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(54) CONTROL DEVICE FOR WEB-HANDLING MACHINES

(71) We, ASEA AKTIEBOLAG, a Swedish Company of Västerås, Sweden, do hereby declare the invention for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following Statement:-

This invention relates to a control arrangement in machining webs, such as paper machines with at least two roll pairs and/or tensioning or stretch rolls, each having a driving means with amplifier for speed control.

In Swedish Patent Specification No. 388,547 there has been proposed a control device for use in a paper web-handling machine having at least two roll pairs and/or stretch rolls with a driving means and amplifier for speed control of each roll pair or stretch roll and with measuring means between roll pairs and/or roll pairs and stretch rolls for measuring the condition of the paper web. The measuring signal is arranged to be supplied to an amplifier or adder, whose output signals are of digital kind and adapted to be supplied to a digital multiplier together with additional signal having a value dependent on the diameter of the corresponding driven roll, the gear ratio, and/or the desired tensioning of the paper web. The output signal of the multiplier is adapted to be supplied to the corresponding speed amplifier. Thus, if the output signal from an adder 1 is $V_0 \times S_1$, where V_0 is the basic speed reference and S_1 the tensioning signal in the corresponding driving means, the output signal from an adder 2 will be $V_0 (S_1 + S_2)$, where S_2 is the tensioning signal in the corresponding driving means, and the output signal from an adder 3 will be $V_0 (S_1 + S_2 + S_3)$.

This type of control works well with, for example, paper webs when it is a question of small values of S , but when this is an arithmetical progression an unreasonably

high influence on a subsequent driving means will be obtained in the case of greater tensioning values, for example 10%.

The present invention aims to provide an improved control device for a web-handling machine.

According to the invention a control device for a web-handling machine having at least two roll pairs and/or tensioning or stretch rolls, each with a driving means and amplifier for speed control, summators being used and supplied with signals from the output side of a preceding or subsequent summator in the direction of working, the output signals of the summators being digital and fed to a digital multiplier together with a digital multiplication signal with a value dependent on the diameter of the corresponding driven roll, the gear ratio and/or the desired stretching of the web, is characterised in that the summators are supplied with signals corresponding to the output signal from a preceding or subsequent summator and from a basic reference voltage source, respectively, multiplied by $1 + S$, where S is the desired relative speed difference (tensioning value) between the driving means to the speed amplifier of which the summator is directly or indirectly connected, and the adjacent driving means, possibly supplemented with an error signal from a corresponding measuring device located between the roll pairs of at least one pair of adjacent roll pairs, or between at least one pair of adjacent tensioning or stretch rolls or between a roll pair and an adjacent tensioning or stretch roll.

A geometrical progression is thus obtained for the input signals to the summators (for summator 2, for example $V_0(1 + S_1)(1 + S_2)$), and the speed relations for summators after an adjustment of a summator are maintained. This makes greater speed adjustments possible, which would not be possible with the control devices

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according to the above-mentioned published Swedish application.

The invention will now be described, by way of example, with reference to the accompanying drawing, the single Figure of which is a schematic diagram of a paper machine.

The machine shown in the drawing has a number of roll pairs 1, 2, 3 and stretch rolls 4, 5, 6 and 7. The roll pairs 1 to 3 and the stretch rolls 4 to 7 are provided with driving means 11, 12 13, 14 15, 16 and 17, respectively. Each of the driving means is a part of a servo system which includes a motor, a tachometer generator and a servo amplifier. The servo systems obtain input signals, developed in a manner described below, relating to a desired speed and compare these with the actual speed output of the tachometer generator to cause the motor to maintain the desired speed in well known fashion. Upstream of the first set of rolls is a conventional apparatus 51 which establishes the paper web and which is driven by an amplifier (not shown) having as an input a desired speed signal $n_0 \text{ref}$. This signal is obtained from a multiplier 53 in which a signal $V_0 + Cr$ obtained from an adder 55 is multiplied by a constant $K_0 I_f(oz)$, this latter signal being a function of a diameter of its associated drive roll, the gear ratio and/or the desired tensioning of the paper web. V_0 is the basic reference voltage for the apparatus and Cr is simply a correction factor. The signal V_0 is obtained from ramp device 18 which obtains an input from a speed set signal on line 57. The ramp device 18 is of conventional design and acts so as to prevent a change at the input from being immediately felt at the output. Thereby rapid changes of the speed in the system cannot take place, but are caused to take place over a period of time. Similar multipliers 53 and adders 55 are associated with each of the other drives.

All that has so far been described is conventional. The improvement of the present invention resides within the apparatus of block 60 (shown in dotted lines) which apparatus develops the reference input signal to the adders 55. As previously indicated, the signals from the adders of the control device described in Swedish Patent Specification No. 388, 547 were given by $V_0(S_1 + \dots S_n)$, where n is the number of the particular roll pair. However in accordance with the present invention, for the first pair of rolls 1 and their associated driving means 11 a signal is developed by first multiplying the signal V_0 by S_1 in a multiplier 31. This signal is then summed with V_0 in an adder 21 so as to develop as an output, for input to the associated adder 55, a signal $V_0(1 + S_1)$. As is indicated the adder can also have as an input a conventional correction factor Cr .

The output signal from the adder 21 is supplied, in the direction of working (arrow A), to a subsequent (or preceding) adder 22 and to a multiplier 32. In the multiplier 32 the signal $V_0(1 + S_1)$ is multiplied by a set relative speed difference S_2 between the driving means 12 and 13, to provide an output signal $V_0(1 + S_1)S_2$ which is supplied to the adder 22 together with the signal $V_0(1 + S_1)$. The output signal of the adder 22 is therefore proportional to $V_0(1 + S_1)(1 + S_2)$. It follows that the output signal of the next adder 23 will be proportional to $V_0(1 + S_1)(1 + S_2)(1 + S_3)$ - i.e. the output signal follows a geometrical progression.

A measuring device may be provided at the respective sections of the paper machine. One such measuring device 32' is shown in the drawing and has an output signal δ which is supplied with a desired reference value δ_r to an adding and integrating device 43. The output, i.e. the error signal $\delta - \delta_r$ from the device 43, is used as the value S_4 which is supplied to a multiplier 34. The output signal from the corresponding adder 24 will be $V_0(1 + S_1)(1 + S_2)(1 + S_3)(1 + S_4)$, etc. The device is built up with digital technology and, as can be seen, an altered setting of S_1 does not involve any relative speed alteration between the other section. At SLACK, the desired slack in the paper web is set at the respective section.

S will constitute a direct setting of the relative speed alteration in relation to the immediately preceding section. The arrangement provides a mathematically correct succession for all values of S , at the same time as the factor S corresponds to the desired quantity to be set.

The main demand on the control system is that it should be possible to make speed adjustment in dependence on variations in the properties of the paper web without the risk of a web break.

The basic speed V_0 is established as a digital value proportional to the desired machine speed, at ramp means 18. Upon starting, the output signal is gradually increased, stepwise until it corresponds to the desired machine speed.

When or if the set speed is changed, the transition to the new value also takes place gradually. The linear ramp device 18 has a knee at the beginning and the end of the change. In most cases it is sufficient to select a ramp having a long integration time for paper machines.

A device according to the invention permits an automatic cascade control of the draw setting. When a draw change occurs or a slack arises within one section (between two driving sections), the subsequent sections are automatically adjusted in order to achieve an unaltered draw between the driven sections.

WHAT WE CLAIM IS:-

1. A control device for a web-handling machine having at least two roll means each controlled by an associated servo system including driving means for the associated roll means, each servo system having associated therewith digital multiplying means having first and second inputs and an output connected to an input of its associated servo system, and summing means adapted to develop a digital reference signal at its output of its associated multiplying means, the second input of the associated multiplying means being adapted to be supplied with a digital signal having a value proportional to at least one of the diameter of the corresponding driven roll means, the gear ratio and the desired stretching of the web, and means, connected between the two summing means associated with the or each adjacent pair of roll means, for developing the reference signal at the output of one of the said two summing means, which last mentioned reference signal has a value corresponding to the output of the other of the said two summing means multiplied by $1 + S$, where S is the desired relative speed difference between the two driving means of the associated adjacent pairs of roll means.
2. A control device according to claim 1, in which the or each roll means consists of a roll pair, or tensioning or stretch rolls.
3. A control device according to claim 1 or 2, in which the summing means associated with the first roll means in the direction of working of the web is adapted to be supplied with the input signal $V_o(1 + S_1)$ where V_o is the output signal from a basic reference voltage source and S_1 is the relative speed difference between the driving means of the first roll means and an adjacent driving means.
4. A control device according to any of the preceding claims, comprising a measuring device located between the roll means of at least one pair of adjacent roll means, and means for using the output of said measuring device in determining said value of S for the or each pair of adjacent roll means.
5. A control device according to any of the preceding claims, in which said means connected between the said two summing means comprises a multiplier having a first input supplied with the signal S , a second input, and an output connected to a first input of the said one summing means, and means connecting the output of the said other summing means both to said second input of the multiplier and to a second input of the said one summing means.
6. A control device for a web-handling machine constructed and arranged substantially as herein described with reference to, and as illustrated in, the accompanying drawing.

7. A web-handling machine comprising a control device as claimed in any of the preceding claims.

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