

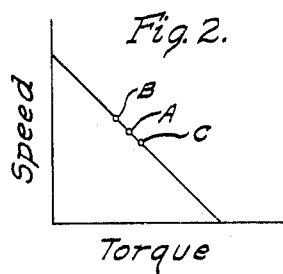
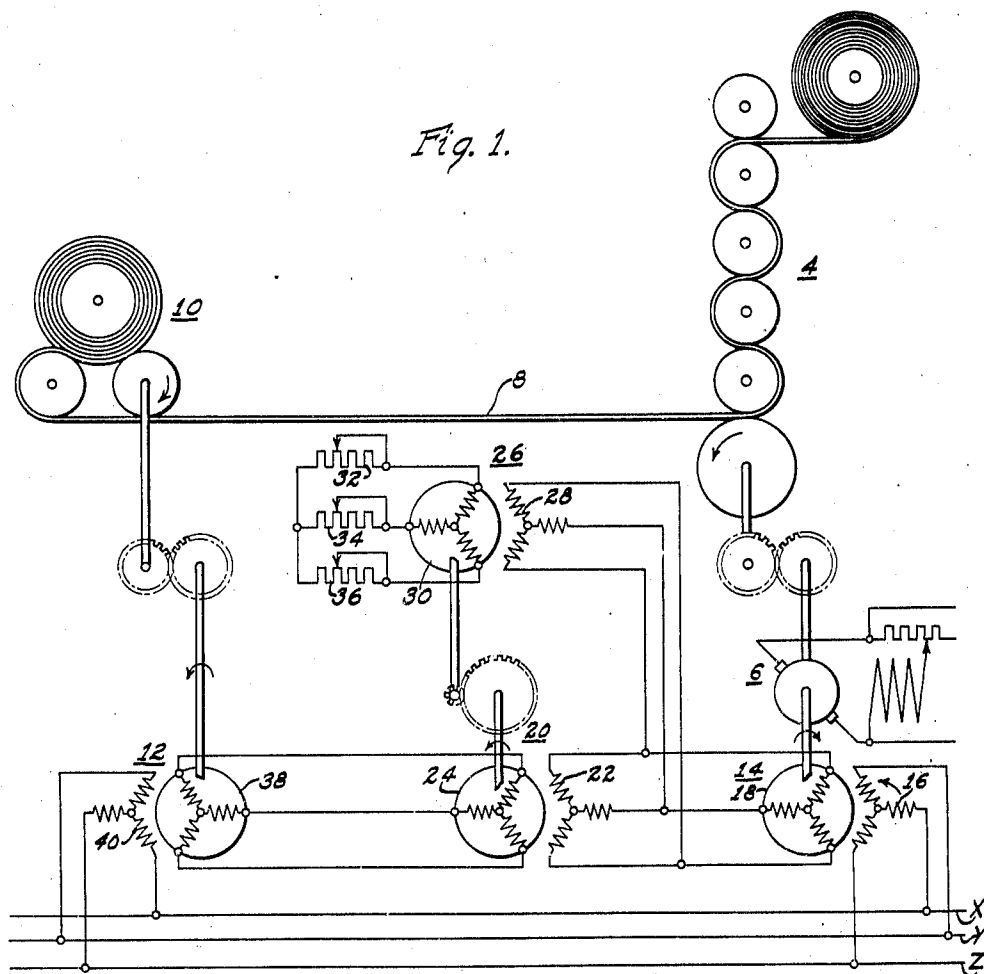
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2,169,016

SYNCHRO-TIE CONTROL

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WITNESSES:

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SYNCHRO-TIE CONTROL

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My invention relates, generally, to speed control systems and, more particularly, to a synchro-tie system for maintaining a substantially constant speed ratio between two rotating elements.

5 In certain industrial operations such, for instance, as paper making, a web of material is passed from one roll to another and is subjected to a tension as it passes between the rolls. It will be apparent that if the web were of some material that could not be easily stretched, it would only be necessary to maintain equal peripheral speeds on the rolls in order to properly pass the web from one roll to the next. If, however, the web were of a material having a tendency to shrink or lengthen while passing between the rolls, the peripheral speeds of the rolls would have to be different by an amount depending upon the amount of shrinking or lengthening of the web. In some of such processes, slippage or creepage exists between the processing rolls and the material being processed, necessitating different peripheral speed ratios of the cooperating rolls depending upon the amount of this slippage or creepage.

25 The rolls cannot be rigidly mechanically connected together so as to maintain a fixed ratio of peripheral speeds determined by the amount of lengthening or shrinking of the web or by slippage or creeping for the reason that the amount of the lengthening or shrinking of the web or the degree of slippage or creeping may vary as between different parts of the web, thus requiring that the ratio of the peripheral speeds of the rolls vary.

35 It is common practice, in carrying out such industrial processes, to drive one of such rolls directly from the other by means of a drive belt and to provide for slippage of the belt on the driven roll to compensate for variations in the ratio of the required peripheral speeds of the rolls. Thus, with the ratio of the peripheral speeds of the rolls adjusted for a given amount of lengthening of the web between the rolls, and an amount of belt slippage to produce this ratio of speeds, in the event that such lengthening increases or decreases, the amount of slippage will automatically vary because of the variation of tension on the web between the rolls thus tending to keep approximately the proper tension on the web regardless of variations in the amount of lengthening of the web between the rolls. It will be apparent that this method of speed control by belt slippage is wasteful of power and causes excessive wear on the operating machinery.

55 An object of my invention is to provide an

electrical drive for associated rotating elements which shall function to provide ratios between the speeds of the rotating elements equivalent to the functioning of a slip belt drive between the rotating elements.

Another object of the invention is to provide an electrical drive connection between roll members which cooperate to move a web member which shall function to vary the ratio of the speeds of the rolls in accordance with variations of the tension on the web member between the rolls.

A further object of the invention is to provide an electrical drive connection between roll members which cooperate to move a web member, which shall function to vary the ratio of the speeds of the rolls in accordance with variations in the amount of change in length of the web member as it is passing between the rolls and which may be selectively adjusted for predetermined normal speed ratios.

A still further object of the invention is to provide an electrical drive connection between roll members which cooperate to move a web member which shall function to vary the ratio of the speeds of the rolls in accordance with the variations in the amount of slippage or creepage of the web member as it is passing between the rolls, and which may be selectively adjusted for predetermined normal speed ratios.

These and other objects and advantages of my invention will be apparent from the following detailed description taken in connection with the accompanying drawing, in which:

Figure 1 is a diagrammatic illustration of a preferred embodiment of my invention as applied to the calender and winding reel of a paper machine, and

Fig. 2 is a graph of the speed-torque characteristics of an auxiliary motor employed in carrying out my invention.

In practicing a preferred embodiment of my invention, a variable speed motor is provided for driving the rolls of a paper calender. A wound rotor polyphase induction generator of the type generally designated as a synchro-tie or selsyn unit in synchro-tie systems having its stator connected to a polyphase source of constant frequency, is driven by the calender driving motor in such a direction with respect to the direction of phase rotation of the flux of the stator of the induction generator, as to produce a frequency which is the sum of the frequencies produced by rotation of the generator rotor and the rotation of the generator stator flux.

An auxiliary wound rotor induction motor having its stator connected to the output circuit of the first induction generator is mechanically connected to drive a second induction generator having its stator connected in the output circuit of the first induction generator. The winding reel is driven by a wound rotor induction motor having its rotor energized by the output of the second generator and its stator connected to the polyphase source of constant frequency. The auxiliary wound rotor induction motor has a variable resistance in its rotor circuit so that its speed and its speed torque characteristics may be varied. This auxiliary motor may be a wound rotor induction motor as herein described, or it may be any motor with a suitable drooping speed-load characteristic similar to that of the wound rotor induction motor, such as a direct current series wound motor of suitable design. The auxiliary motor is geared to drive the rotor of the second induction generator at a comparatively low speed in such a direction with respect to the direction of phase rotation of the flux of the second induction generator as to produce a frequency which is the sum of the frequencies produced by rotation of the generator rotor and the rotation of the generator stator flux.

The speed of the winder driving motor will be proportional to the resultant of the frequencies applied to its rotor and stator and will vary with the speed of the auxiliary motor. Since the speed of the auxiliary induction motor will decrease with increased torque, the winder speed will be automatically decreased with increased torque on the web to thus automatically maintain the desired speed relation to produce the desired substantially constant tension on the web as it passes from the calendar to the winder.

Referring now to Fig. 1 of the drawing, a paper calendar 4 driven by a variable speed motor 6 delivers the strip of paper 8 which is wound by winder 10 driven by a wound rotor induction motor 12. A polyphase induction generator 14, which may be such a generator as is commonly used as the sending unit in synchro-tie systems, is connected on the shaft of the motor 6 or by any other common mechanical means to be driven by motor 6 and to thus have its speed varied with the variations of the speed of motor 6. The stator 16 of the induction generator 14 is connected to be energized from a standard source of alternating current X, Y, Z and to have the direction of rotation of the field flux produced by the stator opposite to the direction of rotation of the motor 18 of the induction generator 14.

A second induction generator 20 has its stator winding 22 connected to be energized by the potential generated by induction generator 14. The rotor 24 of induction generator 20 is driven through suitable gearing at a relatively low speed by the wound rotor induction motor 26. The stator 28 of induction motor 26 is connected to be energized by the output potential of the induction generator 14. The rotor 30 of the induction motor 26 has its windings connected in circuit with variable resistance elements 32, 34 and 36. The direction of rotation of the rotor 24 of induction generator 20 is opposite to the direction of rotation of the flux produced by the stator winding 22 of induction generator 20.

The induction motor 12 which drives the winder 10 has the circuit of its rotor 38 connected to be energized by the output potential from the rotor 24 of induction generator 20. The stator 40 of induction motor 12 is connected to be energized

from the standard source of alternating current X, Y, Z above referred to. The windings of the rotor 38 and the stator 40 of induction motor 12 are so connected that the rotation of the field flux produced by each of these windings is in the same direction.

It will be seen in the operation of the device that the induction motor 12 is driven by the output of the induction generator 14 modified by the output of induction generator 20 which is under control of the induction motor 26. Assuming that the field flux produced by the polyphase stator winding 16 of induction generator 14 is rotating at a speed equivalent to 60 cycle frequency and that the rotor 18 of induction generator 14 is rotating in the opposite direction at a speed equivalent to the 60 cycle frequency, then a potential of 120 cycles frequency will be induced in the rotor winding of induction generator 14 and will be applied to the stator windings of induction generator 20 and induction motor 26. Assume also that the speed of motor 26 is such as to drive the rotor 24 of induction generator 20 at a speed equivalent to a frequency of 10 cycles. This will cause a potential of a frequency of 130 cycles to be generated in the rotor winding of induction generator 20 and to be applied to the winding of the rotor 38 of induction motor 12. Further, assume that the winding 40 of the induction motor 12 is such as to provide a flux rotation at a speed of the equivalent frequency of 60 cycles. With the rotation of the flux produced by the stator winding 40 of induction motor 12 in the same direction as the rotation of the flux produced by winding of the rotor 38 of motor 12, it will be seen that the resultant frequency acting to drive the rotor 38 will be the difference between 130 and 60, or 70 cycles. Thus the speed of rotation of motor 6 and the speed of rotation of motor 12 will bear the ratio of 60 to 70.

The induction motor 26 having the resistance elements 32, 34 and 36 connected in its rotor circuit will have a speed torque characteristic similar to that shown in Fig. 2, that is, its speed will decrease in direction proportional to the torque required to be furnished by it. Let us assume that the induction motor 26 is operating under the conditions represented by the point A on the graph of speed torque of Fig. 2. Under these conditions the motor 26 will be supplying some of the power for driving the induction motor 12 which, in turn, drives the winder 10. If now the tension on the strip of paper 8 should increase for some reason, such as decreased stretching of the strip or increased shrinkage of the strip, a larger torque will be required of motor 26 and it will assume the conditions of operation which may be represented by the point C on the graph of Fig. 2. In supplying this greater torque, the speed of motor 26 has decreased and this has caused a decrease in the speed of rotation of the rotor 24 of induction generator 20. This decrease in the speed of rotation of the rotor 24 will cause a decrease in the speed of rotation of rotor 38, since there will be a resultant decrease in the frequency of the potential applied to the rotor 38 of induction motor 12. As a result, the speed of rotation of the winding 18 will be decreased, thus preventing too great an increase in tension on the paper strip 8.

In a like manner, should the tension on the strip 8 decrease for any reason, such as increased stretching or decreased shrinking of the paper strip, less torque will be required of the motor

26 and it will operate under the conditions represented by the point B on the graph of Fig. 2. This decrease in the torque requirements of induction motor 26 will cause it to increase its speed thus increasing the speed of rotation of the motor 24 of induction generator 20 which, in turn, will cause an increase in the speed of rotation of the induction motor 12 through the increased frequency applied to the rotor of induction motor 12 from the rotor of induction generator 20. This increase in the speed of motor 12 will cause the winder 10 to increase its speed to, in turn, increase the tension on the paper strip 8. Thus it is seen that a substantially constant tension is automatically maintained on the paper strip 8.

If now it is desired to maintain a different tension on the paper strip 8, the resistance elements 32, 34 and 36 in the rotor circuit of induction motor 26 may be so varied as to change the speed torque characteristics of motor 26 and to thus provide a greater torque of motor 26 for a given speed.

It will be seen that the speed of rotation of the motor 26 will vary with the speed of motor 6, since the stator 28 of motor 26 will be excited at a frequency which varies with the speed of motor 6 and for this reason the motor 26 will act to maintain a nearly constant tension upon the paper strip 8 regardless of the speed of operation of the calender and winder.

It will be seen that I have provided a simple and efficient electrical drive connection between a calender and a winder of a paper mill which will function to maintain a substantially constant tension on the paper strip between the calender and winder regardless of the change in stretching or shrinking of the strip between the calender and winder and regardless of the speed of operation of the calender and winder.

In compliance with the requirements of the patent statutes, I have shown and described herein a preferred embodiment of my invention. It is understood, however, that the invention is not limited to the precise construction shown and described but is capable of modification by one skilled in the art, the embodiment herein shown being merely illustrative of the principles of my invention.

I claim as my invention:

1. In a speed control system for automatically maintaining a predetermined tension on a web as it is moved by and passes between spaced roller members, variable speed means for rotating one of said roller members, frequency responsive variable speed means for rotating the other of said roller members, and means for producing a potential which is variable in frequency in accordance with the load on said frequency responsive means and the speed of said first variable speed rotating means for energizing said frequency responsive means.

2. In a speed control system for automatically maintaining a predetermined tension on a web as it is moved by and passes between spaced roller members, variable speed means for driving one of said roller members, generator means driven by said variable speed means for generating a potential having a frequency proportionate to the speed of said variable speed driving means, a variable speed frequency responsive driving means for the other of said roller members, and means responsive to the load on said frequency responsive driving means and the frequency of said generator means for generating a

potential of variable frequency for energizing said frequency responsive driving means.

3. In a speed control system for rotating elements cooperatively engaging a traveling element, rotating means for driving one of the rotating elements, a first polyphase induction generator driven by said rotating means, a polyphase source of excitation for said first induction generator, the rotor of said first induction generator being rotated in such a direction as to generate a potential at a frequency of the sum of the frequencies produced by rotation of the rotor and the rotation of the generator stator flux, a first wound rotor induction motor having its stator connected to be energized by the output potential of said first generator, selectively variable resistance means connected in circuit with the rotor winding of said first induction motor, a second induction generator driven by said first induction motor, the stator of said second induction generator being energized by the output of said first induction generator, the rotor of said second induction generator being driven in such a direction as to generate a potential at a frequency which is the sum of the frequencies produced by the rotation of the rotor and the rotation of the generator stator flux, and a second wound rotor induction motor connected to drive the other rotating element and having its rotor excited by the output potential of said second induction generator and having its stator excited by said polyphase source of excitation.

4. In a speed control system for automatically maintaining a predetermined tension on a web as it is moved by and passes between spaced roller members, variable speed means for rotating one of said roller members, frequency responsive variable speed means for rotating the other of said roller members, means for producing a potential variable in frequency in accordance with the load on said frequency responsive means and the speed of said first variable speed rotating means for energizing said frequency responsive means, and means for selectively varying the rate of variation of said frequency which varies in accordance with the load on said frequency responsive means and the speed of said first variable speed rotating means.

5. In a speed control system for rotating elements cooperatively engaging a traveling element, variable speed driving means for one of said rotating elements, a frequency responsive variable speed means for driving the other of said rotating elements, means for generating a potential for energizing said frequency responsive means variable in accordance with the speed of rotation of said first rotating element and the load on said frequency responsive means, said generating means comprising an induction generator having its stator energized in accordance with the speed of said first-mentioned variable speed driving means, a wound rotor induction motor for driving the rotor of said induction generator, and means for energizing said induction motor stator at a frequency varying with the speed of said first-mentioned variable speed driving means.

6. In a speed control system for rotating elements cooperatively engaging a traveling element, variable speed driving means for one of said rotating elements, a frequency responsive variable speed means for driving the other of said rotating elements, means for generating a potential for energizing said frequency responsive means variable in accordance with the speed of

rotation of said first rotating element and the load on said frequency responsive means, said generating means comprising an induction generator having its stator energized in accordance with the speed of said first-mentioned variable speed driving means, a wound rotor induction motor for driving the rotor of said induction generator, means for energizing said induction motor stator at a frequency varying with the speed of said first-mentioned variable speed driving means, and variable resistance means in the rotor circuit of said induction motor for selectively varying the speed-torque characteristics of said motor.

7. In a system for maintaining the proper speed

relation between a paper calender and a winder cooperating therewith, a variable speed motor for driving the calender, a frequency responsive means for driving the winder, a polyphase generator driven by said calender motor, an induction generator having its stator connected to be energized by said polyphase generator and its rotor connected to energize said frequency responsive means, and an induction motor connected to drive said induction generator, said induction motor comprising a wound rotor, a selectively variable resistance means connected in said rotor circuit and a polyphase stator winding energized by said polyphase generator.

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