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MECHANISM FOR THE CONTROL OF STRIP MATERIALS

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FIG. 1.

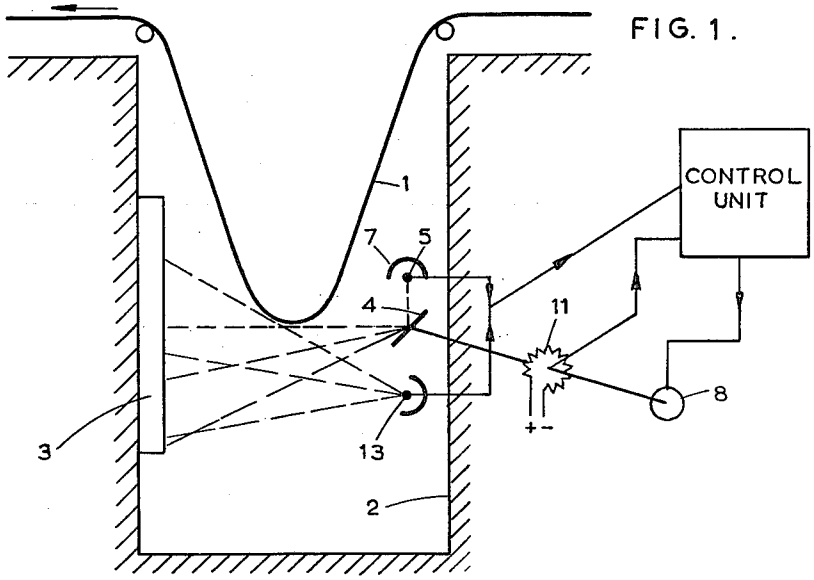
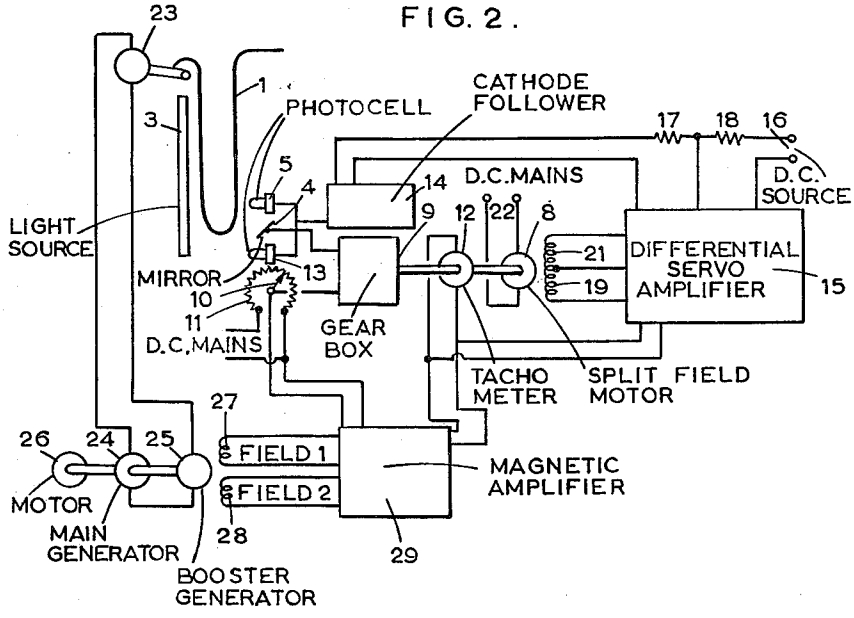


FIG. 2.



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MECHANISM FOR THE CONTROL OF STRIP MATERIALS

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This invention relates to mechanism for the control of movement of strip material being of the kind in which the moving strip is allowed to form a loop under gravity and where the position of the bottom of the loop is sensed by photo-electric means which control the speed of feeding either to or from the loop such that the loop is maintained a constant size irrespective of the speed of movement of the strip.

In our Patent No. 2,888,259 there is described mechanism of the above kind in which the photo-electric means generates signals dependent on both the speed and the actual position of the bottom of the loop, such that the control exerted on the speed of the strip material acts to tend to maintain the bottom of the loop in predetermined position, the signal of speed of the bottom of the loop away from the predetermined position acting additionally to the position signal on the speed of the strip material to restore the bottom of the loop to the predetermined position.

It is an object of the present invention to provide mechanism which is an improvement or modification of the mechanism disclosed in the above patent. The invention is however applicable to other photo-electric control systems for strip material.

More particularly, it is the object of the invention to provide an improved arrangement for sensing the position of the loop which is more reliable and adaptable.

Thus, according to the present invention, there is provided a mechanism of the kind referred to wherein the photo-electric means comprises a first photo-electric device receiving a light beam controlled in accordance with the depth of the loop, and a reference photo-electric device mounted adjacent the first photo-electric device so as to receive a substantially constant amount of light, the two photo-electric devices being so connected that the combined output therefrom is a difference signal.

If desired the system can be modified to form a safety cut-out device which stops the strip feed and/or gives an alarm if the loop should become excessively large or small. In the former case the light beams to both photocells will be cut by the loop so that the difference signal will be approximately zero; in the latter case both photocells will become fully exposed, again producing a difference signal of approximately zero. Thus the safety cut-out is adapted to operate when the difference signal becomes zero.

A preferred embodiment of the invention will now be described with particular reference to the accompanying drawings wherein:

FIGURE 1 is a schematic representation showing the arrangement of the light source, the loop and the photo-electric means; and

FIGURE 2 is a schematic representation of a system for controlling the movement of strip material incorporating the present invention.

The invention will be described by way of example to the control of movement of thin metal strip material. Such material in passing from one machine to another is required to hang in a loop between two supporting rollers so as to provide a certain reserve of material as is well known in the art.

Referring to FIGURES 1 and 2, the loop 1 of strip material is located in a light-tight pit or chamber 2; it

being arranged that the spaces between the loop and the sides of the pit or chamber 2 are of minimum area. On one side of the loop in the pit or chamber is located an elongated light source 3, preferably one with a light-emitting area of substantial height, such as a fluorescent tube mounted vertically. A mirror 4 is rotatably mounted at the end of the pit 2 remote from the light source 3, to receive light therefrom and reflect it upwards on to the light-sensitive surface of a main photo-electric cell 5 as shown by the broken lines in FIGURE 1. A shield 7 around the photocell prevents direct illumination from the light source impinging on the photocell 5 and limiting the light to that which is reflected from the mirror 4 only. The mirror 4 is rotated by a split field motor 8 through the medium of a gear box 9. A further drive from the gear box 9 rotates the movable contact 10 of a potentiometer 11 which is connected across a fixed D.C. source. The drive from the split field motor 8 operates a tachogenerator 12 which generates a D.C. voltage proportional to motor speed. The mirror is rotatably mounted and controlled by the electric motor as described in our Patent No. 2,888,259 to provide a strip control characteristic responding to the rate of change of the loop as well as its actual position.

Underneath the mirror 4 and main photocell 5, a reference photo-electric cell 13 is mounted so as to receive a substantially constant amount of light from the light source 3 so long as the loop 1 lies within its normal operating range of positional variation; the reference photo-electric cell 13 being connected with the main photo-electric cell 5 as shown in FIGURE 1, so as to produce an output signal which varies as the difference between the outputs of the two photo-electric cells 5 and 13. The two cells may be connected in series opposition or may be coupled in any suitable manner to produce the desired signal responsive to the difference of the light beams striking the cells.

The advantage of the above arrangement is that stray light, such as that due to leakage into the pit or chamber housing the loop, irradiates both photocells similarly and therefore the "difference" output is affected only by changes in the position of the loop. Preferably the reference cell 13 receives a light beam similar to the controlling beam but of constant size, so that any variations in the light intensity at the source 3 (e.g. due to supply voltage fluctuations, dust on the bulb or deterioration of the bulb) will affect both photocells equally and the tendency will be to cancel out any consequent changes in the output signal. This arrangement, moreover, reduces the effect of variations in the sensitivity of the photo-electric cells (e.g. due to ageing or temperature changes).

The difference signal from the outputs of the two photocells 5, 13, is initially amplified in a pre-amplifier 14 of the cathode-follower-output type and the output passes to differential servo amplifier 15. The output before being fed into the amplifier 15 is balanced against the voltage from a D.C. source 16 through the medium of two resistors 17 and 18. The output of the tachogenerator 12 is also fed into the differential servo amplifier 15. The outputs from the amplifier 15 are fed to the two halves 19 and 21 of the field of the split field motor 8. These two outputs are arranged in opposition so that the magnetisation of the field of motor 8 represents an amplified version of the difference of the two inputs to amplifier 15. The rotor of the motor 8 is fed from a D.C. source 22 of constant value so that rotation of the motor is dependent upon the direction of magnetisation of the field.

The above arrangement enables the position of the loops 1 to be sensed and the operation is similar to that described in our Patent No. 2,888,259 where if an excess of light falls on photocell 5, split field 19 and 21 is ener-

gised through amplifier **15** to cause motor **8** to rotate, driving mirror **4** in such a direction that the amount of light passing the bottom of the loop and being reflected from the mirror to the photocell **5** is reduced. The output from the tachogenerator **12** provides a velocity signal, the feed-back preventing any tendency for the system to oscillate, whilst at the same time allowing the mirror **4** to follow accurately and reasonably quickly the bottom of loop **1**.

The manner in which signals indicative of the speed and the actual position of the bottom of the loop are used to control the speed of movement of the strip material, has already been fully described in Patent No. 2,888,259 and will only be briefly described herein to facilitate a full understanding of the present invention.

Movement of the strip forming the loop **1** is controlled by a D.C. electric motor **23** (FIGURE 2) which obtains its supply of current from two generators in series, one being a main generator **24** and the other a booster generator **25**. These two generators are driven from an electric or other motor **26** rotating at a substantially constant speed. The booster generator **25** includes two field windings **27** and **28** which are energised from a magnetic amplifier **29**. The magnetic amplifier is controlled by the voltage selected by moving contact **10** of potentiometer **11** and the output voltage of tachogenerator **12**.

In operation, whilst the loop is moving, the mirror **4** continuously seeks an equilibrium position to allow a certain amount of light to impinge on photocell **5**. Signals indicative of the position and angular velocity are fed to the control windings of the magnetic amplifier **29** to produce a voltage at the output of the booster generator **25** which aids or opposes the output from generator **24** according to the relative magnitudes of the position and velocity voltage signals, thereby controlling the speed motor **23** according to whether the feed of the strip is faster or slower than a predetermined value, substantially as described in detail in the aforesaid patent.

It will be appreciated that the control system for the mirror **4** operates to maintain a predetermined constant amount of light on the photocell **5** and that the angle of the mirror necessary to give this condition is a measure of the loop depth. With the arrangement of the present invention, the difference in output of the main and reference photocells **5**, **13**, is maintained constant by the mirror control system operating on the active photocell only, and the angle of the mirror shaft is again a measure of the loop depth.

It will be understood that the above details are given by way of example only and that various modifications may be made. In place of either or each photocell, an equivalent device such as a photo-transistor may be used.

I claim:

1. A strip material control apparatus for a strip delivery means, comprising a chamber, a variable speed driving motor for the strip material, means to maintain a downward loop of the strip material under gravity in said chamber, a photoelectric means to generate signals in accordance with the position and the vertical velocity of the bottom of the loop and a control for the variable speed motor energized by said signals to adjust the motor speed to cause the bottom of the loop to move to a predetermined vertical position and to tend to reduce vertical velocity of the bottom of the loop away from the predetermined position, said photo-electric means comprising a vertically elongated single light source in said chamber, a first photo-electric device in said chamber receiving a light beam from said source controlled in accordance with the depth of the loop, a reference photo-electric device mounted in said chamber below the first photo-electric device so as to receive a substantially constant amount of light from said source, means connecting the two photo-electric devices so that the combined output therefrom is a difference signal, a servo controlled light directing means to adjust flow of light from the source to the first photo-electric device below the bottom of the loop, a servo control energized by said difference signal to adjust the light passing below the bottom of the loop and falling on said first photo-electric device to a predetermined amount, and position and velocity signal generators operated by the servo controlled light directing means.

2. The structure of claim 1, and wherein the photo-electric means generates signals dependent on both the speed and the actual position of the bottom of the loop, and means operated in accordance with said speed-dependent and position-dependent signals to control the variable speed driving motor to maintain the bottom of the loop in a predetermined position in said chamber.

3. The structure of claim 1, and a control device operating responsive to a difference signal of a predetermined value to provide an indication of excessive variation in the depth of the loop.

4. The structure of claim 1, and wherein at least one of the photo-electric devices is a photo-transistor.

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