

5 The invention relates to a method of controlling at least one electric motor at an offset printing machine having a device for forming and allocating a rotational-speed reference value for the at least one electric motor.

10 In the control of electric motors in printing machines, particular requirements are placed on the regulating characteristics of the drive. One important application is the rotational-speed regulation. Its aim is to set and to maintain as accurately as possible a rotational speed of the electric motor, which rotational speed is determined by a predetermined reference value. This predetermined rotational-speed reference value can be given, for example, with the aid of a potentiometer (cf. in this context: Zach, Franz, Leistungselektronik: Bauelemente, Leistungskreise, Steuerungskreise, Beeinflussungen [Power electronics: construction elements, power circuits, control circuits, influences], Springer Verlag Vienna, New York, 1979).

20 An arrangement is also known from DE-A 3,318,250, which ensures the preset rotational speed with great constancy, in that comparisons of the rotational-speed reference value and the rotational-speed actual value are carried out, thus enabling the predetermined rotational speed to be kept constant by appropriate measures. This arrangement has no influence on the predetermined rotational speed as such, the predetermined rotational-speed value is merely kept constant, but the predetermined rotational-speed value is not changed.

30 However, particular demands are also placed on such drive controls in printing machines on the characteristics of the line supply, on the cooling of the modules and on the loading conditions (cf. in this context: Allgemeine Elektrizitäts-Gesellschaft AEG-Telefunken; Hilfsbuch der Elektronik [AEG Telefunken; manual of electronics], Berlin, Frankfurt, 1979; Kolb, Otto, Stromrichtertechnik [Power converter technology], Volume 1, AT Verlag, Aarau, Stuttgart, 1984; Hartel, Walter, Stromrichterschaltungen [Power converter

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circuits], Springer Verlag, Berlin, Heidelberg, New York, 1977). If these requirements are not met, malfunctions, which are reflected in the printing result, but at least, however, undesired stoppage times of the printing machines are to be expected.

The underlying object of the invention is to develop a method which guarantees the continuation of the production of the printing machine under boundary conditions, such as undervoltage, increased ambient or motor temperatures and increased moment demand with as great a printing output as possible.

According to the invention, the object is achieved by the characterising clause of Claim 1. Even if the line voltage of the supply line dropped slightly below the tolerance range, the drive of the printing machine hitherto had to be switched off. By the rotational-speed control according to the invention, the production of the printing machine can be continued in so-called emergency operation.

A further advantage of the invention is that the temperature of the electric motor is measured, and the rotational-speed reference value of the electric motor is reduced if the temperature is exceeded. In the case of drives in printing machines, whose moment characteristic curve drops with decreasing rotational speed, it is possible, even if the ambient temperature is excessively increased and/or the cooling output of the cooling units of the electric motor is reduced, to continue the production of the printing machine by decreasing the rotational speed. This obviates the need for an undesirable switching-off of these modules when the boundary temperature is reached.

The temperature of the drive elements of the electric motor is advantageously measured, and the rotational-speed reference value of the electric motor is reduced if a temperature excess occurs. Consequently, reduced cooling output of the cooling units of the drive elements can be counteracted by decreasing the rotational-speed reference value and a temporary stoppage

of the printing operation can be avoided.

It likewise proves to be an advantage that the driving torque of the printing machine is recorded and that the rotational-speed reference value of the electric motor is reduced if the moment is exceeded.

Since the current of the electric motor is a function of the loading moment, the armature current of the motor is recorded and, when a predetermined boundary value of the current is reached, the armature voltage is reduced in such a way that the armature current does not increase further.

It is now also possible to regulate the rotational speed of the electric motor at a correspondingly reduced armature voltage, which also has the consequence of reduced drive output. The driving torque is preferably recorded at such points which bring about a power-flow, e.g. at drive shafts of electric motors, or at such points which are to be reliably protected from overloading, e.g. damping units or other consumers, whose moment demand is dependent on handling by the operator.

For a printing works, this means that the production of the printing machine can be continued, consequently avoiding the annoying cleaning work of blankets and printing plates during prolonged stoppage times caused by the switch-off, and even the cleaning work of the damping and/or inking units. The rotational-speed reference value can advantageously be reduced by the abovementioned influencing parameters or a combination of these influencing parameters. The determinant influencing parameter is in each case the one which has the greatest influence on the rotational-speed reference value.

The invention is to be discussed in greater detail below with reference to the drawings, in which Figure 1 represents a flow diagram which (lacuna) the sequence up to the change of the reference value of the rotational speed of the motor, Figure 2 represents a circuit diagram for changing the reference value of the rotational speed of the motor, and

Figure 3 represents a characteristic curve of a monitoring unit.

Since, in the present case, the understanding of the description is facilitated in conjunction with Figure 1, apart from reference numerals Figure 1 also contains details in words relating to the meaning of the individual elements contained in Figure 1.

Figure 1 shows the process stages which are necessary to fulfil all the claimed features of the device. The drive is given a rotational-speed reference value 2 in the form of a voltage ${}_1U_{so11}$ 2. This rotational-speed reference value ${}_1U_{so11}$ 2 is in a linear correlation with the desired rotational speed of the driving electric motor. In the next process stage 3, the counter reading of the counter is set at "zero". This counter merely serves for explaining the process stages in the flow diagram. At the enquiry 4, the counter reading is examined.

Since at this point in time the counter value is "0", the measurement 5 of the line voltage U_N takes place. Subsequently, at the decision 6, the voltage value is compared with the product of the predetermined rotational-speed reference value ${}_1U_{so11}$ 2 and a factor k . This factor k is a conversion factor and takes into account, in terms of value, the association of the rotational-speed reference value ${}_1U_{so11}$ 2 with the armature voltage of the electric motor 31, which voltage is the maximum permissible for the drive.

If the supply voltage of the drive is smaller than this product, the rotational-speed reference value voltage ${}_2U_{so11}$ 7 is formed which is a product of the measured line voltage U_N and the factor $1/k$. This guarantees that, in the case of undervoltage, the armature voltage of the electric motor 31 does not exceed the maximum permissible for the drive. Process stage 8 then follows.

If, at the decision 6, the measured supply voltage is not smaller than the product of k and ${}_1U_{so11}$, ${}_2U_{so11}$ 7 is fixed at the same value as ${}_1U_{so11}$. Process stage

8 then follows.

In process stage 8, the counter reading is increased by 1, then at output 9 the reference value ${}_2U_{soll} 7$ is output and relayed to the rotational-speed regulator module 23. Then the counter reading enquiry 10 takes place. Since the counter reading is "1" according to the previous description, that is to say not equal to "3", at enquiry 4 the counter reading is queried again. Since at this point in time the counter reading is "1", that is to say not equal to "0", it is referred to decision 15, at which the counter is queried concerning the counter reading "1".

Since the counter reading is now "1", the measurement 11 of the temperature T takes place and, if the maximum boundary temperature T_{max} is exceeded (enquiry 12), in the process stage 13 the reference value voltage ${}_2U_{soll} 7$ is adapted in accordance with the permissible boundary temperature. Process stage 8 then follows.

For the case of the boundary temperature T_{max} not being reached at enquiry 12, the reference value voltage ${}_2U_{soll} 7$ is fixed at the same value as ${}_1U_{soll} 2$. Process stage 8 then takes place, in which the counter reading is increased by "1". The reference value ${}_2U_{soll} 7$ is output in the following output 9.

Since the counter reading is "2" after the previous operation, that is to say not equal to "3", at enquiry 4 the counter reading is queried again. Since at this point in time the counter reading is "2", that is to say not equal to "0", it is referred to decision 15, at which the counter is queried concerning the counter reading "1".

Since the counter reading is now "2", the measurement 16 of the torque M takes place and, if the maximum driving torque M_{max} is exceeded (decision 17), the reference value voltage ${}_2U_{soll} 7$ is decreased in process stage 13 by a fixed amount which is, inter alia, dependent on the moment characteristic curve of the prevailing load. Process stage 8 then takes place. For the case of the maximum driving torque M_{max} not being reached at

decision 17, ${}_2U_{sol1}$ 7 is fixed at the same value as ${}_1U_{sol1}$. Process stage 8 then takes place, in which the counter reading is increased by "1". The reference value ${}_2U_{sol1}$ 7 is output in the following output 9.

5 Since the counter reading is "3" after the previous operation, it is referred to process stage 3, in which, as at the beginning, the counter reading is set to "0". The operation proceeds as already described.

10 As reference value voltage ${}_2U_{sol1}$ 7, the lowest value in each case after a complete run is output in output 9 and maintained over a further run.

Figure 2 represents a diagrammatic illustration of the drive control having a device for changing the rotational speed of the electric motor 31.

15 The line voltage U_N 32 supplies the electric motor 31 via the power converter 33. The measurement of the rotational speed of the motor takes place via the tachometer generator 22 which is connected mechanically to the motor shaft (not illustrated) of the electric motor 31.
20 The tachometer generator 22 generates the rotational-speed actual value and makes the latter available to the rotational-speed regulator module 23 which forms the comparison between the reference value 21 and this rotational-speed actual value and supplies an output
25 signal, which corresponds to the desired regulating characteristics, to the current regulator module 26. Based on this information and the information on the current level which is recorded by a current transformer 25, the current regulator module 26 forms the drive
30 signal for the power converter 33.

35 The claimed device 18 receives as input parameter the reference value ${}_1U_{sol1}$ 19. As already described, the output parameter ${}_2U_{sol1}$ 21 is formed in the device 18 and made available as reference value input parameter to the rotational-speed regulator module 23. Significant influencing parameters for the output parameter ${}_2U_{sol1}$ 21 can be U_N , U_T and U_M (N stands for line, T stands for temperature, M stands for torque). The reference value ${}_1U_{sol1}$ 19 is formed by a reference value generating device (not

illustrated) which, in the simplest case, can be a potentiometer, for example. The reference value ${}_1U_{so11}$ 19 corresponds to the value of the desired rotational speed of the motor. The input parameter U_T is generated by a
5 temperature signal generating device 20. In said device, the measurement voltage, generated by a thermocouple, for example, is increased and adapted to a corresponding voltage level. The input parameter U_M is generated in the example with the aid of the same current transformer 25
10 which supplies the current actual value to the current regulator module 26.

Figure 3 shows the characteristic curve 27 of the reference value voltage ${}_2U_{so11}$ as a function of the reference value voltage ${}_1U_{so11}$. The uninterrupted characteristic curve 27 represents the course of ${}_2U_{so11}$ if the
15 supply voltage, the temperature of the drive elements and the moment loading are within the permissible range. The dashed characteristic curves 28, 29, 30 show the course of ${}_2U_{so11}$ if one of the abovementioned conditions is not
20 met. Depending on the size of the deviations, different limits result, as described, for the characteristic curves 28, 29, 30 of ${}_2U_{so11}$.

The decrease in the reference value can also be undertaken manually after a visual and/or acoustic alarm
25 which indicates the fulfilment of one of the above-mentioned features.

List of reference numerals

- 1
- 2 Rotational-speed reference value
- 3 Process stage
- 4 Enquiry
- 5 Measurement
- 6 Decision
- 7 Rotational-speed reference value voltage ${}_2U_{soll}$
- 8 Process stage
- 9 Output
- 10 Counter reading enquiry
- 11 Measurement
- 12 Enquiry
- 13 Process stage
- 14 Fixing
- 15 Decision
- 16 Measurement
- 17 Decision
- 18 Device
- 19 Reference value ${}_1U_{soll}$
- 20 Temperature signal generating device
- 21 Reference value
- 22 Tachometer generator
- 23 Rotational-speed regulator module
- 24 Temperature sensor
- 25 Current transformer
- 26 Current regulator module
- 27 Characteristic curve
- 28 Characteristic curve
- 29 Characteristic curve
- 30 Characteristic curve
- 31 Electric motor
- 32 Line voltage
- 33 Power converter

Patent claims

1. Method of controlling at least one electric motor (31) at an offset printing machine, having a device (18) for forming and predetermining a rotational-speed reference value (21) for the at least one electric motor (31), characterised in that the rotational-speed reference value (21) is reduced as a function of the line voltage measured, if the line voltage is inadequate, and/or as a function of the temperature measured, if the permissible temperature of the electric motor and/or of its control elements is exceeded, and/or as a function of the moment measured, if the permissible moment demand is exceeded.
2. Method of controlling at least one electric motor at an offset printing machine according to Claim 1, characterised in that the driving torque of the printing machine is recorded by means of a strain gauge.
3. Method of controlling at least one electric motor at an offset printing machine according to Claim 1, characterised in that the driving torque is recorded by measuring the current of the electric motor (31).

