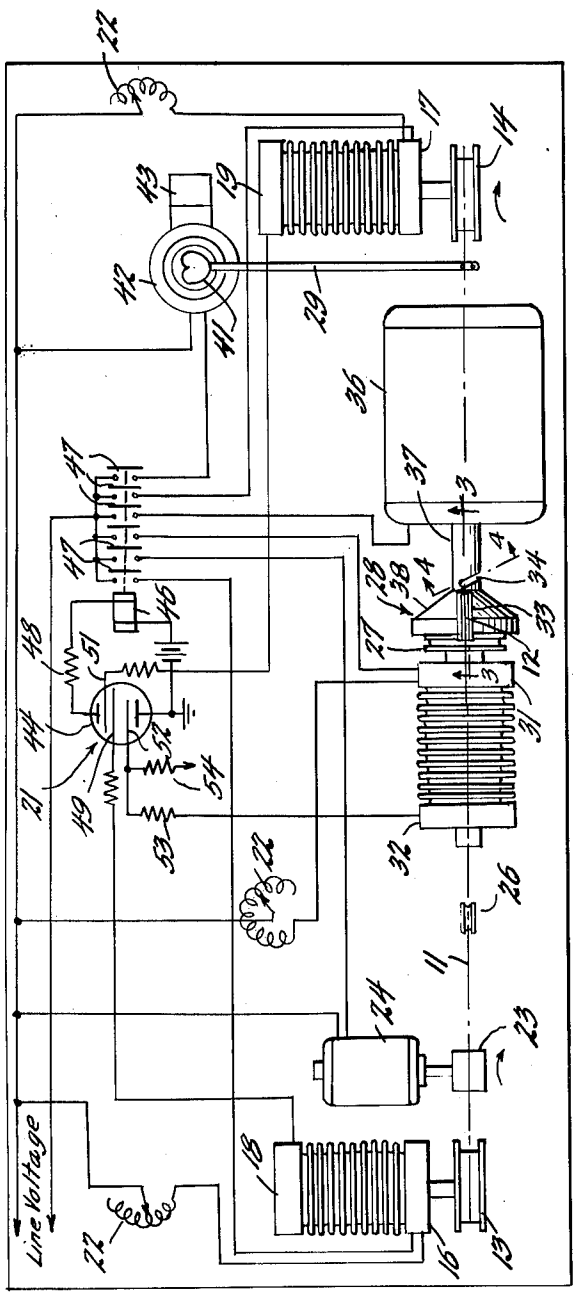


FIG. 1.

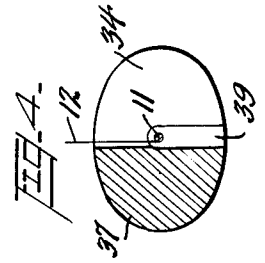


FIG. 4.

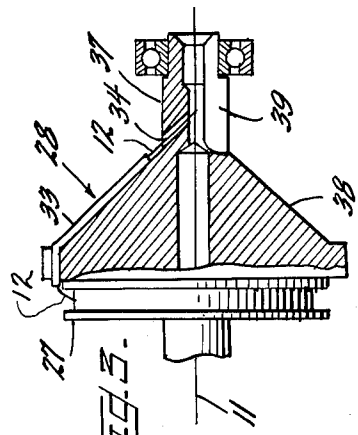


FIG. 3.

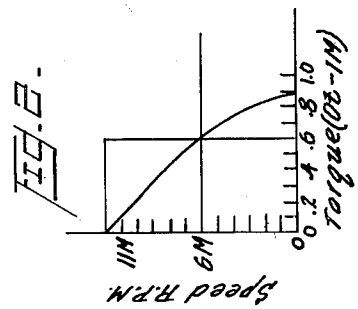


FIG. 2.

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WIRE WRAPPING MACHINE

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This invention relates to a wire wrapping machine and more particularly to a machine for applying a strand to a moving carrier wire in spiral convolutions.

An object of this invention is to wrap a strand about a continuously moving carrier wire.

A further object of this invention is to provide an improved winding head for applying a strand to a moving carrier wire.

Still another object of this invention is to provide a control system for stopping a wrapping machine upon the breaking or exhaustion of a strand being applied to a moving carrier wire.

Apparatus for accomplishing these and other objects may include motor-driven takeup and supply spools between which a carrier wire to be wrapped is passed at a constant speed and tension. The carrier wire passes through a torque motor-driven strand supply bobbin and a hollow winding head which is driven by a synchronous motor. The torque motor driving the bobbin is adjusted so that a constant tension is maintained in the strand as it is payed from the bobbin and through the winding head where it is laid onto the moving carrier wire in spiral convolutions. The torque motors driving the carrier wire supply and takeup spools and the bobbin each drive a generator, the output of which is connected to a control amplifier. The output of the generator driven by the bobbin motor is utilized to cause the amplifier to energize a relay connected thereto to stop the wrapping machine upon the breaking or exhaustion of the strand. The output of the generators driven by the torque motors driving the supply and takeup spools are utilized to stop the wrapping machine upon the breaking or exhaustion of the carrier wire.

Other objects and advantages will be apparent from the following detailed description when taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a plan view of a wire wrapping machine for applying a strand to a moving carrier wire together with an electrical control circuit embodying the principles of the invention;

FIG. 2 discloses the speed-torque characteristics of a torque motor used to drive a bobbin from which the strand is supplied;

FIG. 3 is an enlarged cross-sectional view taken along the line 3—3 in FIG. 1 showing a winding head and the manner in which the strand supplied from a bobbin is laid onto a carrier wire which passes through the hollow winding head; and

FIG. 4 is an enlarged cross-sectional view taken along the line 4—4 of FIG. 1 showing the relationship of slots formed in the winding head.

Referring now to FIG. 1, a carrier wire **11** about which a strand **12** is to be wrapped is passed between a payoff spool **13** and a takeup spool **14**. The payoff and takeup spools **13** and **14** are driven by high-speed torque motors **16** and **17**, respectively, which in turn drive generators **18** and **19** connected to a control amplifier **21**. The output voltages developed by the generators **18** and **19**, are a function of the respective motor speeds.

The torque motors **16** and **17** are each provided with an adjustable field winding **22** which is connected to a suitable source of line voltage. The torque motors **16** and **17** may be regulated by adjusting the control voltage in the field windings **22**.

The carrier wire **11** is looped about a capstan **23** which is driven by a synchronous motor **24** connected to a suitable line voltage. The torque motor **16** is driven so as to oppose rotation of the supply spool **14** and the capstan **23** draws the carrier wire **11** from the supply spool under tension. With this arrangement a constant tension is maintained in the carrier wire as the torque motor **17** drives the takeup spool **14** against the friction developed between the capstan **23** and the carrier wire **11** and the opposing force of torque motor **16**.

The carrier wire **11** also passes over a guide roller **26**, through a strand supply bobbin **27**, a winding head **28**, and a traversing or distributing arm **29** which lays the carrier wire **11** evenly on the takeup spool **14**. The carrier wire passes along the axis of rotation of both the bobbin **27** and the winding head **28**.

The strand supply bobbin **27** is driven by a torque motor **31** which also drives a generator **32**, the output of which is connected to the amplifier **21**. The voltage developed by the generator **32** is a function of the bobbin speed. The torque motor **31** is similar to the torque motors **16** and **17** and is provided with an adjustable field winding **22** which is connected to a suitable line voltage.

The strand **12**, which may be a flat, rectangular wire, is payed from the bobbin **27** through a tube-like channel or guide **33** secured to the winding head **28**, into a slot **34** formed in the winding head **28**. The slot **34** is formed at an angle of 45 degrees with the longitudinal axis of the winding head **28** which is driven by a synchronous motor **36** energized from a suitable source of line voltage. The motor **36** is mounted coaxially with the winding head **28** and is provided with a hollow drive shaft through which the carrier wire **11** passes.

Referring to FIG. 3, a detailed view of the winding head **28** is shown. The winding head **28** comprises a shaft **37** having a longitudinal bore therethrough which is an extension of the hollow drive shaft (not shown) of the motor **36**. The carrier wire **11** passes through the bore of the shaft **37** and on the longitudinal axis of the winding head **28**. A conical end portion **38** formed on the shaft **37** is adjacent the bobbin **27**. The tube-like channel guide **33** secured to the conical end portion **38** of the shaft **37** extends above the bobbin **27** to receive the strand **12** as it is payed off.

The channel **33** directs the strand **12** into the slot **34** in the hollow shaft **37**. The slot **34** is cut to a depth beyond the center of the hollow shaft **37**, as shown in FIG. 4, to provide the necessary clearance so that the strand **12** may pass around the carrier wire **11** within the winding head **28**. The strand **12** rests against the bottom of the slot **34** as it approaches the center of the shaft **37**. This action provides sufficient back pressure to prevent bowing in the strand **12**. This back pressure or drag keeps the strand **12** flat and at the desired wrapping angle of 45 degrees with the longitudinal axis of the shaft

37. Thus the strand 12 is evenly wrapped along the length of the carrier wire 11 at an angle of 45 degrees.

The shaft 37 is also provided with an additional slot 39 cut along a portion of the length thereof. The slot 39 opens into the bore of the shaft 37 and the slot 34. This construction permits the carrier wire 11 to be easily threaded through the winding head 28 and the strand 12 to be wrapped around the carrier wire 11 when starting the wrapping operation.

Upon leaving the winding head 28 the spirally wrapped carrier wire 11 is taken up on the spool 14. The carrier wire 11 is guided onto the takeup spool 14 in even layers by the distributing arm 29 which is reciprocated by a heart-shaped cam 41 driven by a motor 42. A register 43 actuated by the cam-actuated distributing arm 29 is provided to record the amount of carrier wire taken up on the spool 14.

As stated, the control amplifier 21 receives the output of the generators 18, 19, and 32. The amplifier 21 may be a conventional vacuum tube-type amplifier and comprises a vacuum tube 44 having a suitable plate voltage. A relay 46 for opening normally closed contacts 47, as well as a suitable load resistor 48, is also connected in the plate circuit of the tube 44. The generators 18 and 19 are connected to control grids 49 and 51 of the tube 44 while the generator 32 is connected to a control grid 52 of the tube 44 across a resistor 53. The resistor 53 and a grid-leak resistor 54 are chosen so that the tube 44 will conduct to energize the relay 46 only when the output of either of the generators 18, 19, or 32 exceeds a predetermined value.

The output voltage of the generator 32 is a function of the speed of the bobbin 27, both being driven by the torque motor 31. The torque motor 31 is connected to the synchronous motor 36 by means of the strand 12 which is payed from the bobbin 27 to the winding head 28. Initially the control voltage of the torque motor 31 is set so that the tension developed in the strand 12 under stalled conditions, for instance as will occur in starting, will not break the strand 12. This, of course, may be varied depending upon the type of strand being wrapped. The tension in the strand 12 may be varied by adjusting the field winding 22 of the torque motor 31.

Referring to FIG. 2, the speed-torque characteristic curve of a typical torque motor suitable for driving the strand supply bobbin 27 and the payoff and takeup spools 13 and 14 is shown. The motor torque is expressed in ounce-inches, the inches in this case referring to the radius of the bobbin utilized per ounce of tension to be developed in the strand. As the torque decreases the speed of the motor 31 increases. This occurs when the tension in the strand 12 decreases, such as when the strand 12 breaks. The torque motor 31 cannot reach the same speed as the motor 36 so long as the strand 12 links the two motors because of the drag in pulling the strand 12 from the bobbin 27.

Upon exhaustion of or the breaking of the strand 12, the motors 31 and 36 will no longer be connected and the torque of the motor 31 will fall off toward zero. As shown in FIG. 2, the speed of the torque motor 31 will rapidly increase when this occurs. This in turn will increase the output of the generator 32 causing the tube 44 to conduct to energize the relay 46. The tube 44 may be biased so as to conduct when the voltage of the generator 32 reaches any desired value. The torque motors 16 and 17 operate in a similar fashion when the carrier wire 11 breaks or is exhausted. In such event either of the motors 16 or 17 will rapidly increase their respective speed when the torque of that machine falls toward zero. This in turn increases the output of the generators 18 or 19 to cause the tube 44 to conduct and energize the relay 46.

The torque motors 16, 17 and 31, the synchronous motors 24 and 36, and the motor 42 are each connected to a suitable line voltage through one of the normally closed contacts 47. Upon energization of the relay 46, the contacts 47 will be opened to disconnect the respective units from the line voltage and thus stop the wrapping machine.

Operation

In starting the wrapping machine, the carrier wire 11 is first wrapped around the capstan 23, threaded through the bobbin 27, winding head 28, and traverse arm 29, and attached to the takeup spool 14. The strand 12 is passed through the guide 33 and the slot 34 in the shaft 37. A few turns of the strand 12 around the carrier wire 11 are made to connect the strand thereto. The torque motor 31 is started first and rotates in a direction opposite to the convolutions of the strand 12 on the bobbin 27, but it installs against tension in the strand 12 which is held firmly against the carrier wire 11 at an angle of 45 degrees by the winding head 28. The synchronous motors 24 and 36 and the torque motors 16 and 17 are then started. The motor 36 rotates the winding head 28 in the same direction as the bobbin 27 is rotated. As the carrier wire 11 reaches normal running speed, the synchronous motor 36 quickly accelerates. The torque motor 31 responds to the resulting relief of tension in the strand 12 and rapidly reaches the desired operating speed. The drawing of the strand 12 from the bobbin 27 prevents it from rotating as fast as the winding head 28. Thus the torque motor 31 does not reach or overrun the synchronous motor as long as the motors are linked by the strand 12. The bobbin rotates at a slower speed than the winding head 28. The desired tension is maintained in the strand 12 by adjusting the winding 22 of the torque motor 31.

Upon the exhaustion or breaking of the strand 12, the torque of motor 31 will fall off toward zero and torque motor 31 will speed up causing the amplifier 44 to energize the relay 46 and stop all of the motors. If the carrier wire 11 should break either of the motors 16 or 17 will overdrive their respective generators 18 or 19 to cause the amplifier 44 to conduct and stop all of the motors.

It will be understood that the above-described arrangement of circuits and apparatus together with the construction of elemental parts is simply illustrative of an application of the principles of the invention, and many other modifications may be made without departing from the scope of the invention.

What is claimed is:

1. A wire wrapping machine for applying a strand to a moving carrier wire comprising a strand supply bobbin mounted coaxially with the moving wire, a winding head mounted coaxially with the carrier wire and adjacent the strand supply bobbin for receiving the strand from said bobbin and wrapping the strand around said carrier wire, means for driving the bobbin, means for driving the winding head at a faster rate of speed than the bobbin so as to maintain a constant tension in the strand as it is applied to the carrier wire by the winding head, and means controlled by the bobbin driving means for interrupting said bobbin and winding head driving means when the tension in the strand falls below a predetermined amount.

2. A wire wrapping machine for applying a strand to a moving carrier wire which comprises means for advancing a carrier wire, a strand supply bobbin mounted coaxially with the carrier wire, a torque motor for driving the bobbin, a generator driven by said torque motor for producing a voltage which is a function of the speed of the supply bobbin, a winding head mounted coaxially with the carrier wire and adjacent the strand supply bobbin for receiving the strand from said bobbin and wrapping the strand around the carrier wire, a synchronous motor for driving the winding head to withdraw the strand under tension, means for adjusting the torque motor to vary the tension in the strand, and means responsive to the voltage produced by the generator when the strand breaks for stopping the carrier wire advancing means.

3. A serving head for applying a strand to a moving carrier wire which comprises a cylindrical shaft having a longitudinal bore therein mounted coaxially with the mov-

ing wire, a conical end portion formed on the shaft, a strand channel guide secured to the face of the conical portion of the shaft and extending along the longitudinal axis thereof for receiving a strand to be wrapped about the moving carrier wire, the cylindrical shaft having a slot therein which begins at the point where the conical portion of the shaft begins on the cylindrical shaft, the slot extending at an angle of 45 degrees to the longitudinal axis of the shaft and more than 180 degrees around the circumference of the shaft, said slot being cut to a depth beyond the longitudinal axis of the shaft, a motor connected to the shaft for rotating said shaft whereby the strand is pulled through the channel guide and along the bottom of the slot where it is applied to the moving carrier wire at an angle of 45 degrees therewith when the serving head is rotated.

4. A winding head for applying a strand to a moving carrier wire from an independently driven strand supply bobbin mounted coaxially with the carrier wire which comprises a hollow, cylindrical shaft mounted coaxially with the carrier wire, said shaft having a conical-shaped end portion adjacent the strand supply bobbin, a channel guide secured to said conical end portion of the shaft and extending above the supply bobbin to receive the strand as it is payed from the strand supply bobbin, the cylindrical portion of the hollow shaft having a slot therein at an angle of 45 degrees with respect to the longitudinal axis of the shaft for guiding the strand onto the moving carrier wire as it passes along the longitudinal axis of said shaft, and a motor connected to said shaft for rotating the shaft to wrap the strand about the moving carrier wire at an angle of 45 degrees with respect to the carrier wire.

5. In a wire wrapping apparatus, a bobbin for supporting convolutions of strand material, said bobbin having an axial bore, means for supporting a supply of wire, means for advancing a wire through said axial bore, a wrapping unit comprising a shaft flaring into a conical head at one end thereof, means for mounting said head to position the base of the conical head next to a side of said bobbin, said shaft being provided with an axial bore to receive the wire, a guide extending along the side of said conical head for receiving the strand, said shaft having a slot formed therein to extend at a 45-degree angle with respect to the axis of the shaft for receiving the strand emanating from the guide, said slot extending beyond the axis of the shaft and intersecting the axial bore in said shaft, a torque motor for urging the bobbin to rotate in a direction opposite to the direction that the convolutions of strand are laid on the bobbin, means for rotating the wrapping unit in the same direction as the bobbin to unwind the strand from the bobbin to permit the torque motor to rotate the bobbin, and means rendered effective by the breaking of the strand and the speeding up of the torque motor for interrupting said rotating means.

6. Wire handling apparatus for maintaining a constant tension in a wire as it passes between a takeup spool and a wire supply spool which comprises a first torque motor for opposing rotation of the wire supply spool, a generator driven by the first torque motor, the output voltage of which is a function of the speed of the first torque motor, a capstan disposed between the wire supply and takeup spools, the wire being looped about said capstan, a synchronous motor for driving the capstan at a constant speed to draw the wire from the supply spool under tension, a second torque motor for driving the takeup spool against the tension in the wire resulting from the friction between the capstan and the wire and the effect of the first torque motor, the tension in the wire acting as a load on the second torque motor, means for adjusting the first and second torque motors to maintain the desired tension in the wire, a generator driven by the second motor for producing a signal voltage which is a function of the speed of the second torque motor, an

amplifier for receiving the voltages produced by the generators which is biased so as to conduct only when the generator voltages rise above a preselected value as determined by the tension in the wire, and relay means connected to said amplifier for stopping the wire handling apparatus when the wire breaks to remove the load on the second torque motor.

7. A wire wrapping machine for applying a tensioned strand to a moving carrier wire which comprises means for advancing a carrier wire, a strand supply bobbin mounted coaxially with the carrier wire, a first means for driving the bobbin, a generator driven by said first driving means for producing a voltage proportional to the speed of said first driving means, means for receiving a strand from said bobbin and for wrapping the strand around the carrier wire, a second means for driving said receiving and wrapping means relative to said bobbin to withdraw the strand from said bobbin under tension, and means responsive to the voltage produced by the generator for stopping the carrier wire advancing means when the tension in the strand falls below a predetermined amount.

8. A wire wrapping machine for applying a strand to a moving carrier wire which comprises means for advancing the carrier wire, a strand supply bobbin mounted coaxially with the carrier wire, a motor for rotating the bobbin, a generator driven by said motor which produces a voltage output proportional to the speed of said motor, a wrapping unit mounted adjacent said bobbin and connected to said bobbin by said strand, means for rotating said wrapping unit in the same direction as said bobbin to wrap the strand on said wire, and means responsive to the voltage from said generator for stopping the advancing means when the strand breaks and releases the connection between the bobbin and said wrapping unit.

9. A wire wrapping machine for applying a strand to a carrier wire which is moving from a supply spool to a takeup spool which comprises a first means for driving said supply spool, a first generator driven by said first means, a second means for driving said takeup spool, a second generator driven by said second driving means, a strand supply bobbin mounted coaxially with the carrier wire, a third means for driving said bobbin, a third generator driven by said third driving means, a wrapping unit mounted adjacent said bobbin and coaxially with the carrier wire for receiving the strand from said bobbin and wrapping the strand around the carrier wire, a fourth means for driving the wrapping unit to withdraw the strand from the bobbin, and means rendered effective when the strand or wire breaks and responsive to the voltage produced by the first, second, and third generators for stopping the first, second, third and fourth driving means.

10. A wire wrapping machine for applying a strand to a carrier wire which comprises means for advancing the carrier wire, a strand supply bobbin mounted coaxially with the carrier wire, a first motor for driving the bobbin, a generator driven by said first motor for producing a voltage proportional to the speed of said first motor, a wrapping unit for receiving a strand from said bobbin and for wrapping the strand around the carrier wire, a second motor for driving said wrapping unit at a faster speed than said bobbin to tension the strand, means for adjusting the first motor to vary the tension in the strand, and means responsive to the voltage produced by the generator when the tension in the strand falls below a predetermined value for stopping the advancing means.

11. A wire wrapping machine for applying a strand to a carrier wire which is passed between a supply spool and a takeup spool which comprises a first motor for driving said supply spool, a first generator driven by said first motor for producing a voltage proportional to the speed of said first motor, a second motor for driving said takeup spool to tension said wire, a second generator driven by said second motor for producing a voltage pro-

portional to the speed of said second motor, a strand supply bobbin mounted coaxially of said wire, a third motor for driving said bobbin, a third generator driven by said third motor for producing a voltage proportional to the speed of said bobbin, a wrapping unit mounted coaxially of said wire and adjacent said bobbin for receiving the strand from said bobbin and wrapping the strand about the carrier wire, a fourth motor for driving said wrapping unit at a greater speed than said bobbin to tension the strand between said wrapping unit and said bobbin, means for adjusting the third motor to vary the tension on said strand, and means responsive to the voltage from said first, second, and third generators for stopping said first,

second, third, and fourth motors when the tension in the wire or strand decreases to a predetermined value.

References Cited in the file of this patent

UNITED STATES PATENTS

859,216	Hadley	July 9, 1907
1,365,442	Anderson	Jan. 11, 1921
1,592,909	Sleeper	July 20, 1926
1,990,082	Morgan	Feb. 5, 1935
2,003,353	Fantone et al.	June 4, 1935
2,279,115	Ewaldson et al.	Apr. 7, 1942
2,544,442	Boyce	Mar. 6, 1951
2,555,045	Lind	May 29, 1951
2,743,063	Soussloff	Apr. 24, 1956