July 23, 1968 W. J. LUCAS 3,393,503

SPEED CONTROL OF STRANDING EQUIPMENT

Filed Dec. 20, 1966

FIG. 1.

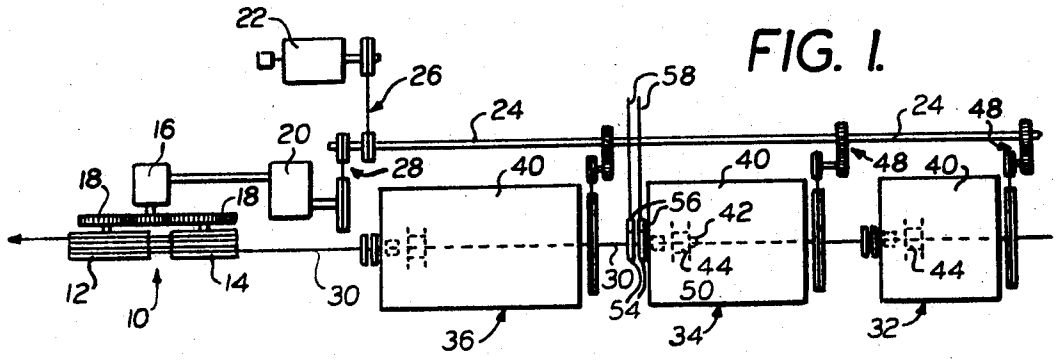
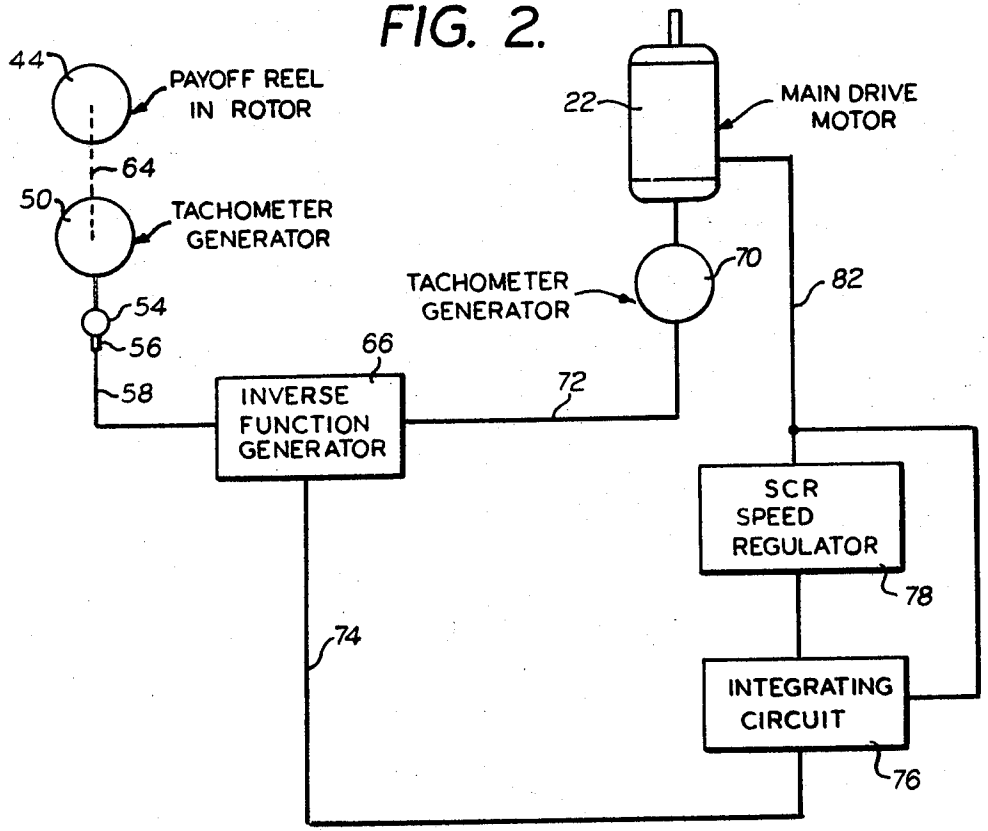


FIG. 2.



INVENTOR
WILLIAM J. LUCAS
BY Sandoe, Naill, Schottler & Wichstrom
ATTORNEYS.

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SPEED CONTROL OF STRANDING EQUIPMENT

William J. Lucas, Holmdel, N.J., assignor to General Cable Corporation, New York, N.Y., a corporation of New Jersey

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ABSTRACT OF THE DISCLOSURE

Stranding machines used for making cables have their speed limited by the centrifugal effect which results from the weight of the bobbins.

With lighter bobbins, the machine can be safely run at higher speeds. This invention provides an automatic control for the speed of cable-stranding machines; and the control takes advantage of the fact that the bobbins become lighter as the wire on them is used up. The invention increases the speed of a stranding machine progressively and proportionately as the bobbins become lighter. Tachometer generators on the stranding machine motor and on one of the bobbins have their output connected with a speed controller for the motor, and the speed controller responds to differences between the tachometer generator outputs.

Brief description of the invention

This invention provides an improved speed control for a cable-stranding machine which has co-ordinated power means for advancing a cable and supplying strands for the cable. In the preferred embodiment, a capstan that advances the cable is driven by the same motor that drives rotors of the strand supply sections through appropriate gearing or other motion-transmitting connections; but it will be understood that separate motors with provision for co-ordinating their speeds can be used and come within the expression "motor means."

As the wires on bobbins of the strand supply rotors are payed out, the total weight of each bobbin becomes less, and the rotor by which the bobbins are carried can run safely at higher speed. The invention speeds up the strand supply rotors in proportion to the weight reduction of the bobbins, and the weight reduction is preferably determined by the change in diameter of the reel of wire on the bobbin.

It is sufficient to rely upon the wire on any one bobbin of one section of the stranding machine because all of the bobbins are of the same capacity and all of them contain substantially the same amount of wire when the stranding operation is started. A bobbin rotates progressively faster as the amount of wire decreases, because of the reduced diameter of the reel of wire. This invention takes advantage of this increase in bobbin speed to determine the amount of reduction in weight of the bobbins and to determine the extent to which the rotor that carries the bobbins can be increased in speed with safety.

In order to maintain a constant lay of the strands, any increase in the speed of the rotors that carry the bobbins must be accomplished by a corresponding increase in the speed at which the cable advances axially. An important feature of the invention relates to the apparatus for co-ordinating changes in the orbital speed of the bobbins and the axial speed of the cable.

By increasing the speed of a cable-stranding machine as it becomes safe to do so, the output of the machine is increased with resulting reduction in the cost of cable manufacture.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

Brief description of the drawing

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views:

FIGURE 1 is a diagrammatic view of cable-stranding equipment having the automatic speed control means of this invention; and

FIGURE 2 is a wiring diagram for the speed control means of the apparatus shown in FIGURE 1.

Detailed description of the invention

The stranding equipment includes a capstan **10** which includes two drums **12** and **14** that rotate on parallel axles and that are driven through a gear box **16** and gearing **18** for transmitting motion from the gear box to both of the drums **12** and **14**. Power is supplied to the gear box **16** from a variable speed transmission **20** which is driven by a motor **22** through a jack shaft **24**.

The motor **22** is connected with the jack shaft **24** through belt-and-pulley connections **26**; and the jack shaft **24** is connected with the input end of the transmission **20** by other belt-and-pulley connections **28**. It will be understood that the expression "belt-and-pulley connections" is used in a broad sense to describe flat and V-belt drives, either single or multiple, and also chain-and-sprocket connections.

A cable **30** passes around the capstan drums **12** and **14**; and the rotation of these drums advances the cable **30** axially at a controlled speed which depends upon the speed of the motor **22** and the adjustment of the variable speed transmission **20**. Wire strands for the cable **30** are supplied from stranders **32, 34** and **36**. The strander **32**, for example, may supply 12 wires to the cable. The strander **34** may supply 18 wires; and the strander **36** may supply 24 wires. It will be understood that there may be other sections of the stranding equipment, for example stranders for supplying 30 wires beyond the strander **36**, and other layers of wire depending upon the desired size of the cable. Also there may be another section ahead of the strander **32** for supplying, for example, 6 wires. Thus the stranders **32, 34** and **36** are merely representative of successive sections of wire stranding equipment for applying layers of wire to a cable.

Each of the stranders **32, 34** and **36** includes a frame **40** which supports a plurality of bobbin holders **42** at angularly spaced locations around the cable **30**. Only one bobbin holder **42** is shown in the drawing for each frame **40** in order to simplify the drawing. These stranders are of well-known construction in cable-stranding equipment and the details of their construction form no part of the present invention. It is sufficient to understand that the frame **40** rotates about an axis substantially coincident with the axis of the cable **30** and that the bobbin holders **42** have orbital movement around the cable **30**. A bobbin **44** on the bobbin holder **42** supplies wire to the cable as the cable is advanced through the frame **40**, and the lay of the wire depends upon the axial speed of the cable **30** with respect to the orbital speed of the bobbin **44**. The same lay can be obtained with faster cable movement provided the orbital movement of the bobbin **44** is increased proportionately.

The frame **40** is rotated by power supplied from the jack shaft **24** through motion-transmitting connections **48** which may consist of gearing or belts or any other conventional means for transmitting rotary motion from one element to another. Such drives of successive stranders from a common power source are also well known and

their particular construction forms no part of the present invention.

Since the bobbin-carrying frame **40** of each of the stranders **32**, **34** and **36** is driven from the same jack shaft **24** through similar motion-transmitting connections **48**, all of the frames **40** rotate at speeds depending on the lay of the wires for each layer in the cable. Since the stranders **32**, **34** and **36** are driven from the same motor **22** as drives the capstan **10**, the axial speed of the cable **30** and the orbital speed of the bobbins **44** remain in constant coordinated relation with one another.

There is a tachometer generator **50** operatively connected with at least one of the bobbins **44** in at least one of the stranders **32**, **34** and **36**. In FIGURE 1 there is a tachometer generator **50** connected with a bobbin **44** of each of the stranders **32**, **34** and **36**. In the operation of this invention, only one of the tachometers **50** is used at any particular time. The reason for having a tachometer **50** on each strander is that the operation of the stranding equipment for making different kinds of cable may use different ones of the stranders on different occasions and the provision of a tachometer generator **50** on each strander insures that there will always be a tachometer generator which can be used for the purposes of this invention regardless of which strander or group of stranders is used for a particular cable.

In describing the tachometer generator **50** as "operatively connected" with the bobbin **44**, it will be understood that the type of connection is unimportant. It is sufficient that the output of the tachometer generator **50** corresponds to the speed of rotation of the bobbin **44**. The connection may be a mechanical one, as by a jaw clutch, or it may be a magnetic clutch, or the generator output may be produced by rotation of the bobbin **44** through a magnetic field.

The rotating frame **40** has slip rings **54** connected to the tachometer generator to provide conductors for brushes **56** which carry the generator output to a conductor circiut **58** of a speed controller, which will be described in connection with FIGURE 2.

With the stranding equipment of FIGURE 1 operating at a constant axial speed for the cable **30**, the lineal speed of the wire passing from each bobbin **44** is constant; but as the diameter of the reel of wire remaining on a bobbin **44** decreases, this same lineal speed causes a faster rotation of the bobbin **44**. This increases the output voltage of the tachometer generator **50**.

The reduction in diameter of the reel of wire on each bobbin **44** represents a decrease in weight of wire carried by the rotating frames **40** and a reduction in the centrifugal effect on the rotating frames. The reduced centrifugal effect makes it safe and practical to rotate the frames **40** at higher speed.

By increasing the speed of the motor **22**, the axial speed of the cable **30** and the rotary speed of the frames **40**, both increase without changing the lay of the wires. Thus the output of the stranding equipment can be increased; and with properly designed speed controllers, the stranding equipment can increase in speed automatically so as always to run at a maximum, optimum speed which depends upon the weight of wire carried on the bobbins of the rotary frames **40**.

FIGURE 2 shows a wiring diagram for the stranding equipment illustrated in FIGURE 1. To simplify the drawing, the wiring diagram is a single-wire diagram. The operative connection between the bobbin **44** and the tachometer generator **50** is indicated by the reference character **64**. The slip rings **54** connect with the conductor circuit **58**. This circuit supplies the voltage output of the tachometer generator to a voltage divider or inverse function generator **66**. Another tachometer generator **70**, driven by the motor **22**, has its output voltage supplied to the inverse function generator **66** by a conductor circuit **72**. The construction of the tachometer generator **70** may be the same as that of the tachometer generator **50**. It may be operatively connected with the motor **22** in the same way, and it may, if desired, be built into the motor **22**, that is, it may be a coil of the motor **22**.

The inverse function generator **66** supplies a control signal, through a conductor circuit **74**, to an integrating circuit **76** which controls a silicon-controlled rectifier **78**, connected with the field of the main drive motor by a conductor circuit **82**. Thus the speed of the motor **22** can be regulated by the relative outputs of the tachometer generators **50** and **70** so as to change the motor speed **22** to compensate any imbalance of the output of these tachometer generators **50** and **70**.

The preferred embodiment of the invention has been illustrated and described, but changes and modifications can be made and some features can be used in different combinations without departing from the invention as defined in the claims.

What is claimed is:

1. Cable stranding equipment including in combination a strander comprising a rotatable frame, a bobbin holder on the frame, feed means for advancing the cable, motor means driving the bobbin holder frame and the feed means at coordinated speed dependent upon the desired lay of the strands, and control means responsive to reduction in the amount of wire on a bobbin holder for increasing the speed of the motor means to drive the bobbin holder frame and the feed means at progressively higher speed and in substantially constant speed coordination with one another.

2. The cable stranding equipment described in claim **1** characterized by a plurality of bobbin holder frames at successive locations along the path of the cable for applying successive layers of strands to the cable, the control means being operatively connected with only one bobbin on only one of the bobbin holder frames.

3. The cable stranding equipment described in claim **1** characterized by the rotatable frame and the feed means being driven by a common motor, and at least one of them being connected with the motor through a variable speed transmission that is adjustable to change the relative speed of the rotatable frame and the motor with respect to one another to change the lay of the strands on the cable.

4. The cable stranding equipment described in claim **1** characterized by the control means including a generator responsive to the speed of rotation of a bobbin on one of the bobbin holders, another generator responsive to the speed of the motor means, and an inverse function generator to which the outputs of the other generators are supplied.

5. The cable stranding equipment described in claim **1** characterized by the control means including a generator, an electric circuit having an output responsive to the speed of the motor means, and an output comparator connected with said electric circuit and connected also with the output of said generator for comparing motor and bobbin speeds.

6. The cable stranding equipment described in claim **1** characterized by the control mechanism including a comparator, a first generator responsive to the speed of rotation of a bobbin on one of the bobbin holders, a second generator that supplies a reference output, means for integrating the outputs of the generators, and a speed regulator for the motor means responsive to the means for integrating the outputs of the generators.

7. The cable stranding equipment described in claim **1** characterized by the control means including a tachometer generator rotated by a bobbin as the bobbin is rotated by the paying out of wire therefrom, another tachometer generator rotated by the motor means, a voltage divider to which the output of both generators is supplied for comparison, and means responsive to voltage differences at the voltage divider for changing the speed in a motor means in a direction to compensate for the voltage difference.

8. The cable stranding equipment described in claim 7 characterized by the control means also including a silicon controlled rectifier in the field circuit of the motor means and responsive to voltage from the voltage divider, the silicon controlled rectifier being correlated with the field of the motor means and with the voltage divider to increase the speed of the motor means in response to output from the bobbin tachometer generator in excess of the output of the tachometer generator of the motor means.

9. The cable stranding equipment described in claim 8 characterized by the control means also including an integrating circuit to which voltage from the voltage divider is supplied, the silicon controlled rectifier being connected with and responsive to the output of said integrating circuit.

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FRANK J. COHEN, *Primary Examiner.*

DONALD E. WATKINS, *Assistant Examiner.*