Feb. 24, 1959 L. W. SCHEU 2,875,388

UNIFORM TENSION-MAINTAINING MOTOR CONTROL

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FIG-1

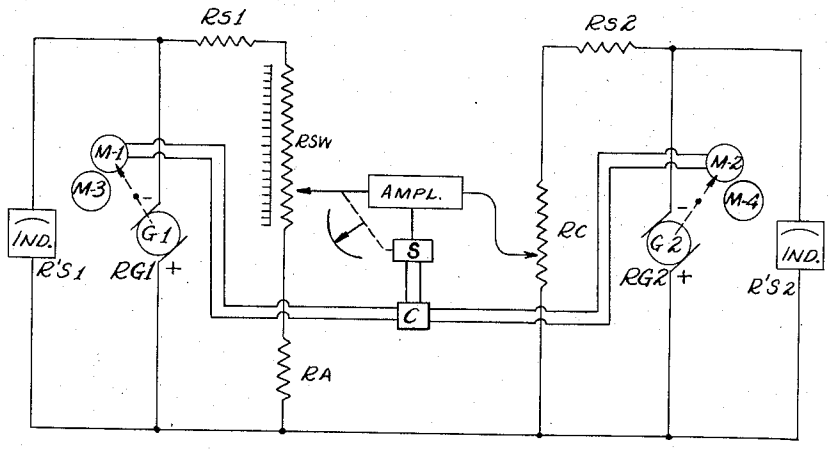
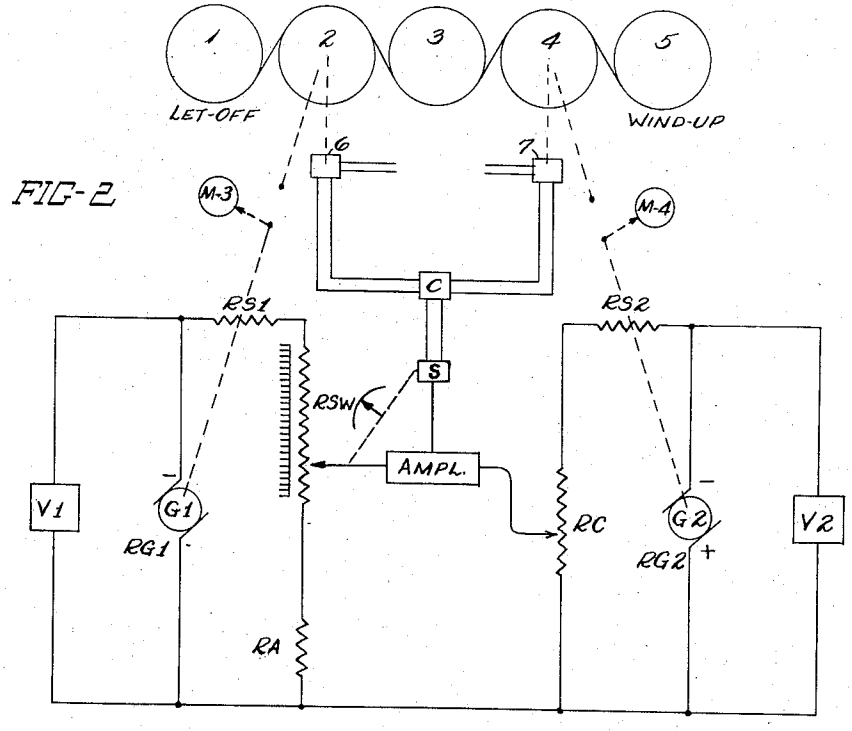


FIG-2



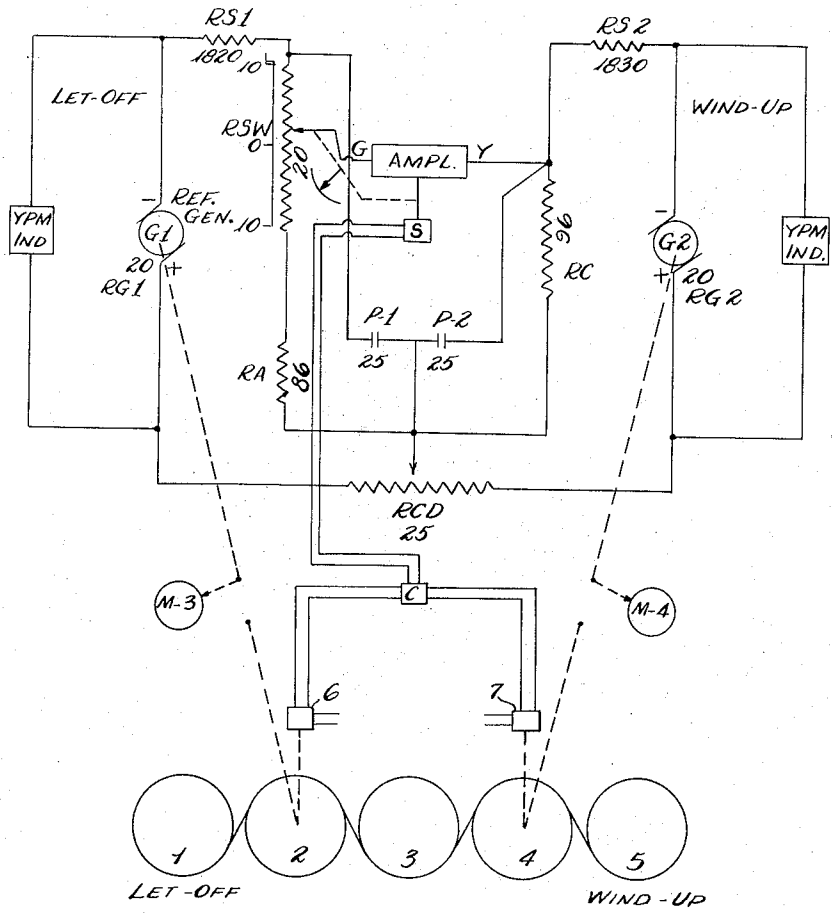
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FIG-3



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2,875,388

UNIFORM TENSION-MAINTAINING MOTOR CONTROL

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4 Claims. (Cl. 318—7)

This invention relates to a novel combination of apparatus including an electric circuit and more specifically to means for synchronizing the speed of two independent rolls over which continuous material is passing.

In certain industrial processes, an endless element of fabric, paper, plastic, rubber or the like in sheet or filament form is passed through a continuous train of processing equipment. Such an element is fed from a let-off roll and passed through processing equipment in train to a so-called wind-up roll to be wound upon itself or into the convolutions of a suitable liner. Between the let-off roll and wind-up roll are numerous intermediate rolls used to snub or drive the continuous element. The rates of rotational speed of the intermediate rolls may be varied to apply tension or relaxation to the passing element. The wind-up roll, the let-off roll and the intermediate rolls conventionally are driven by electric motors to impart drive to the passing element.

In processing tire cord fabric, for example, it is desirable to pass continuous fabric before it is cut into short lengths through certain zones of treatment by equipment in train in which the fabric is impregnated with rubber by calendering or by dipping in a rubbery solution. During the calendering or dipping operation or during subsequent treatment, different tensions expressed in terms of stretch in percent of original length are applied to the passing fabric in the various zones of operation. This means that at several different places along the length of fabric being treated, the tension impressed on the fabric and the stretch of the fabric will be different. Although different, at different sections along its length, the stretch of the fabric must be maintained constant and uniform to yield a uniform product. This means that a change of speed of a drive roll anywhere along the fabric length must be accompanied by a corresponding change of speed of the other rolls or the stretch of the fabric will change. To control individually each of the rolls to maintain the constant and uniform tension on the fabric necessary to give a uniform product has been a problem defying solution. Conventional apparatus has been unsatisfactory to produce the desirable result.

The present invention accurately measures the speed of a roll by a tachometer generator and by an electrical circuit which sets and maintains the speed of a second roll at a rate synchronized with the first roll.

It is therefore an object of this invention to provide means for accurately and uniformly measuring and synchronizing the speed of independently driven generators. It is also an object of this invention to provide means for synchronizing the operation of two rolls rotating at different rates of speed. Yet a further object of the invention is to provide an electrical circuit which automatically synchronizes the speed of rotation of at least two independently electrically driven rolls at a constant and uniform rate. Another object of the invention is to provide a pair of rotating rolls over which passes continuous fabric material, one of said rolls responsive

through an electrical circuit to the change in speed of the other roll. Another object of the invention is to provide an electrical circuit through which one electric motor is quickly and uniformly responsive to the changes of speed of a second electric motor.

These and other objects of the invention will be more fully understood with reference to the specification, claims and drawings of which:

Figure 1 is a circuit diagram of a modification of the invention wherein one generator is responsive through electrical linkages to the change of rate of speed of another generator.

Figure 2 is a diagrammatic drawing showing the combination of the novel electrical circuit with driver rolls used for processing continuous material such as tire fabric.

Figure 3 is a circuit diagram of a modification of the invention.

Referring to Figure 1, G–1 and G–2 are direct current tachometer generators such as [1] Weston Model 750 having linear voltage and circuit outputs and preferably equal internal resistances and equal E. M. F.—R. P. M. outputs. Generator G–1 is driven by motor M–1 and motor M–2 drives generator G–2. Resistors RS–1 and RS—2 are conventional limiting or ballasted resistors and serve to limit the current flowing in the respective generators. RG–1 and RG–2 are the internal resistances of the tachometer generators G–1 and G–2 respectively. RA is a suppressor resistor having a resistance determined by the potential drop across potentiometer resistance RSW. RSW is a standard slide wire potentiometer resistance mounted in a conventional potentiometer type recorder such as a [2] Brown Electronic Recorder Model 153. RC is a potentiometer type resistance having a resistance value determined to some extent by the range of speeds over which generators G–1 and G–2 are required to operate. "AMPL" is a voltage detector and is preferably the amplifier in the electronic recorder. S is a two phase servomotor in the Electronic Recorder responsive to the output of the amplifier "AMPL" and designed to actuate the potentiometer resistance RSW. Two voltmeters, IND–2 and IND–1, measure the voltage output of each respective generator at any instant.

In the operation of the circuit as shown, the generator G–2 is driven by electric motor M–2 and may be referred to as the reference generator. Generator G–1 has a voltage output determined by the speed of electric motor M–1. Any change in the speed of the motor M–2 driving generator G–2 causes a change in potential in the circuit of resistor, RC, RS–2 and G–2. There is therefore a difference in potential between that circuit and the circuit of G–1, RS–1, RA and RSW. This difference in voltage is detected by the amplifier "AMPL" which immediately actuates the servo motor S, to move the slider on slide wire potentiometer resistance RSW to change the potential distribution of RSW in the manner accomplished by the "[1] Brown Continuous Balance System." The change in RSW balances the voltage between the circuit of G–1 and G–2 out to zero. A pointer or a pen, X, may be attached to the slider on the slide wire so that it marks a record on a chart. At the same time, a conventional controller [2] C may be actuated by the servo motor to bring motor M–2 back to the same speed as the motor M–1. It will be seen that a simple, accurate and rugged system is available for synchronizing motor M–1 with M–2.

In the modification of the invention shown in Figure 2, the motors M–1 and M–2 have been removed and the generators G–1 and G–2 have been directly attached

[1] Weston Electric Instrument Corporation, Newark, New Jersey.

[2] Sold by Brown Instrument Division, Minneapolis Honeywell Regulator Company, Philadelphia, Pennsylvania.

to the axles of two driving rolls, 2 and 4 of a fabric processing device. In this device, the fabric being processed is fed from let-off roll 1 and passed over and under rolls 2, 3 and 4 respectively. Roll 5 is a wind-up roll driven by conventional means not shown. Roll 2 may be driven by electric motor 6 at a slower rate of speed than roll 4 driven by motor 7 with the result that tension will be applied to the fabric between rolls 2 and 4. It is of extreme importance that the differential in speed between rolls 2 and 4 be maintained uniformly.

To maintain these rolls at a uniform differential in speed, generator G–2 is attached to the axle of roll 4 and generator G–1 is attached to the axle of roll 2. By the conventional adjustable shunts in generators G–1 and G–2, the system may be calibrated before the start of a production run so that the potential in the circuit of G–1 equals the potential in the circuit of G–2 when rolls 2 and 4 respectively are driven at the desired speeds by conventional drive motors 6 and 7. Once production has started, a change of speed of either roll 2 or 4 for any reason will result in a potential difference between the circuit of generator G–1 and the circuit of generator G–2. This potential difference will be amplified by the voltage amplifier, "AMPL" which will actuate the servo motor, S, to adjust RSW to change the potential in the circuit of G–1 to equal the potential in the circuit of generator G–2. Motors 6 and 7, driving rolls 2 and 4 are responsive through a conventional instrument controller, C, to the movements of the servo motor, S, so that action of that motor to balance the two circuits to zero adjusts the speed of the drive motors of rolls 2 and 4 to maintain a uniform differential of speed between those two rolls.

The modification of the invention shown in Figure 3 provides means for balancing the circuit of generator G–1 against the circuit of generator G–2 to calibrate the system before use so that there is no difference in potential between the two circuits. By reference to Figure 3, it will be seen that the sum of the resistances of the circuits of generators G–1 and G–2 are as follows:

	G–1		G–2
	Ohms		*Ohms*
RS–1	1,820	RS–2	1,830
RG–1	20	RC	96
RA	86	RG–2	20
RSW	20	½ RCD	12.5
½ RCD	12.5		
	1,958.5		1,958.5

To calibrate the two circuits, the generators G–1 and G–2 are disengaged from their respective textile drive rolls 2 and 4 of Figure 2 and respectively attached to two [1] synchronous motors M–3 and M–4 respectively. The generators therefore will produce identical voltages and if any of the resistances of either circuit have changed value for any reason, the voltage differential through amplifier "AMPL" will cause the slide on RSW to assume a new position other than zero in order to bring the voltage differential between the two circuits back to zero. The slide of RSW may be set at zero on its own scale in this modification of the invention by moving the pointer on RCD, a [2] potentiometer resistance to either the right or left to throw more or less resistance into circuit of either generator G–1 or G–2 as necessary.

Once the pointer of RSW is at zero, the circuits of generator G–1 and G–2 are in voltage balance and the device is calibrated. The generators now may be disengaged from the synchronous motors and connected to the drive rolls 2 and 4 of the textile apparatus as shown in Figure 2. To smooth out the action of the pen recorder X in this modification of the invention, two capacitors, P–1 and P–2 may be placed in the circuits of generator G–1 and generator G–2 respectively.

To measure the rate of travel of fabric moving through the equipment processing train, the voltmeter V–1 and V–2 shown in Figure 2 may be calibrated to read in yards per second since the rolls 2 and 4 are rotating at substantially the same velocity as the rate of travel of the fabric passing thereover. The voltmeter scale may be replaced with a scale calibrated in yards per "minute."

The resistors, generators, motors, amplifiers, servo motors, etc. used in the invention are conventional units commercially available. The circuits described and illustrated are given by way of example only and it will be obvious that modification of the invention may be made within the scope of the following claims:

I claim:

1. A device for maintaing constant, uniform stretch on continuous material being frictionally driven by two rolls rotating at different speeds, comprising electric motors to drive said rolls, two tachometer generators of equal voltage output when driven at equal speeds respectively connected to said rolls, electric circuits each including one said generator, a first potentiometer resistance in one circuit and a second potentiometer resistance in the second circuit, a voltage amplifier connected to and sensitive to said first potentiometer resistance, a servo motor connected to and responsive to the output of said amplifier, a controller responsive to said servo motor and adapted to vary the speed of said electric motors, and said second potentiometer resistance responsive to said servo motor whereby a potential difference between said circuits activates said servo motor to synchronize the speed of rotation of said rolls to return the potential difference between said circuits to zero.

2. A device for maintaining constant, uniform stretch on continuous material being frictionally driven by two rolls rotating at different speeds, comprising electric motors to drive said rolls, two tachometer generators of equal voltage output when driven at equal speeds respectively connected to said rolls, electric circuits each including one said generator, a first potentiometer resistance in one circuit and a second potentiometer resistance in the second circuit, a voltage amplifier connected to and sensitive to said first potentiometer resistance, a controller adapted to vary the speed of said electric motors, means responsive to the output of said amplifier and adapted to activate said controller, and said second potentiometer resistance adapted to be varied by said responsive means whereby a potential difference between said circuits activates said motor to synchronize the speed of rotation of said rolls to return the potential difference between said circuits to zero.

3. A device for maintaining constant, uniform stretch on continuous material being frictionally driven by two rolls rotating at different speeds, comprising electric motors to drive said rolls, two tachometer generators of equal voltage output when driven at equal speeds respectively connected to said rolls, electric circuits each including one said generator, a first potentiometer resistance in one circuit and a second potentiometer resistance in the second circuit a voltage amplifier connected to and sensitive to said first potentiometer resistance, a servo motor connected to and responsive to the output of said amplifier, a controller responsive to said servomotor and adapted to vary the speed of said electric motors, said second potentiometer resistance adapted to be varied by said servomotor, and two synchronous motors each connected to respective generators and adapted to drive said generators when said rolls are idle whereby when said rolls are operating a potential difference between said circuits activates said servo motor to synchronize the speed of rotation

[1] Such as model SNY–12–P–2246 sold by Bodine Electric Co., Chicago, Illinois.

[2] Such as series A–10 sold by Clarostat Mfg. Co., Dover, N. H.

of said rolls to return the potential difference between said circuits to zero, and when said rolls are idle said two circuits may be balanced and calibrated by operating said synchronous motors and adjusting said second potentiometer resistance.

4. A device for maintaining constant, uniform stretch on continuous material being frictionally driven by two rolls rotating at different speeds, comprising electric motors to drive said rolls, two tachometer generators of equal voltage output when driven at equal speeds respectively connected to said rolls, electric circuits each including one said generator, a first potentiometer resistance in one circuit and a second potentiometer resistance in the second circuit, a voltage amplifier connected to and sensitive to said first potentiometer resistance, a controller adapted to vary the speed of said electric motors, means responsive to the output of said amplifier and adapted to activate said controller, said second potentiometer resistance responsive to said responsive means, and two synchronous motors each connected to respective generators and adapted to drive said generators when said rolls are idle whereby when said rolls are operating a potential difference between said circuits activates said responsive means to synchronize the speed of rotation of said rolls to return the potential difference between said circuits to zero, and when said rolls are idle said two circuits may be balanced and calibrated by operating said synchronous motors and adjusting said second potentiometer resistance.

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