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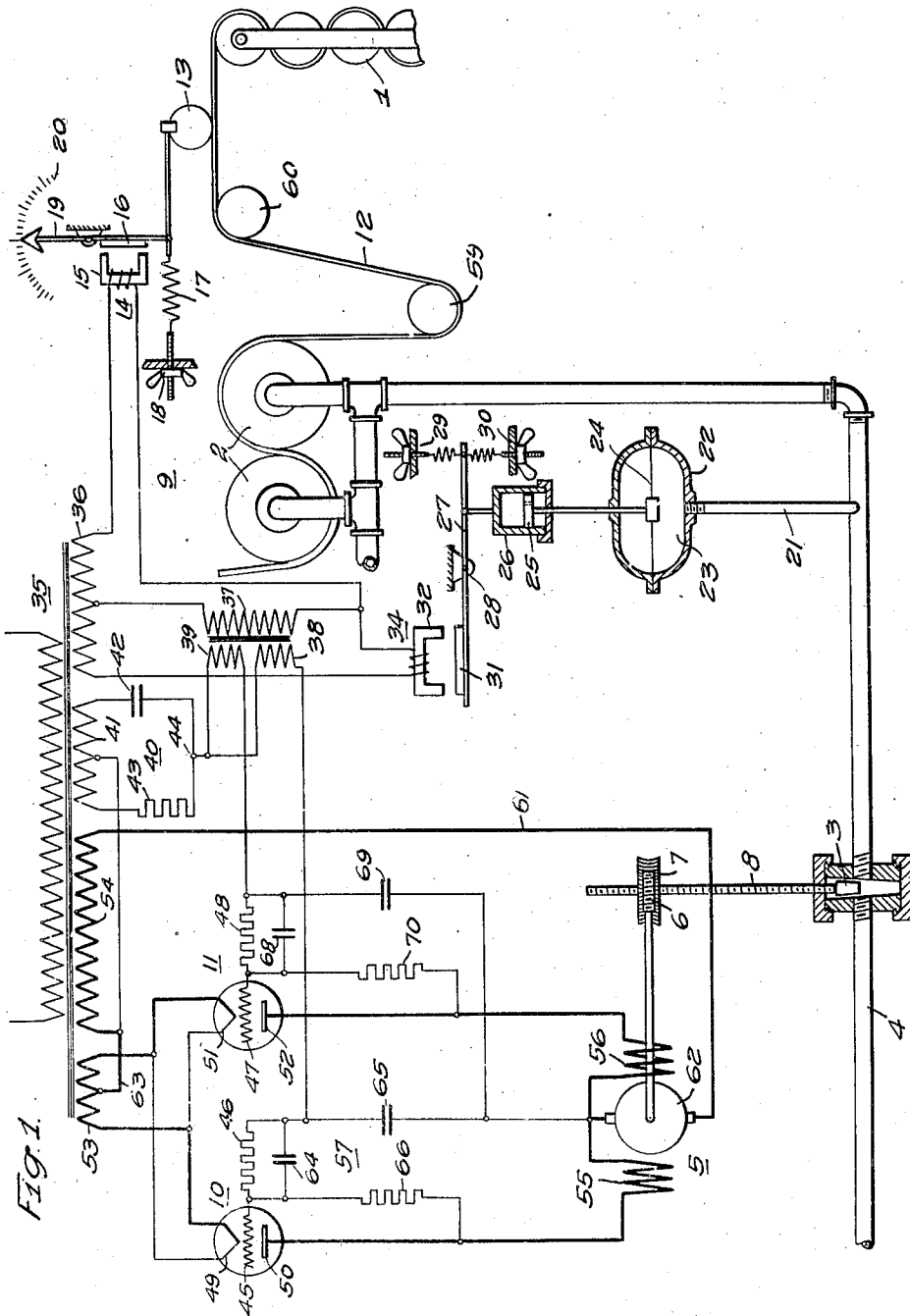
S. A. STAEGE

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PAPER DRYNESS CONTROL

Filed May 26, 1934

2 Sheets-Sheet 1



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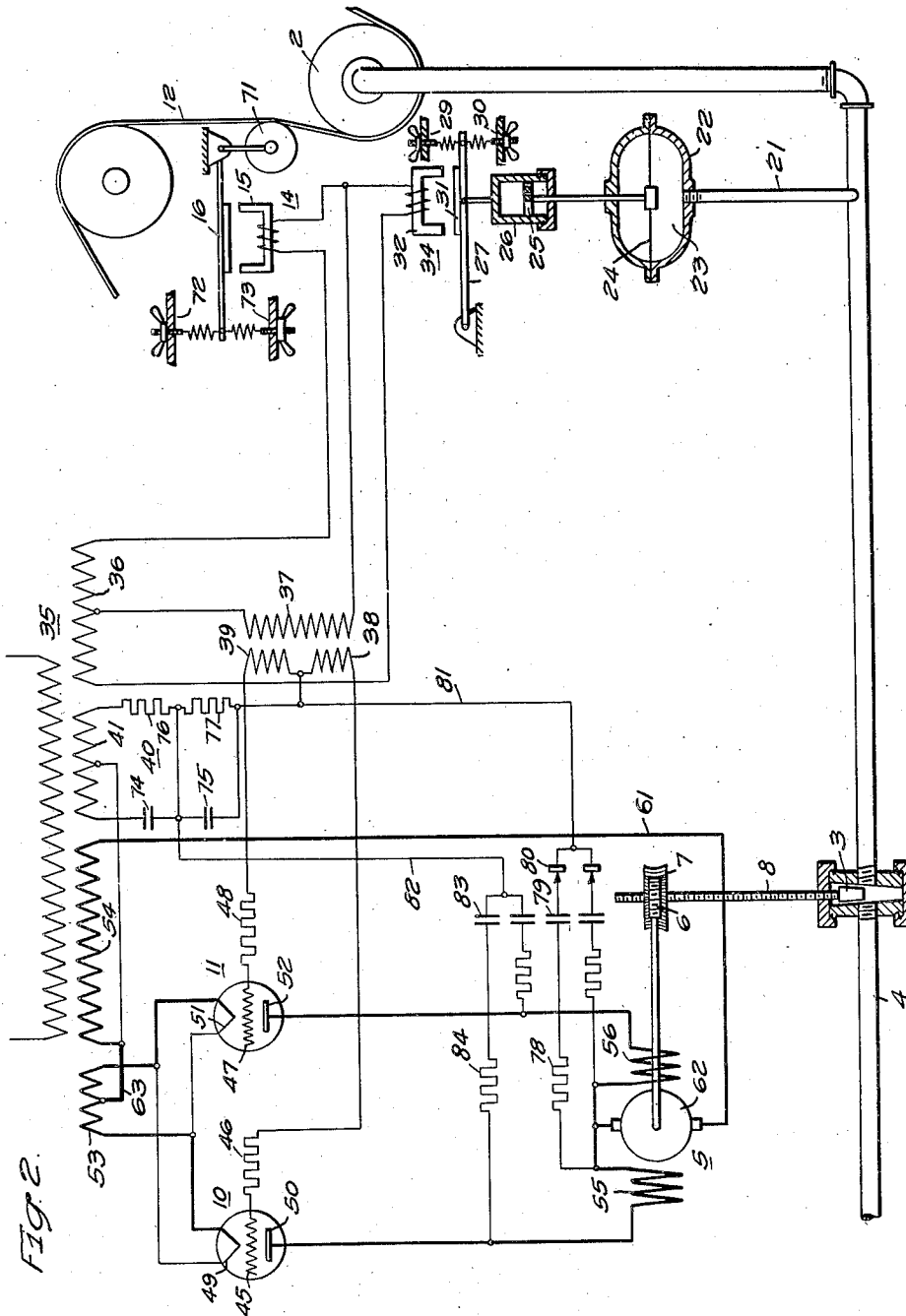
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PAPER DRYNESS CONTROL

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This invention relates to control systems for motors, and more particularly to systems of control wherein a motor governing the operation of a material drier is controlled in response to the degree of dryness of the material being dried.

In the art of making paper the drying operation is an important feature and, to properly control the drying before the paper passes to the first calender, some means should be provided for controlling the admission of steam to the drier.

One object of my invention is to measure the dryness of paper, preferably between the drier and the first calender or in some cases at another location within the drier, and to control the drying operation by the measured dryness.

Another object of my invention is to control the drying rate in a paper drier as a function of the dryness of the paper leaving the drier but wherein the corrective action is effected in small increments to thus prevent hunting.

A further object of my invention is to measure the dryness of paper or other material by means of a drag element engaging the material, which element controls electric discharge devices which, in turn, control a motor for changing the drying rate of the material.

A further object of my invention is to measure and control the drying rate of a drier for material as a function of the tension in the material with variations in moisture therein.

Other objects and advantages of my invention, not specifically recited hereinbefore, will become apparent from a study of the following specification, when considered in conjunction with the accompanying drawings, in which:

Figure 1 is a diagrammatic view showing a drier, a calender and a system of control for controlling the operation of the drier; and

Fig. 2 is a modification showing elements similar to those shown in Fig. 1.

Referring more particularly to Fig. 1, I have shown therein a calender 1 and the drums 2 of a drier for material passing through the drier to the calender. The drums 2 are merely two of a large number of drums included in a drier, all of which are supplied with steam or some other hot fluid for effecting a drying operation of the paper or other material that may pass through the drier. I show but two drums because two are sufficient to illustrate the novel features of my invention.

A valve 3 is provided for controlling the rate of admission of the steam to the drums 2 from a supply pipe 4. The position of this valve is controlled by a motor 5 operating the valve 3 through a worm 6, worm wheel 7 and threaded valve stem 8. The motor 5 is of the reversing type and is controlled in its direction of operation by a dryness-measuring device 9, which, in turn, controls a pair of electric discharge devices

10 and 11 adapted to supply the motor 5 with energy varying in amount and direction, depending upon the dryness of the paper or other material 12 that is being dried. When one tube or discharge device becomes conducting the motor operates in one direction and when the other tube becomes conducting the motor operates in the reverse direction.

The dryness measuring and controlling device 9 includes a drag member 13 controlling the reactance of a reactor 14. The reactor 14 has a magnetic circuit including a stationary member 15 and a movable member 16, the position of which is determined by the adjustment of spring 17 through adjusting means 18 (co-operating nut and screw, for example) and the dryness of the material 12. The dryness of the material 12 varies the coefficient of friction, and in consequence, the member 13 will variably drag over the material 12 responsive to such variations in the coefficient of friction. When the friction increases armature 16 is moved toward the right, increasing the air gap in the magnetic circuit of the reactor 14 and thus changing the reactance value of this reactor. At the same instant, the dryness is indicated by the pointer 19 on the scale 20.

A pipe 21 is connected in the pipe leading from the valve 3 to the drums 2, to permit the steam pressure to enter the region 23 of the chamber 22 to thus control the position of diaphragm 24 with variations in the steam pressure in the drier drums 2. The diaphragm 24 is provided with a piston 25 operating in a cylinder 26.

The cylinder 26 is connected to a lever 27, pivoted at 28, and adjusted to a given position by the adjustable spring assemblies 29 and 30. With variations in pressure in the drier drums 2, the position of lever 27 is changed and, in consequence, the air gap for reactor 34 is changed by reason of the fact that the movable armature 31 is shifted with reference to the stationary portion of the magnetic circuit 32 of the reactor 34.

A transformer 35 is provided to supply the required energy for motor 5 and the electric discharge devices 10 and 11, and the circuits for the respective reactors 14 and 34. The transformer 35 is provided with a secondary winding 36 for energizing the reactors 14 and 34, which reactors are connected in a Wheatstone bridge arrangement in such manner that one-half of the secondary winding 36 and one reactor constitute one leg of the bridge, whereas the other half of the transformer and the other reactor constitute the other leg of the bridge. A primary winding 37 is connected in the potentiometer circuit of this Wheatstone bridge arrangement and, as is well known for this type of circuit, any unbalance in the reactance between the reactors 14 and 34 will cause a current to flow in the pri-

mary winding 37, thereby inducing a current in the secondary windings 38 and 39 of the grid control circuit 40.

The grid control circuit i. e. the phase-shift grid biasing circuit 40 includes a secondary winding 41, a capacitor 42 and a resistor 43. The upper terminals of the respective secondary windings 38 and 39 are connected to a junction 44 intermediate the capacitor 42 and the resistor 43. The other terminal of secondary winding 38 is connected to the grid 45 of the electric discharge device 10 through a resistor 46 whereas the other terminal of the secondary winding 39 is connected to grid 47 of the electric discharge device 11 through a resistor 48.

The electrical characteristics of the phase shift grid biasing circuit 40 are so selected for normal operation that the bias of the respective grids 45 and 47 with reference to the anodes 50 and 52 of the electric discharge devices 10 and 11, respectively, is such that these discharge devices will be caused to break down or become conducting substantially at the end of each positive portion of an alternating-current wave. An unbalance in the Wheatstone bridge arrangement will thus cause either the electric discharge device 10 or the device 11, as the case may be, to break down earlier during an alternating-current wave and thus supply the motor 5 with sufficient energy to operate to readjust the valve 3 and thus reestablish the balance between the reactors 14 and 34. This will become more apparent from a study of the sequence of operation given hereinafter.

The cathodes 49 and 51 are energized from a secondary winding 53, whereas the motor 5 is connected to be energized from the secondary winding 54 of the transformer 35.

Both of the electric discharge devices are provided with timing circuits so related to the grids of these devices and the motor field windings 55 and 56, respectively, that the motor will be caused to operate at a lower and lower speed until the necessary correction has been accomplished. When very nearly the necessary correction has been accomplished the speed of the motor will be sufficiently slow so that over travel is prevented. No hunting can thus take place.

Assume that the paper 12 is moved from the drier over the guide or idling rollers 59 and 60 to the calendar 1, and that a given amount of steam is supplied to the drier. If for some reason, the dryness in the paper is not of the appropriate value, such improper dryness will influence the position of the drag block 13 of the dryness-indicating device 9, and in consequence, the movable armature 16 will be moved either toward or away from the stationary portion of the magnetic circuit of the reactor 14.

If it be assumed that an insufficient amount of steam was transmitted to the drier and that the paper is moving to the calendar with an excessive amount of moisture therein, the coefficient of friction will rise. In consequence, the air gap for the reactor 14 will be increased. This unbalancing of the Wheatstone bridge circuit causes a current to flow through primary winding 37 and, since the secondary windings 38 and 39 are connected in the phase shift grid biasing circuit 40, the bias on the grids 45 and 47 will be changed. The connection, however, is such that only one of the electric discharge devices will have its grid bias made more positive with reference to the cathode, and in consequence, the particular discharge device thus affected will break down

during an earlier portion of the alternating current wave and thus become more conducting than the other discharge device.

For the assumption made, the bias of the grid 45 is changed, and in consequence, the electric discharge device 10 becomes conducting. An energizing circuit is thus established from the right-hand terminal of the secondary winding 54 through conductor 61, armature 62, field winding 55, anode 50, cathode 49, the secondary winding 53 and conductor 63 to the left-hand terminal of the secondary winding 54.

It should be noted that the grid resistor 46 is connected in shunt relation to the field winding 55, and the instant current begins to flow in the field winding 55 the tendency would be to make the grid again less positive with reference to the anode and, thus reduce the speed of the motor or stop it slightly in advance of complete correction. However, to prevent such immediate nullification of the operation set up by reason of the unbalance in the Wheatstone bridge arrangement, the capacitor 64 is provided in shunt relation to the resistor 46. A second capacitor 65 is also provided to prevent a closed circuit from being established in shunt relation to the field winding 55, and in shunt relation to the resistor 46 through the resistor 66.

In view of the timed biasing effect accomplished by the capacitor 64 the motor 5 will operate for a short interval of time until the capacitor 64 has become fully charged, whereupon the electric discharge devices will cease to operate. This operation of the motor will first be at a comparatively high speed and as the capacitor 64 becomes charged the tube 10 will break down, that is, become conducting at successively later periods of the alternating-current wave. However, if the unbalance still obtains in the Wheatstone bridge arrangement, the electric discharge device 10 will again become conducting after more current passes through the field winding 55.

Operation of the motor 5, of course, changes the position of valve 3 and since it was assumed an insufficient amount of steam was being admitted to the drums 2, valve 3 will be moved upwardly, thus admitting more steam to the drums 2. With a wider opening of valve 3 the pressure in the region 23 of the chamber 22 rises and the diaphragm 24 is moved upwardly. As the diaphragm 24 moves upwardly the piston 25 moves the cylinder 26 upwardly, thereby increasing the air gap in the reactor 34 to reestablish the balance. The piston 25 is provided with leakage apertures so that lever 27, after a time, again takes the balanced position. This permits successive corrections to take place. With the operation of the motor 5 the air gap for the reactor 34 becomes greater until a balance is again established between the reactance of the reactors 14 and 34.

When an excessive amount of steam is admitted to the drum 2, the drag member or block 13 will be actuated toward the left by the spring 17, and in consequence, the air gap will decrease for the reactor 14. This will change the bias on grid 47 of discharge device 11 and cause the motor 5 to operate in a reverse direction. It is, of course, understood that for the reverse operation capacitors 68 and 69 and resistor 70 have the same function as capacitors 64 and 65 and resistor 66, utilized in connection with the discharge device 10.

In the modification shown in Fig. 2, the tension of the material, being a measure of the dry-

ness thereof, is utilized to indicate and control the dryness of the material. The movable armature 16 of the reactor 14 is mounted on a bell-crank lever and the armature 16 is held in a given position of adjustment by a pair of adjustable springs 72 and 73. The armature 16 is mounted on one arm of a bell-crank lever provided with the roller 71 engaging the material 12. The reactor 34 is also mounted slightly differently, but the function thereof is essentially the same.

The electric discharge devices 10 and 11 are controlled in their operation by a phase shift circuit 40 including the capacitors 74 and 75 and the resistors 76 and 77. To vary the bias on the grids of the respective tubes, when an unbalance occurs because of a variation in the dryness of the material, shunt circuits for the respective field windings 55 and 56 are provided, which circuits include capacitors, resistors and a pair of rectifiers. The rectifiers are utilized to prevent the capacitors from discharging through the field windings.

An unbalance occurring in the Wheatstone bridge arrangement will cause the motor 5 to start. However, to prevent the bias of the grid of the particular tube that may be conducting from immediately changing to a stable condition, a shunt circuit is established for the field winding that may be energized. If the field winding 55 is energized, this circuit may be traced through resistor 78, capacitor 79, rectifier 80, conductor 81, resistor 77, conductor 82, capacitor 83 and resistor 84. The temporary change of the current in the resistor 77, while the rectifiers mentioned are being charged, delays the changing of the bias on the grid 45 and in consequence the discharge tube 10 continues to operate until the capacitors are charged, whereupon the operation of the motor ceases.

If the proper balance has not been established on the reactors 14 and 34, the motor may again start operating and this cycle is repeated until the required change in the admission of the steam is made so that the appropriate dryness is effected for the material 12.

If the unbalance is in a different sense than just discussed, it is, of course, apparent that the tube 11 will be operated in a manner similar to that just discussed for tube 10.

I claim as my invention:

1. In a system of control for a drier, in combination, a plurality of drying elements, a valve for controlling the rate of admission of the drying medium to the drier elements, a motor for operating said valve, an electric discharge device connected in circuit relation with the motor and adapted to directly energize said motor, a control grid for said electric discharge device, a timing circuit for preventing the deenergization of the electric discharge device prior to the lapse of a definite interval of time after its energization, and paper dryness indicating means for controlling the grid of the electric discharge device as a function of the dryness of the paper.

2. In a system of control for a drying machine, in combination, a valve for controlling the rate of admission of the drying medium to the drier, a motor for operating the valve, a pair of electric discharge devices interconnected with said motor and adapted to energize the motor for forward

and reverse operation, depending upon which of the electric discharge devices becomes energized, grids for said electric discharge devices, means for changing the bias of the grids, a Wheatstone bridge arrangement including a pair of reactors and a pair of secondary windings of the transformer, and a potentiometer circuit, said means for controlling the grids being interconnected with the potentiometer circuit of the Wheatstone bridge arrangement, means for moving material to be dried through the drier, a friction member engaging the material and controlling the reactance of one of said reactors, and a pressure-responsive device interconnected with the drier and responsive to the pressure of the drying medium in the drier for controlling the reactance of the second reactor.

3. In a system of control for a drier, in combination, means for moving material to be dried through the drier, a friction member engaging the material and controlled in its position by the dryness of the material being dried, an electrical reactor controlled by the friction means, a second electrical reactor responsive to the rate of admission of the drying medium to the drier, a valve for controlling the admission of drying medium to the drier, a motor for controlling said valve, and means responsive to the differential effect of said reactors for controlling the operation of said motor.

4. In a system of control for a drier, in combination, means for moving material to be dried through the drier, a friction member engaging the material and controlled in its position by the dryness of the material being dried, an electrical reactor controlled by the friction means, a second electrical reactor responsive to the rate of admission of the drying medium to the drier, a valve for controlling the admission of drying medium to the drier, a motor for controlling said valve, and means, responsive to the differential effect of said reactors, for effecting the operation of said motor in successive steps.

5. In a system of control for a drier, in combination, means for moving material to be dried through the drier, a tension member engaging the material and controlled in its position by the dryness of the material being dried, an electrical reactor controlled by the tension means, a second electrical reactor responsive to the rate of admission of the drying medium of the drier, a valve for controlling the admission of drying medium to the drier, a motor adapted to control the valve, and means responsive to the differential effect of said reactors adapted to control the operation of said motor.

6. In a system of control for a drier, in combination, means for moving material to be dried through the drier, a tension member engaging the material and controlled in its position by the dryness of the material being dried, an electrical reactor controlled by the tension means, a second electrical reactor, responsive to the rate of admission of the drying medium to the drier, a valve for controlling the admission of the drying medium to the drier, a motor adapted to control said valve, and means, responsive to the differential effect of said reactors, for effecting the operation of said motor in successive steps.

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