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EP 0 413 445 B1

Description

This invention is concerned with improvements in or relating to folding machines, comprising a main drive shaft driven by a motor, folding instrumentalities arranged at an operating locality of the machine, workpiece feeding means operable in timed relation with the rotation of the main drive shaft for feeding a workpiece to be folded through the operating locality, and operator-controlled feed speed variation means for varying the speed of rotation of the main drive shaft.

One such machine is described in EP-A-0 110 591 wherein the motor by which the main drive shaft is driven incorporates an integral clutch-and-brake arrangement together with an electronic control, whereby the output speed of the motor can be accurately controlled, and the operation of the motor is under the control of the operator via a foot treadle connected to the motor, and more specifically to the electronic control arrangement thereof, by a mechanical linkage. Apart from the fact that such a motor arrangement is relatively expensive, in addition the degree of control of the speed of rotation of the main drive shaft is not especially high, in so far such control relies solely upon the manipulation of the foot treadle. For example, in the case of an inexperienced operator wishing to operate the machine at less than full speed, such an operator has to control the reduced speed range using only that amount of travel of the foot treadle to which the desired speed range relates, so that in effect the control of the rotational speed becomes more coarse over the reduced speed range than is the case where the more experienced operator is using the full speed range. Clearly, therefore, the speed control arrangement in this case acts against the inexperienced operator when it would be preferable for the speed control arrangement to accommodate the learning cycle. Again, in other circumstances it may be desirable to operate the machine at a constant feed in circumstances where, because of the size of the workpiece, the operator is unable to actuate the foot treadle, but clearly the feed speed (and thus the rotational speed of the main drive shaft) will have to be set appropriate to the workpiece and will certainly not always be the maximum feed speed of the machine. To cater for such circumstances, therefore, a higher degree of control of the rotational speed of the main drive shaft is again desirable.

It is thus the object of the invention to provide an improved folding machine in which a higher degree of control of the speed of rotation of the main drive shaft is achieved without additional expenditure on the speed control arrangement, but preferable rather with a cost reduction in this regard.

This object is resolved in accordance with the present invention, in a machine as set out in the first paragraph above, in that the motor for the main drive shaft is an a.c. induction motor provided with an inverter, and in that the feed speed variation means comprises a transducer providing an analogue output which is variable according to the setting of the transducer under operator control, the machine being further characterised by an analogue-to-digital converter which receives the analogue output of the transducer and converts it to a digital value which is thus variable in accordance with the setting of the transducer, computer control means for receiving the digital value and for modifying it in accordance with one or more inputs each in the form of a signal having a value determined according to an operational setting of the folding machine, and a digital-to-analogue converter for converting the digital value, thus modified, to an analogue drive signal which is supplied to the inverter, such that the speed of rotation of the a.c. motor, and thus of the main drive shaft, is determined in accordance with the setting of the transducer, but modified in accordance with one or more of said inputs.

It will thus be appreciated that in the machine in accordance with the invention the speed of rotation of the main drive shaft is now controlled by the computer control means, thereby providing the facility not only for greater speed control, as will be discussed in greater detail hereinafter, but also enabling the speed control arrangement to be integrated into the main control system of the machine. At the same time, by replacing the clutch-and-brake arrangement of the earlier machine with a simple transducer, which can of course be incorporated within the foot treadle, a simpler and less expensive operator-actuable control is achieved.

In one embodiment of the present invention, the machine comprises conventional workpiece feeding means, viz. an orbitally movable hammer-and-anvil arrangement driven by the main drive shaft. In such embodiment, advantageously the output of the transducer may be dedicated over different sections of its range to different functions. Thus the output may correspond, according to its value, to a "stop" condition, a "drive" condition or a condition in which the operation of the machine is stopped with the hammer-and-anvil in a closed condition. To this end the treadle or like control may be biased away from one end of the traverse of the transducer into its "stop" condition, so that it can be moved in one direction of traverse to its "drive" condition or in an opposite direction to said further condition. It will of course be appreciated that in the "drive" condition the output will be variable over a relatively wide range to provide the workpiece feed speed variation function of the treadle.

One advantage of utilising the computer control means to control the speed of rotation of the main drive shaft is that the possibility of a feedback arises and preferably in accordance with the invention monitoring means is provided whereby the speed of rotation of the main drive shaft is monitored, and more particularly the drive signal supplied to the inverter from the computer control means is modified by an input from the monitoring means if and to the extent that the actual speed of rotation as monitored does not match the notional speed which corresponds to the particular setting of the transducer, such modification being such as to effect matching of said actual speed with said notional speed.

For facilitating control of the workpiece feed, furthermore, speed range variation means may also be provided which provides an input to the computer control means whereby the speed range, within which the speed of rotation of the main drive shaft can be varied under the control of the operator as aforesaid, can be varied, the variation being proportional in respect of any setting of the feed speed variation means such that for a given such setting the speed of rotation of the main drive shaft will vary in accordance with the proportion set by the speed range variation means. Such a machine, it will be appreciated, thus enables not only the maximum operation speed of the machine to be pre-set, which can in itself be advantageous, but further, by proportionally varying all the speeds within the selected speed range, enables the selected speed range to be controlled in response to the whole of the allowed travel of the feed speed variation means, so that the degree of control afforded by the foot treadle or the like is not rendered coarser by reason of a reduction in the maximum operational speed.

In the machine in accordance with the invention, furthermore, conveniently feed length variation means is provided for varying the distance through which a workpiece is fed by the workpiece feeding means for each rotation of the main drive shaft. In said machine the feed length variation means comprises an n.c. motor operation of which is effective, in response to control signals supplied by the computer control means, to displace a feed length control lever whereby to cause the feed length to be varied, and the computer control means calculates the rate at which a feed length variation is to take place based upon the required displacement of said lever to achieve a desired feed length variation and also the speed of rotation of the main drive shaft.

It will of course be appreciated that the invention is also applicable to so-called thermo-cementing and folding machines, more particularly of the aforementioned type comprising also adhesive supply means, including a gear pump driven by an n.c. motor, for supplying adhesive to portions of a workpiece to be folded as it is fed through the operating locality of the machine by the workpiece feeding means, the computer control means also supplying to said n.c. motor a drive signal the value of which is dependent upon the speed of rotation of the main drive shaft and operational state of the feed speed variation means. In the machine in accordance with the invention, furthermore, preferably said drive signal, and thus the rate of adhesive supply, is dependent upon the value of the digital signal supplied to the computer control means, but modified as aforementioned. In this way, therefore, the drive signal to the n.c. motor can be varied not only according to the feed speed, as detected by the monitoring of the main drive shaft rotation, but also proportionally with the value of the signal applied by the adhesive supply rate setting means, so that an even deposition of adhesive can be achieved regardless of the feed speed and the rate of adhesive supply required. In the machine in accordance with the invention, furthermore, operator-actuable means may be provided which provides an input to the computer control means and by which a plurality of pre-settings can be made for the workpiece feed length for selection according to the contour of the workpiece edge to be folded, the arrangement being such that the feed length variation means is effective to set the feed length in accordance with a selected one of such settings upon receipt of an appropriate signal from the computer control means. In practice, preferably the "standard" pre-set feed length is the feed length which is used when a straight portion (i.e. a portion without significant edge curvature) of the workpiece is being processed, while the other pre-set feed lengths are introduced when portions of significant curvature, usually referred to as "outside" or "inside" corners of the workpiece, are being treated. By an "outside" corner, where referred to herein, is to be understood an edge portion having a curvature the centre of which lies within the body of the workpiece, and an "insider" corner refers to an edge portion of curvature the centre of which lies outside the main body of the workpiece. (It will be appreciated that in folding an outside corner in general an amount of material is folded over which is in excess of the material onto which it is being folded so that it is necessary to "pleat" the folded edge, while in the case of an inside corner less material is being folded over and it is necessary often to "snip" the folded edge in order to distribute it evenly.

As in the machine disclosed in EP-A 0110591 preferably the workpiece detecting devices are disposed at or adjacent the operating locality of the machine and comprise a "workpiece present" detecting device, which serve to detect the presence of a workpiece, and also a "corner" detecting device which serves to detect the approach of both "outside" and "inside" corners (as hereinbefore defined) to the operating locality as the workpiece is being fed therethrough. In the operation of the machine detection of an approaching corner thus serves to cause an appropriate one of the pre-set feed lengths to be selected while the "workpiece present" detecting device causes the supply of adhesive to be initiated when the presence of a workpiece is detected thereby. Moreover, in the machine in accordance with the invention conveniently operator-actuable means is provided by which an input is provided to the computer control means whereby the feed speed variation means is disabled and the "workpiece present" detecting device is enabled to initiate also operation of the workpiece feeding means when the presence of a workpiece is detected thereby, the speed of rotation of the main drive shaft being set at the maximum within the selectively set speed range and the various pre-set feed lengths being selected according to the contour of the workpiece edge as detected by the "corner" detecting device. In this way, it will be appreciated, the operator can control the operation of the machine without accessing the transducer, it being of course desirable that the maximum feed speed as set is appropriate to the edge contour of the workpiece being operated upon.

It will thus be appreciated that, in using the machine in accordance with the invention, a greater degree of control over not only the feed speed (or speed of rotation of the main drive shaft) is obtained but also a greater control over the adhesive supply and other operating functions of the machine.

There now follows a detailed description to be read with reference to the accompanying drawings, of one machine in accordance with the invention, which machine has been selected for description merely by way of exemplification of the invention and not by way of limitation thereof.

In the accompanying drawings:-

Figure 1 is a front view of the machine in accordance with the invention;

Figure 2 is a block diagram of an electronic control circuit of said machine;

Figures 3A and 3B constitute a flow chart relating to the control of the general operation of the machine;

Figures 4A and 4B constitute a flow chart indicating the control of the speed of rotation of a main drive shaft of the machine;

Figure 5 is a flow chart indicating the control of the rate of adhesive supply; and

Figure 6 is a flow chart indicating the manner in which a feed length adjustment takes place.

The machine in accordance with the invention now to be described is a so-called thermo-cementing and folding machine, which finds use in the shoe industry and allied trades and is generally similar, except as hereinafter described, to the machine described in GB-A 2141968, itself a modification of the machine described in EP-A 0110591. The machine thus comprises a work table 10 on which a workpiece can be supported at an operating locality of the machine, at which conventional folding instrumentalities are located, comprising a fold-initiating block 12 having an upwardly curved work-guiding surface 14, a gauge finger 16, a creaser foot 22 and a lip turner (not shown), which completes the fold of the workpiece edge over the creaser foot. During folding, adhesive can be applied to the workpiece edge through an outlet in the creaser foot, to which adhesive is supplied via a delivery tube 24 from a melt chamber 28 under the action of a gear pump 26. The melt chamber 28, delivery tube 24 and creaser foot 22 are heated respectively by heaters H1, H2, H3. Other features of the folding instrumentalities are shown in Figure 1.

"Downstream" of the folding instrumentalities are located conventional edge snipping means generally designated 30, comprising a fixed and movable blade 32, 34, and conventional workpiece feeding means in the form of an orbitally moving hammer-and-anvil arrangement (not shown), which also serves to consolidate the fold. A work release clamp (not shown) is also provided for clamping the work against the under-side of the creaser foot during the return movement of the hammer-and-anvil arrangement.

The hammer-and-anvil arrangement is driven through a main drive shaft (not shown) by means of an electric motor M1 operation of which is controlled in turn by computer control means (see Figures 2 to 6) through an inverter I. The inverter receives drive signals from the computer control means in the form of a voltage, and supplies corresponding control signals, also in the form of a voltage, to the electric motor. The electric motor is in this case an a.c. induction motor. As will be hereinafter described in detail, the motor and more particularly the speed of the motor, and thus the speed of rotation of the main drive shaft (hereinafter referred to as the "feed speed") may be controlled either automatically or by the operator using a first treadle (not shown), which incorporates a transducer T (Figure 2). In addition, a second treadle (also not shown) is provided by means of which, by selectively depressing respectively the toward and heelward portions thereof, two switches S6, S7 can be actuated under operator control. Again as will be described in detail hereinafter, switch S6 actuates a stepping motor SM1 by which, through a mechanical arrangement including a feed length control lever (not shown), the amount through which the hammer-and-anvil arrangement moves fore-and-aft for each revolution of the main drive shaft (hereinafter referred to as the "feed length") is varied thus to effect pleating of the folded over margin of the workpiece. Similarly switch S7 operates a solenoid SOL2 which causes the edge snipping means 30 to operate and at the same time operates the motor SM1 to vary the feed length according to the appropriate setting.

For determining the feed length provision is made in the form of three selector devices SS1, SS2, SS3 on a control panel 36 of the machine. Each selector device comprises a digital display and means for scrolling up or down the displayed numerical indicator; each selector or device is thus capable of selecting a feed length in a range 0 to 9. The first selector device SS1 is utilised to set the feed length for "normal" operation, the second SS2 for a snipping operation (which will normally occur when an "inside" corner is passing through the operating locality), and the third SS3 for a pleating operation (which will usually occur when an "outside" corner is passing through the operating locality). It is to be understood that in general, as is common in folding machines, the pleating feed length is likely to be relatively short, in order to enable pleating to be effected, while the "snipping" feed length will normally be somewhat longer, in order to avoid mere fraying of the edge by too many snips being made in the fold.

The feed length can be set up for each operation of the machine, but a further selector device SS4 is also provided on the control panel. This further device incorporates a twin digital display and serves to enable a double-digit style number to be allocated to each combination of feed lengths selected, the style number providing access, via the computer control means, to a memory in which information relating to the feed lengths is stored at an address accessed by the style number.

The machine has a "mains on/off" switch S1, a "motor on/off" S2, a "work lamp on/off" switch S3 and so-called knee-switch S5 for purposes which will be described later.

The control panel 36 of the machine also has the following switches for the purposes set out hereinafter:

Switch S4, which is an "adhesive supply on/off switch incorporating a first pilot light, indicating "on", a second pilot light which, as the adhesive is heating, flashes to indicate adhesive is not available for supply, but which, when the temperature of the adhesive has been reached, is continuously illuminated to indicate that the adhesive supply is available, and a third light which indicates that the adhesive is in fact being supplied:

Switch S8, by which the second treadle is enabled/disabled:

Switch S9, by which selectively snipping, pleating and adhesive on/off functions can be effected automatically or under operator control, pilot lights being provided for indicating which mode has been selected:

Switch S10, which is a three-position pre-selector switch by which the operator can selectively utilise the knee-switch S5 when the machine is operating in its "automatic" operating mode (as selected by switch S9). More specifically, switch S10 can be switched between "off", in which the knee-switch S5 is not effective, an "adhesive inhibit" position, in which, when the knee-switch S5 is held operated, the supply of adhesive to the creaser foot 22 is inhibited, and a "snip inhibit" position, in which the edge snipping means is disabled while the knee-switch S5 is held operated;

Switch S11, by which the control of the motor is selectively achieved automatically or under operator control, pilot lamps being provided for indicating which selection has been made; and

Switch S12, by which the selection of a "pleating" feed length can be prevented.

Also on the control panel 36 are further selector devices, each of which comprises a plurality of bars which can be illuminated to indicate a progressive incrementing or decrementing of a value, selector buttons (+ and -) being provided for effecting such incrementing and decrementing:

Device SS5, by which the supply of adhesive at the start of a cycle of operation of the machine may be delayed;

Device SS6, by which, the density of "snipping" can be selected by the operator, generally in the manner set out in GB-A 2148541;

Device SS7, by which, as will be described in detail hereinafter, the range of speeds over which the machine will operate up to a pre-set maximum can be selected;

Device SS8, by which the temperature of the creaser foot 22 can be varied; and

Device SS9 serves to control the operating speed of the stepping motor SM2 by which the rate of adhesive supply can be controlled as will be described hereinafter.

When the machine is in an automatic mode of operation (selected by switch S9), the control of adhesive supply (on/off function) and the selection of feed length is effected using a sensing arrangement including two emitters E1, E2 (constituting first sensing means of the machine) by which the supply of adhesive is controlled, four emitters E3, E4, E5, E6 (constituting third sensing means of the machine) by which an approaching "inside" corner in the edge contour of the workpiece being operated upon is sensed and which control solenoid SOL2 and also serve to select the "snipping" feed length, and a further emitter E7 (constituting second sensing means of the machine) by which an approaching "outside" corner in the workpiece edge contour is sensed and the "pleating" feed length selected.

In the machine in accordance with the invention, when switch S1 is switched on, mains power is supplied sequentially to heaters H1, H2 and H3 such that the various integers heated thereby reach operating temperature at essentially the same time. When the temperature of each integer is reached, then, assuming that switch S4 is switch "on", the appropriate lamp indicates that adhesive is available and that the machine is ready for operation. At the same time, power is supplied to solenoid SOL2, which, in response to appropriate signals, controls the edge snipping arrangement 30, and also to a transformer (not shown) which steps down the voltage to 12 volts for supply to a work lamp circuit which includes the "worklamp" switch S3. The 12 volt circuit is an a.c. supply, but from this is derived an unsmoothed 12 volts d.c. circuit which supplies power to a mains-controlled control box CB supplying a "mains interrupt" signal, to be referred to hereinafter. In addition, there is derived from the 12 volt a.c. circuit a smoothed 12 volt d.c. circuit which supplies power to stepper motor SM2, which drives the gear pump and also to stepper motor SM1, by which a feed length control lever is operated; this lever is displaceable under the action of the stepper motor, such displacement causing the feed length to be varied. (This arrangement is well known in folding machines.) From the smoothed 12 volt d.c. circuit, furthermore, is derived a 5 volts circuit, which drives a central processor unit CPU and associated circuits and also provides power to the various switches and integers of the electrical and electronic circuits of the machine.

The central processor unit CPU, which controls the machine, is constituted by a single-chip 8-bit micro-computer (in casu, a Zilog Z8681 which, in addition to a micro-processor, also incorporates a random access memory/scratch pad RAM (shown separately in Figure 2); this micro-processor is obtainable from Zilog Inc). For the internal timing of the CPU a system clock C, comprising a free-running 12 MHz crystal, is provided. The CPU is connected via input-output bus I/OB with input and output ports IP, OP, a non-volatile memory in the form of an EPROM (erasable programmable read-only memory), which is accessed by the CPU via the I/OB for instructions to execute, and an EEPROM (electrically erasable programmable read-only memory) for the storage of style and "machine status" information. In addition, an analogue-to-digital converter ADC is provided, to which analogue signals are supplied by the various integers shown in Figure 2, including the transducer T and thermistors TS1, TS2, TS3 (which sense the temperatures of the components heated by heaters H1, H2, H3). The ADC is interrogated by the CPU, via the data bus I/OB, each time a mains interrupt signal is supplied to the CPU by the control box CB. More particularly the various channels of the ADC are interrogated

in turn, one in response to each mains interrupt in a so-called "wrap around" sequence. The ADC supplies information as to the state of the interrogated channel via the input port IP. The various switches and selector devices supply information as to the state of the interrogated channel via the data bus I/OB. In addition a digital-to-analogue converter DAC is provided which supplies analogue control signals to the inverter I for driving the motor M1, in accordance with digital signals received from the CPU. The control circuit also comprises a re-set sub-circuit R which is directly connected into the CPU and by which, upon starting up of the machine, the CPU is enabled to set the controls to their correct state in a rapid manner. A shaft encoder E driven by the main drive shaft is also provided having a direct "interrupt" input to the CPU.

In response to the various signals thus supplied to the CPU, the CPU supplies outputs OP via the data bus I/OB to sub-circuits controlling the heaters H1, H2, H3, the solenoid SOL2, drives for stepper motors SM1, SM2 emitters E1 to E7 and relay RL1, as well as to the inverter I as already referred to. The relay RL1 serves as a "watch dog" over the whole of the control circuit. To this end, it is maintained in a "made" condition during normal operation of the machine by a control sub-circuit which is "refreshed" at regular intervals, failure to refresh the sub-circuit causing the relay RL1 to drop out. More particularly, the sub-circuit receives a signal at each mains interrupt, the signal serving to change the state of the circuit between "1" and "0", the arrangement being such that switching to the "1" state constituting the "refresh" signal. The sub-circuit is arranged to become de-energised, in the absence of a refresh signal, after a time interval which is greater than the interval between two "1" signals. De-energisation of the sub-circuit of course switches off the relay, thereby terminating the power supply to the machine.

In the machine in accordance with the invention the emitters E1 to E7, constituting the various sensing means, are actuated in response to control pulses supplied by the CPU sequentially thereto at each system clock interrupt and emit pulses of infra-red radiation, which are separately received by the receiver E/R located in the machine head above the emitters. In other machines in accordance with the invention other types of sensing means may of course be utilised.

Figures 3 to 6 constitute flow charts indicating various functions of the software by which the machine in accordance with the invention is controlled. It will be noted that there are no inscriptions within any of the boxes of the flow charts, but rather a full description of each step is appended to this specification.

Referring now to Figures 3A and 3B which relate to the general running of the machine, at the first step 650 the status of switch S9 is checked to determine whether the adhesive supply (on/off), snipping and pleating functions are to be controlled automatically, namely through the emitters E1 to E7, or under operator control, using the knee-switch S5 and treadles; the machine in this regard operates in the same manner as described in GB-A 2141968. If a "No" is obtained, indicating that "manual" has been selected, at step 652 a command is issued to ensure that the motor will not operate in "automatic" mode, and at step 654 the status of knee-switch S5 is monitored. If the machine is not switched on, then the software loops back to step 650, but in the event that the knee-switch is actuated, adhesive is supplied, initially, i.e. at the start of a cycle of operation of the machine, with a "fast forward" operation of the motor to give a surge, generally as described in EP-A 0110591 (step 656). The control of the rate of adhesive supply will be described hereinafter in connection with Figure 5. The status of knee switch S5 continues to be monitored at step 658; it will be recalled that as described in GB-A 2141968, the knee switch must be released by the operator and re-actuated in order to switch off the adhesive flow. When such flow is switched off, the operation of the stepping motor SM2 is stopped and reversed to provide for suck-back of the adhesive, both initially and thereafter intermittently, as described in detail in EP-A 0154441 (step 660).

It is also to be noted that throughout the operation as set out above, the various switches and selector devices, e.g. those relating to the control of the snipping and pleating functions are regularly and frequently monitored and any signals therefrom processed.

In the event that "automatic" operation is selected at step 650, then the status of emitters E1, E2 is interrogated (step 662). In the event that the emitters are uncovered, then a command is issued to ensure that the motor will not operate in "automatic" mode (step 664) and the circuit loops back to step 650. Where the emitters E1, E2 are covered, indicating that a workpiece is present then any delay in the initiation of adhesive supply, as selected by selector device SS5 is executed (step 666) and thereafter the status of switch S11 is interrogated, to determine whether the motor M1 is to be controlled automatically or by the operator using the right hand treadle. In the case of "automatic" selection, the motor M1 is switched on (step 670). If the "manual" operation is selected, on the other hand, then a signal is awaited from transducer T associated with the right hand treadle; this will be described in greater detail with reference to Fig. 4A and 4B. At step 674 the supply of adhesive is initiated, in the same manner as described previously with reference to step 656 and this continues until the emitters E1, E2 are once more uncovered (step 674). Upon the uncovering of the emitters, indicating that a workpiece is no longer present, a delay in switching off the adhesive supply is calculated (step 676), on the basis of rotations of the main drive shaft between the uncovering of the first emitter and that of the second; it will be appreciated that the two emitters lie one after the other in the general feed direction. The calculated delay is then implemented at step 678 and thereafter the adhesive supply is switched off (step 680), in the same manner as described with reference to step 660.

At step 682 the status of switch S11 is once more interrogated, essentially to ensure that the workpiece is fed completely out of the operating locality, the arrangement being such that if "automatic" operation has been selected, a

delay, based upon the current feed length selected by one of selected devices SS1, SS2, SS3, is calculated and implemented (684 and 686) prior to the motor M1 being switched off (step 688). In the event that "manual" operation has been selected, then it is assumed that the operator will ensure that the workpiece has been fed from the operation locality. Thereafter the circuit loops back to step 650.

As described in detail in GB-A 2141968, when "automatic" is selected at step 650, then in the event that switch S10 is appropriately set, the knee-switch may serve to inhibit either "snipping" or the adhesive supply when actuated. On the other hand, when "automatic" operation is selected by means of switch S11, operation of the knee-switch S5 acts as an emergency stop.

Referring now to Figures 4A and 4B, which relate to the control of the motor M1 and more particularly to the operation of the machine depending upon the selection made by switch S11, at step 700 the status of said switch is interrogated. If "automatic" operation is selected then at step 702 the status of the emitters E1, E2 is interrogated, that is to say the presence of a workpiece is checked for. If a workpiece is present then at step 704 the "basic speed" of the motor is set at 2,400 rpm; this is in fact a function of the software itself, the particular speed being assessed as being the optimum for the operation of a machine of this kind. At step 706 thereafter the status of selector device SS7, by which a proportional value of the set speed (in this case 2,400 rpm) is selected by the application of a reduction factor and at step 708 the software then calculates, e.g. by look-up tables, the value of the drive signal to be supplied to the motor M1 to achieve the desired speed and the drive signal is supplied accordingly. At step 710 the actual speed of rotation of the main drive shaft, which is monitored by the shaft encoder E, is calculated from the output of the encoder and at step 712 the difference between the calculated and the actual speed is determined and compared with a pre-set tolerance. If the difference does not lie within the given tolerance, then the drive signal supplied to the motor M1, as previously calculated at step 708, is modified according to a feedback factor (step 714), said factor being calculated so as to bring actual speed of rotation of the shaft up to the desired speed and this feedback factor is then applied to the drive signal value (step 716). The feedback factor is thereafter stored and is applied, without further modification, provided that the difference between the desired and actual speed of rotation of the main drive shaft remains within the tolerance. The appropriate drive signal is thus applied to motor M1 (step 718) and the circuit then loops once more back to step 700.

In the event that at step 702 the emitters E1, E2 become uncovered, indicating that a workpiece is no longer present, then, bearing in mind that this circuit is continuously looping, at step 720 a signal to stop the operation of motor M1 is supplied.

In the case where at step 700 a "manual" operation has been selected, then at step 722 the status of the signal from the transducer associated with the right hand treadle is interrogated, in particular, the treadle will either indicate a "stop" condition or a "drive" condition, in which latter case the value of the signal from the transducer will be converted proportionally to a motor speed. The transducer is also able to provide a further signal, namely by the operator depressing the treadle with her heel to signal a requirement that the machine is brought to a stop with the hammer-and-anvil arrangement in a closed condition; this may be desirable where a workpiece has not been completely processed but rather it is desirable to carry out some intermediate operation on the workpiece part-way through a cycle of operation. At step 724, therefore, this condition of the transducer is sought and in the event that a corresponding signal is provided, then at step 726 the motor M1 is switched off with the hammer-and-anvil arrangement in closed condition. Otherwise if no such signal has been provided, then at step 728 the status of the transducer is interrogated as to whether it is in a "stop" or "drive" condition. If "stop" has been selected, then the circuit leads to step 720 and the motor M1 is switched off, this time with the hammer-and-anvil arrangement in an open condition. In the event that "drive" has been selected, then steps 706 and subsequent steps are followed as described above; that is to say the reduction factor which is set by device SS7 is applied to the motor speed set according to the position of the transducer in "drive" mode and drive signals are supplied to the motor M1 as aforesaid.

Figure 5 relates to the operation of the adhesive supply means, more particularly the signalling supplied to stepping motor SM2. Thus, at step 730 the required adhesive supply rate is checked for, as set by selector device SS9 and, in accordance with the current speed of rotation of the main drive shaft, as checked from the shaft encoder (step 732), the requested adhesive supply rate is modified proportionally, namely by dividing the actual speed of rotation of the main drive shaft by 2,400 and thus arriving at a proportion to be applied to the requested adhesive rate (step 734). At step 736 and 738 the question of whether a snipping or pleating operation respectively has been selected is posed. To this end, in "automatic" mode the status of the various emitters E3 to E7 will be addressed, whereas in "manual" mode the status of the left hand treadle is interrogated. In the event that neither a snipping nor a pleating operation has been selected then at 740 the appropriate drive signal is supplied to motor SM2 to achieve the adhesive supply rate as determined at step 734. In the event that either a snipping or a pleating operation has been selected, then at step 742 the calculated adhesive supply rate required is again modified according to the setting of the appropriate one of selector devices SS2 and SS3. In this regard it will be noted that the setting of the desired adhesive supply rate will be applicable whenever "normal" feeding of the workpiece is taken place, as determined by the setting of selector device SS1. The modification of the delivery rate in accordance with the setting of either one of devices SS2 and SS3 will be proportional, in the same ratio as that between the settings of the selected device and device SS1. Thereafter, at step 744, the

adhesive supply rate as determined at step 734 is modified by this further modification factor and thereafter the appropriate drive signal is supplied to motor SM2 (step 740).

Figure 6 indicates further aspects of the software relating to the adjustment of feed length which will take place during the operating cycle of the machine. It will thus be appreciated that, as with the sections of software to which Figures 4 and 5 also relate, these sub-programs are accessed regularly and frequently during the general operation of the machine as set out in Figure 3. The particular sub-program is brought into effect only if a change in feed length is indicated, either by a signal from the emitters E3 to E7 or a signal from the left hand treadle, depending on the particular mode of operation of the machine. In the event that a new feed length is indicated then at step 750 the question is posed as to whether a feed length change is currently taking place. If so, then at step 752 an instruction to wait for the current change to be completed is supplied. At step 754 the displacement of the feed length control lever necessary to bring about the required change of feed length is calculated in terms of steps of stepping motor SM1 by which the position of the lever is varied. It is the intention that any change of feed length which takes place during the operating cycle of the machine, i.e. when the machine is actually running, is effected smoothly as opposed to previous machines in which the change has been effectively instantaneous, leading to "snatching" of the workpiece as the change takes place. If, however, the motor M1 is not in fact operating at the time of the feed length change, as checked at step 756, then the feed length change can be promptly executed and to this end at step 758 the motor feed speed is treated as at the maximum so that the change of feed length is effected in the quickest possible time. In the event that the machine is operating at the time then the actual speed of rotation of the main drive shaft is calculated using shaft encoder E (step 760). Whichever information is thus supplied, at step 762 the stepping rate of stepping motor SM2 required to displace the feed length control lever through the appropriate distance within a pre-set number of, e.g. 3, revolutions of the main drive shaft (which will give an allowed time dependent upon the speed of rotation of the drive shaft as calculated at step 760 or set at step 758) is calculated, such calculation being of course dependent upon the maximum stepping rate limit for the motor SM2. In the event that the stepping motor cannot achieve the stepping rate required, then it will be operated at a maximum speed to achieve the change of feed length in the smallest time commensurate with that speed.

If desired, the change in the rate of adhesive supply corresponding to the feed length change may also be similarly "phased" to achieve a smooth transition.

At step 764 the calculated stepping rate is then implemented and the control lever displaced. It will thus be appreciated that, using the machine in accordance with the invention, significantly greater control over the operation of the various motors incorporated in the machine can be achieved, in particular by the application of computer control tech-

niques.

APPENDIX

5 650 Switch S9: Is automatic control of adhesive
supply, snipping and pleating by sensors (as
opposed to operator control) selected?

10 652 Cancel automatic motor (M1) run request.
654 Is knee-operated adhesive supply control switch
S5 actuated (adhesive "on")?

15 656 Switch motor SM2 to "fast forward" (adhesive surge)
and initiate adhesive supply.
658 Is knee-operated adhesive supply control switch
S5 actuated (adhesive "off")?

20 660 Switch motor SM2 to reverse (intermittent
suck-back)
662 Are "workpiece present" sensors E1, E2 covered?

25 664 Switch off motor M1
666 Initiate adhesive supply delay (if any): Selector
device SS5

30 668 Switch 11: Is operation of motor M1 set to
automatic?
670 Switch on motor M1

35 672 Switch motor SM2 to "fast forward" (adhesive
surge) and initiate adhesive supply.
674 Are "workpiece present" sensors E1, E2 covered?

40 676 Calculate delay in switching off the adhesive
supply.
678 Implement delay in switching off the adhesive
supply

45 680 Switch motor SM2 to reverse (intermittent
suck-back)
682 Switch 11: Is operation of motor M1 set to
automatic?

50 684 Calculate delay in switching off motor M1
686 Implement delay in switching off motor M1
688 Switch off motor M1

55

5 700 Switch 11: Is operation of motor M1 set to automatic?

702 Are "workpiece present" sensors E1, E2 covered?

704 Set motor (M1) speed at maximum

10 706 Apply to maximum set at 704 any selected reduction factor : device SS7

708 Calculate value of drive signal to motor M1 required to achieve desired speed of rotation of main drive shaft

15 710 Calculate actual speed of rotation of drive shaft from encoder and determine feedback factor

20 712 Is difference between selected and actual shaft speed within tolerance?

714 Modify feedback factor

25 716 Apply feedback factor to drive signal value

718 Supply drive signal to motor M1

720 Stop motor M1 when "home" position is sensed

30 722 Read transducer signal and convert to motor (M1) speed

724 Is "hammer closed" stop position command signalled?

35 726 Switch off motor M1 in "hammer closed" position

728 Is motor (M1) stop position command signalled?

730 Access required adhesive supply rate (Switch SS4)

40 732 Calculate actual speed of rotation of main drive shaft from encoder

734 Modify required adhesive supply rate by factor: actual speed (rpm)/2,400

45 736 Is "snipping" feed length selected?

738 Is "pleating" feed length selected?

740 Supply drive signal to motor SM2 to achieve adhesive supply rate as determined at 734 or 744

50 742 Calculate modification factor according to selected feed length as a proportion of "straight" feed length

55

744 Modify by modification factor the adhesive supply
 rate as determined at 734
 750 Is feed length in course of being changed?
 752 Wait for completion of current change
 754 Calculate (in terms of steps) required
 displacement of feed length control lever
 756 Is motor M1 stopped?
 758 Apply maximum value to speed of rotation of main
 drive shaft
 760 Calculate actual space of station of main drive
 shaft from encoder
 762 Calculate stepping rate required to displace feed
 length control lever in time equivalent to
 pre-set number of revolutions of main drive shaft
 (subject to maximum stepping rate limit)
 764 Initiate displacement of feed length control
 lever

Claims

1. Folding machine comprising

a main drive shaft driven by a motor (M1),
 folding instrumentalities (12,14,16,22,30) arranged at an operating locality of the machine,
 workpiece feeding means operable in timed relation with the rotation of the main drive shaft for feeding a
 workpiece to be folded through the operating locality, and
 operator-controlled feed speed variation means (T) for varying the speed of rotation of the main drive shaft,
 characterised in that the motor (M1) for the main drive shaft is an a.c. induction motor provided with an inverter (I),
 and in that the feed speed variation means (T) comprises a transducer (T) providing an analogue output which is
 variable according to the setting of the transducer under operator control,
 the machine being further characterised by an analogue-to-digital converter (ADC) which receives the analogue
 output of the transducer (T) and converts it to a digital value which is thus variable in accordance with the setting
 of the transducer (T),
 computer control means for receiving the digital value and for modifying it in accordance with one or more
 inputs (SS7, 714) each in the form of a signal having a value determined according to an operational setting of the
 folding machine, and
 a digital-to-analogue converter for converting the digital value, thus modified, to an analogue drive signal
 which is supplied to the inverter (I), such that the speed of rotation of the a.c. motor (M1), and thus of the main drive
 shaft, is determined in accordance with the setting of the transducer (T), but modified in accordance with one or
 more of said inputs.

2. Machine according to Claim 1 wherein the workpiece feeding means comprises an orbitally movable hammer-and-
 anvil arrangement driven by the main drive shaft,
 characterised in that the output of the transducer (T) corresponds, according to its value, to a "stop" condition, a
 "drive" condition or a condition in which the operation of the machine is stopped with the hammer-and-anvil in a
 closed condition.

3. Machine according to Claim 1 or Claim 2 wherein monitoring means (E) is provided whereby the speed of rotation of the main drive shaft is monitored, characterised in that the drive signal supplied to the inverter (I) from the computer control means is modified by an input from the monitoring means (E) if and to the extent that the actual speed of rotation as monitored does not match the notional speed which corresponds to the particular setting of the transducer (T), such modification being such as to effect matching of said actual speed with said notional speed.
4. Machine according to any one of Claims 1 to 3 characterised by speed range variation means (SS7) which provides an input to the computer control means whereby the speed range, within which the speed of rotation of the main drive shaft can be varied under the control of the operator as aforesaid, can be varied, the variation being proportional in respect of any setting of the feed speed variation means such that for a given such setting the speed of rotation of the main drive shaft will vary in accordance with the proportion set by the speed range variation means.
5. Machine according to Claim 4 wherein a maximum speed is set for the output speed of the motor (M1) and thus for the rotation of the main drive shaft, characterised in that the speed range variation means is effective to select a speed range having a maximum which represents a proportion of the thus set maximum.
6. Machine according to any one of the preceding Claims wherein feed length variation means is provided for varying the distance through which a workpiece is fed by the workpiece feeding means for each rotation of the main drive shaft, characterised in that the feed length variation means comprises an n.c. motor (SM1) operation of which is effective, in response to control signals supplied by the computer control means, to displace a feed length control lever whereby to cause the feed length to be varied, and in that the computer control means calculates the rate at which a feed length variation is to take place based upon the required displacement of said lever to achieve a desired feed length variation and also the speed of rotation of the main drive shaft.
7. Machine according to any one of the preceding Claims further comprising adhesive supply means (SM2,22 to 28), including a gear pump (26) driven by an n.c. motor (SM2), for supplying adhesive to portions of a workpiece to be folded as it is fed through the operating locality by the workpiece feeding means, the computer control means supplying to said n.c. motor (SM2) a drive signal the value of which is dependent upon the speed of rotation of the main drive shaft and the operational state of the feed speed variation means (-,SM1), characterised in that said drive signal, and thus the rate of adhesive supply, is dependent upon the value of the digital signal supplied to the computer control means, but modified as aforementioned.
8. Machine according to Claim 7 wherein operator-actuable means (SS9) is provided for setting the rate of adhesive supply, characterised in that said means (SS9) is effective to supply a signal, the value of which varies according to the selected setting, to the computer control means, and in that the value of the drive signal supplied by the computer control means to the n.c. motor (SM2) for the gear pump (26) is thus dependent also upon the value of the signal supplied by the adhesive supply rate setting means (SS9).
9. Machine according to Claim 8 characterised in that operator-actuable means (SS1,SS2,SS3) is provided which provides an input to the computer control means and by which a plurality of pre-settings can be made for the workpiece feed length for selection according to the contour of the workpiece edge to be folded, the arrangement being such that the feed length variation means (-,SM1) is effective to set the feed length in accordance with a selected one of such settings upon receipt of an appropriate signal from the computer control means, and in that one of the pre-set feed lengths is used as a standard and selection thereof is ineffective to vary the rate of adhesive supply as set by the operator-actuable adhesive supply rate setting means (SS9), but the selection of another of the pre-settings is effective to cause said rate to be varied, such variation being proportional to the difference between the standard and the selected pre-set feed lengths.
10. Machine according to Claim 5 and 9 wherein workpiece detecting devices (E1 to E7) are disposed at or adjacent the operating locality of the machine and comprising a "workpiece present" detecting device (E1,E2) which serves to detect the presence of a workpiece, and thus cause the supply of adhesive to be initiated, and also a "corner" detecting device (E3 to E7) which serves to detect the approach of both "outside" and "inside" corners (as hereinbefore defined) to the operating locality as the workpiece is being fed therethrough, characterised in that in response to detection of an approaching corner an input is provided to the computer control means whereby an appropriate one of the pre-set feed lengths is selected, and in that operator-actuable means (S11) is provided by which an input is provided to the computer control means whereby the feed speed variation means (T) is disabled and the "workpiece present" detecting device (E1,E2) is enabled to initiate also operation of the workpiece feeding means when the presence of a workpiece is detected

thereby, the speed of rotation of the main drive shaft being set at the maximum within the selectively set speed range and the various pre-set feed lengths being selected according to the contour of the workpiece edge as detected by the "corner" detecting device (E3 to E7).

5 Patentansprüche

1. Umbugmaschine, die
 - eine durch einen Motor (M1) angetriebene Hauptantriebswelle umfaßt,
 - Umbugelemente (12, 14, 16, 22, 30), die in einem Arbeitsbereich der Maschine angebracht sind,
 - eine Arbeitsstück-Vorschubeinrichtung, die in zeitlich abgestimmter Relation mit der Drehung der Hauptantriebswelle betrieben wird, um ein umzubuggendes Arbeitsstück durch den Arbeitsbereich zu transportieren und
 - eine durch die Arbeitskraft zu betätigende Einrichtung zum Ändern der Vorschubgeschwindigkeit (T), um die Drehzahl der Hauptantriebswelle zu verändern,
 - dadurch gekennzeichnet, daß der Motor (M1) für die Hauptantriebswelle ein mit einem Frequenzumformer (I) ausgestatteter Wechselspannungs-Induktionsmotor ist,
 - und dadurch, daß die Einrichtung zum Ändern der Vorschubgeschwindigkeit (T) einen Signalumformer (T) umfaßt, der mit einem Analog-Ausgang ausgestattet ist, welcher entsprechend der Einstellung des Signalumformers durch die Arbeitskraft gesteuert verändert werden kann,
 - wobei die Maschine darüberhinaus durch einen Analog-Digital-Umwandler (ADC) gekennzeichnet ist, welcher den Analog-Ausgang des Signalumformers (T) erhält und ihn in einen digitalen Wert umwandelt, der somit entsprechend der Einstellung des Signalumformers (T) verändert werden kann,
 - eine Computersteuerungs-Einrichtung, um den Digitalwert aufzunehmen und ihn in Übereinstimmung mit einem oder mehreren Eingängen (SS7, 714) zu ändern, jeweils in Form eines Signals mit einem entsprechend einer Betriebseinstellung der Umbugmaschine festgelegten Wert
 - und einen Digital-Analog-Umwandler, um den so geänderten Digitalwert zu einem Analog-Antriebssignal umzuwandeln, welches zum Frequenzumformer (I) geliefert wird, sodaß die Drehzahl des Wechselstrommotors (M1), und somit der Hauptantriebswelle, entsprechend der Einstellung des Signalumformers (T), jedoch in Übereinstimmung mit einem oder mehreren der genannten Eingänge geändert, festgelegt wird.
2. Maschine gemäß Anspruch 1, bei welcher die Arbeitsstück-Vorschubeinrichtung eine durch die Hauptantriebswelle angetriebene, sich kreisförmig bewegende Hammer- und Amboß-Einrichtung umfaßt,
 - dadurch gekennzeichnet, daß der Ausgang des Signalumformers (T) entsprechend seines Wertes einem "Stopp"-Zustand, einem "Antriebs"-Zustand oder einem Zustand, bei welchem der Betrieb der Maschine mit der Hammer- und Amboß-Einrichtung in geschlossenem Zustand gestoppt wird, entspricht.
3. Maschine gemäß Anspruch 1 oder Anspruch 2,
 - in welcher eine Kontrolleinrichtung (E) zur Verfügung steht, durch welche die Drehzahl der Hauptantriebswelle überwacht wird,
 - dadurch gekennzeichnet, daß das von der Computersteuerungseinheit zum Frequenzumformer (I) gelieferte Antriebssignal durch einen Eingang von der Kontrolleinrichtung (E) geändert wird, wenn und soweit die bei der Überwachung festgestellte aktuelle Drehzahl nicht mit der Nominal-Drehzahl, die der speziellen Einstellung des Signalumformers (T) entspricht, übereinstimmt, wobei eine solche Änderung derart erfolgt, daß die genannte aktuelle Drehzahl mit der genannten Nominal-Drehzahl übereinstimmt.
4. Maschine gemäß einem der Ansprüche 1 bis 3,
 - gekennzeichnet durch eine Einrichtung zum Ändern des Geschwindigkeitsbereichs (SS7), welche einen Eingang zur Computersteuerungseinrichtung zur Verfügung stellt, durch welche der Geschwindigkeitsbereich, innerhalb dessen die Drehzahl der Hauptantriebswelle wie oben erwähnt von der Arbeitskraft gesteuert verändert werden kann, verändert werden kann, wobei die Veränderung in Bezug auf jede Einstellung der Einrichtung zum Ändern der Vorschubgeschwindigkeit proportional ist, sodaß sich die Drehzahl der Hauptantriebswelle für eine solche bestehende Einstellung in Übereinstimmung mit der durch die Einrichtung zum Ändern der Geschwindigkeitsstufe eingestellten Proportion verändert.
5. Maschine gemäß Anspruch 4, bei welcher eine Maximalgeschwindigkeit für die Ausgangsgeschwindigkeit des Motors (M1) und somit für die Drehung der Hauptantriebswelle eingestellt wird,
 - dadurch gekennzeichnet, daß die Einrichtung zum Ändern des Geschwindigkeitsbereichs bewirkt, daß ein Geschwindigkeitsbereich mit einem Maximalwert ausgewählt wird, welcher proportional zu dem so eingestellten Maximalwert ist.

6. Maschine gemäß einem der oben erwähnten Ansprüche, bei welcher eine Einrichtung zum Ändern der Vorschublänge zur Verfügung steht, um die Strecke, um welche ein Arbeitsstück von der Arbeitsstück-Vorschubeinrichtung bei jeder Drehung der Hauptantriebswelle vorgeschoben wird, zu verändern,
 dadurch gekennzeichnet, daß die Einrichtung zum Ändern der Vorschublänge einen NC-Motor (SM1) umfaßt, dessen Betrieb als Reaktion auf durch die Computersteuerungseinrichtung gelieferte Steuerungssignale bewirkt, daß ein Vorschublängen-Steuerungshebel verschoben wird, um dadurch die Vorschublänge zu verändern,
 und dadurch, daß die Computersteuerungseinrichtung die Stufe berechnet, mit der eine Änderung der Vorschublänge stattfinden soll, auf der Basis der erforderlichen Verschiebung des genannten Hebels, um eine gewünschte Änderung der Vorschublänge zu erreichen und auch die Drehzahl der Hauptantriebswelle.
7. Maschine gemäß einem der oben erwähnten Ansprüche, die darüberhinaus
 eine Klebstoffzuführeinrichtung (SM2, 22 bis 28) mit einer von einem NC-Motor (SM2) angetriebenen Zahnradpumpe (26) umfaßt, um Klebstoff zu den umzubuggenden Abschnitten eines Arbeitsstücks zu transportieren, während es durch die Arbeitsstück-Vorschubeinrichtung durch den Arbeitsbereich der Maschine transportiert wird, wobei die Computersteuerungs-Einrichtung zu dem genannten NC-Motor (SM2) ein Antriebssignal liefert, dessen Wert von der Drehzahl der Hauptantriebswelle und dem Betriebszustand der Einrichtung zum Ändern der Vorschubgeschwindigkeit (-, SM1) abhängt,
 dadurch gekennzeichnet, daß das genannte Antriebssignal, und somit die Klebstofftransportstufe, vom Wert des zu der Computersteuerungs-Einrichtung gelieferten digitalen Signals, das jedoch wie oben erwähnt geändert wird, abhängt.
8. Maschine gemäß Anspruch 7, bei welcher eine durch die Arbeitskraft zu betätigende Einrichtung (SS9) zur Verfügung steht, um die Klebstofftransportrate einzustellen,
 dadurch gekennzeichnet, daß die genannte Einrichtung (SS9) bewirkt, daß ein Signal, dessen Wert sich entsprechend der ausgewählten Einstellung verändert, zu der Computersteuerungs-Einrichtung geliefert wird,
 und dadurch, daß der von der Computersteuerungs-Einrichtung zum NC-Motor (SM2) gelieferte Wert des Antriebssignals für die Zahnradpumpe (26) somit auch vom Wert des von der Einstelleinrichtung der Klebstoffzuführrate (SS9) gelieferten Signals abhängt.
9. Maschine gemäß Anspruch 8,
 dadurch gekennzeichnet, daß eine durch die Arbeitskraft zu betätigende Einrichtung (SS1, SS2, SS3) zur Verfügung steht, die mit einem Eingang zu der Computersteuerungs-Einrichtung ausgestattet ist, und durch welche mehrere entsprechend der Kontur der umzubuggenden Arbeitsstückkante auswählbare Voreinstellungen für die Arbeitsstück-Vorschublänge vorgenommen werden können, wobei die Anordnung derart ist, daß die Einrichtung zum Ändern der Vorschublänge (-, SM1) bewirkt, daß die Vorschublänge nach Erhalt eines entsprechenden Signals von der Computersteuerungs-Einrichtung in Übereinstimmung mit einer solchen ausgewählten Einstellung eingestellt wird,
 und dadurch, daß eine der voreingestellten Vorschublängen standardmäßig verwendet wird und die Auswahl dieser Vorschublänge die durch die von der Arbeitskraft zu betätigende Einstelleinrichtung für die Klebstoffzuführrate (SS9) eingestellte Klebstoffzuführrate nicht verändert, die Auswahl einer anderen der Voreinstellungen jedoch bewirkt, daß die genannte Rate verändert wird, wobei eine solche Änderung proportional zur Differenz zwischen der standardmäßigen und der ausgewählten voreingestellten Vorschublänge ist.
10. Maschine gemäß Anspruch 5 und 9, bei welcher Arbeitsstück-Detektor-Einrichtungen (E1 bis E7) an oder neben dem Arbeitsbereich der Maschine angebracht sind und eine Detektoreinrichtung "Arbeitsstück vorhanden", (E1, E2) umfassen, welche dazu dient, zu erfassen, ob ein Arbeitsstück vorhanden ist, und damit bewirken, daß der Klebstofftransport gestartet wird, und auch eine "Kanten"-Detektor-Einrichtung (E3 bis E7), die dazu dient, die Annäherung sowohl von "Außen"-, als auch von "Innen"-bögen (wie an früherer Stelle beschrieben) an den Arbeitsbereich zu erfassen, während das Arbeitsstück durch diesen transportiert wird,
 dadurch gekennzeichnet, daß aufgrund des Erfassens einer sich annähernden Kante ein Eingang zu der Computersteuerungs-Einrichtung gebildet wird, wodurch eine geeignete der vorgewählten Vorschublängen ausgewählt wird,
 und dadurch, daß eine durch die Arbeitskraft zu betätigende Einrichtung (S11) zur Verfügung steht, welche mit einem Eingang zur Computersteuerungs-Einrichtung ausgestattet ist, wodurch der Einrichtung zum Ändern der Vorschubgeschwindigkeit (T) die Wirkung genommen und die Detektor-Einrichtung "Arbeitsstück vorhanden" (E1, E2) wirksam wird, um, wenn diese erfaßt, daß ein Arbeitsstück vorhanden ist, auch den Betrieb der Arbeitsstück-Vorschubeinrichtung zu starten, wobei die Drehzahl der Hauptantriebswelle innerhalb des wahlweise eingestellten Geschwindigkeitsbereichs auf maximal eingestellt ist und die verschiedenen voreingestellten Vorschublängen ent-

sprechend der durch die "Kanten"-Detektor-Einrichtung (E3 bis E7) erfaßten Kontur des Arbeitsstücks ausgewählt werden.

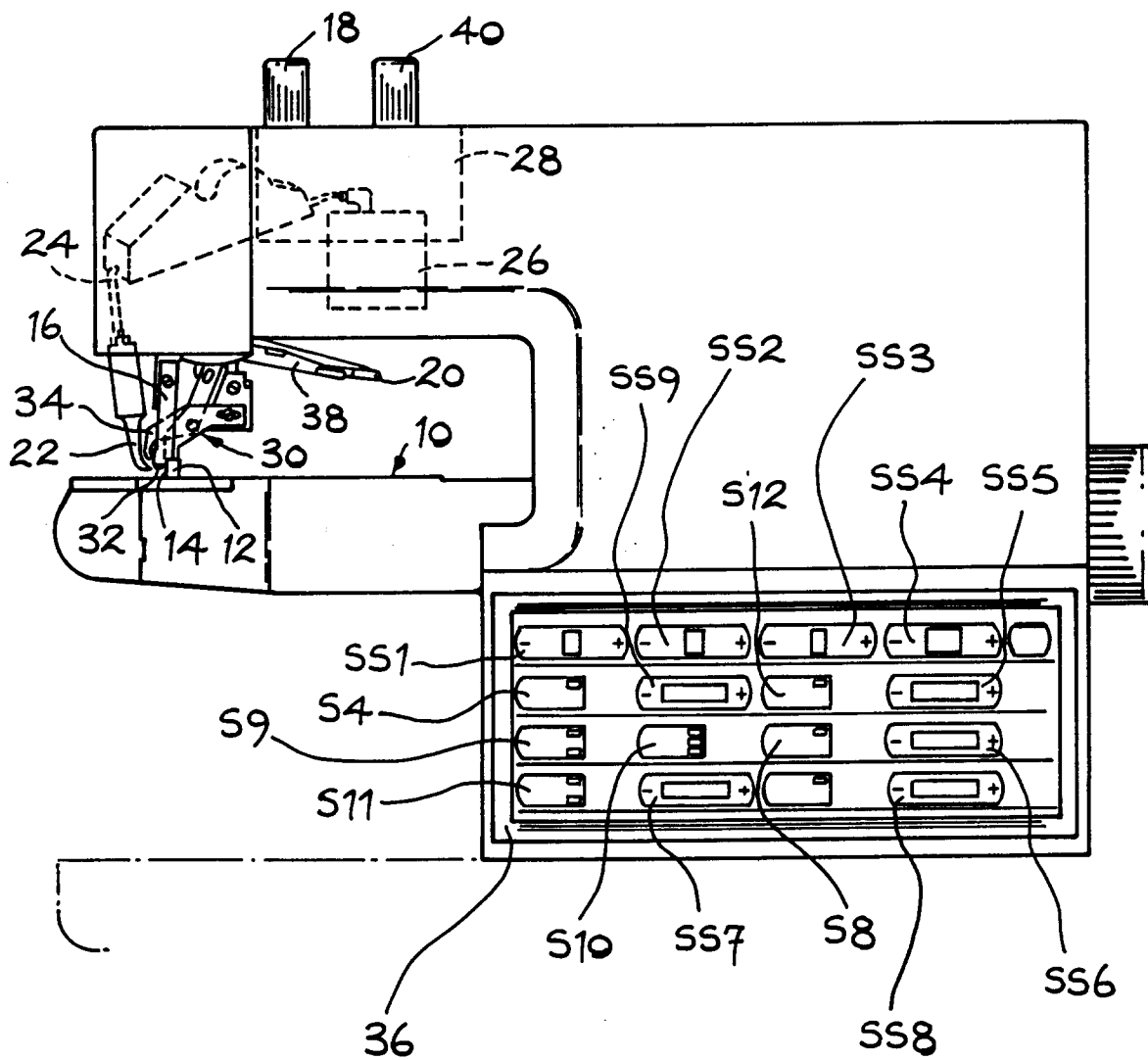
Revendications

1. Machine à plier comprenant
un arbre menant principal entraîné par un moteur (M1),
des instruments de pliage (12, 14, 16, 22, 30) disposés à un emplacement de travail de la machine,
un moyen d'alimentation de pièces à travailler capable de fonctionner en relation synchronisée avec la rotation de
l'arbre menant principal pour faire passer une pièce à travailler devant être pliée par l'emplacement de travail, et
un moyen (T) de variation de vitesse d'alimentation commandé par l'opérateur, servant à faire varier la vitesse de
rotation de l'arbre menant principal,
caractérisée en ce que le moteur (M1) pour l'arbre menant principal est un moteur à induction à courant alternatif
pourvu d'un onduleur (I),
et en ce que le moyen de variation de vitesse d'alimentation (T) comprend un transducteur (T) produisant une sortie
analogique qui est variable selon le réglage du transducteur sous la commande de l'opérateur,
la machine étant en outre caractérisée par un convertisseur analogique-numérique (ADC) qui reçoit la sortie ana-
logique du transducteur (T) et la convertit en une valeur numérique qui est ainsi variable selon le réglage du trans-
ducteur (T),
un moyen de commande par ordinateur servant à recevoir la valeur numérique et à la modifier selon une ou plusieurs
entrées (SS7, 714) chacune sous forme d'un signal ayant une valeur déterminée selon un réglage d'exploitation de
la machine à plier, et un convertisseur numérique-analogique servant à convertir la valeur numérique, ainsi modifiée,
en un signal de commande analogique qui est fourni à l'onduleur (I), de telle sorte que la vitesse de rotation du
moteur à courant alternatif (M1), et donc de l'arbre menant principal, est déterminée selon le réglage du transducteur
(T) mais modifiée selon une ou plusieurs desdites entrées.
2. Machine selon la revendication 1, dans laquelle le moyen d'alimentation de pièces à travailler comprend un arran-
gement à marteau-enclume mobile de manière orbitale et entraîné par l'arbre menant principal,
caractérisée en ce que la sortie du transducteur (T) correspond, selon sa valeur, à un état d'"arrêt", un état de
"marche" ou un état dans lequel le travail de la machine s'arrête, l'arrangement à marteau-enclume étant dans un
état fermé.
3. Machine selon la revendication 1 ou la revendication 2, dans laquelle on prévoit un moyen de surveillance (E) grâce
auquel on surveille la vitesse de rotation de l'arbre menant principal, caractérisée en ce que le signal de commande
fourni à l'onduleur (I) en provenance du moyen de commande par ordinateur est modifié par une entrée provenant
du moyen de surveillance (E) si et dans la mesure où la vitesse réelle de rotation telle que surveillée ne correspond
pas à la vitesse fictive qui correspond au réglage particulier du transducteur (T), une telle modification étant de
nature à effectuer une mise en correspondance de ladite vitesse réelle et de ladite vitesse fictive.
4. Machine selon l'une quelconque des revendications 1 à 3, caractérisée par un moyen de variation de gamme de
vitesses (SS7) qui fournit une entrée au moyen de commande par ordinateur grâce auquel on peut faire varier la
gamme de vitesses dans les limites de laquelle on peut faire varier la vitesse de rotation de l'arbre menant principal
sous la commande de l'opérateur comme susmentionné, la variation étant proportionnelle à tout réglage du moyen
de variation de vitesse d'alimentation de sorte que pour un réglage donné de ce type la vitesse de rotation de l'arbre
menant principal variera selon la proportion réglée par le moyen de variation de gamme de vitesses.
5. Machine selon la revendication 4, dans laquelle on règle une vitesse maximale pour la vitesse de sortie du moteur
(M1) et donc pour la rotation de l'arbre menant principal, caractérisée en ce que le moyen de variation de gamme
de vitesses sert à sélectionner une gamme de vitesses ayant une valeur maximale qui représente une proportion
de la valeur maximale ainsi réglée.
6. Machine selon l'une quelconque des revendications précédentes, dans laquelle on prévoit un moyen de variation
de longueur d'alimentation servant à faire varier la distance sur laquelle une pièce à travailler est alimentée par le
moyen d'alimentation de pièces à travailler pour chaque rotation de l'arbre menant principal,
caractérisée en ce que le moyen de variation de longueur d'alimentation comprend un moteur à commande numé-
rique (SM1) dont la mise en service sert, en réponse à des signaux de commande fournis par le moyen de commande
par ordinateur, à déplacer un levier de commande de longueur d'alimentation pour ainsi provoquer la variation de
la longueur d'alimentation, et en ce que le moyen de commande par ordinateur calcule la vitesse à laquelle doit

avoir lieu une variation de longueur d'alimentation sur la base du déplacement requis dudit levier afin d'obtenir une variation de longueur d'alimentation désirée et également la vitesse de rotation de l'arbre menant principal.

7. Machine selon l'une quelconque des revendications précédentes, comprenant en outre
un moyen d'alimentation en adhésif (SM2, 22 à 28), comportant une pompe à engrenages (26) entraînée par un moteur à commande numérique (SM2), servant à alimenter en adhésif des portions d'une pièce à travailler devant être pliée lorsque le moyen d'alimentation de pièces à travailler la fait passer par l'emplacement de travail, le moyen de commande par ordinateur fournissant audit moteur à commande numérique (SM2) un signal de commande dont la valeur dépend de la vitesse de rotation de l'arbre menant principal et de l'état d'exploitation du moyen de variation de vitesse d'alimentation (-, SM1),
caractérisée en ce que ledit signal de commande, et ainsi la vitesse d'alimentation en adhésif, dépend de la valeur du signal numérique fourni au moyen de commande par ordinateur, mais modifié comme susmentionné.
8. Machine selon la revendication 7, dans laquelle on fournit un moyen actionnable par l'opérateur (SS9) servant à régler la vitesse d'alimentation en adhésif, caractérisée en ce que ledit moyen (SS9) sert à fournir un signal, dont la valeur varie selon le réglage sélectionné, au moyen de commande par ordinateur, et en ce que la valeur du signal de commande fourni par le moyen de commande par ordinateur au moteur à commande numérique (SM2) pour la pompe à engrenages (26) dépend ainsi également de la valeur du signal fourni par le moyen de réglage de vitesse d'alimentation en adhésif (SS9).
9. Machine selon la revendication 8, caractérisée en ce qu'on prévoit un moyen actionnable par l'opérateur (SS1, SS2, SS3), qui fournit une entrée au moyen de commande par ordinateur et grâce auquel on peut effectuer une pluralité de pré-réglages pour la longueur d'alimentation des pièces à travailler à sélectionner selon le contour du bord de la pièce à travailler devant être pliée, l'arrangement étant tel que le moyen de variation de longueur d'alimentation (-, SM1) sert à régler la longueur d'alimentation selon un réglage sélectionné parmi ces réglages lors de la réception d'un signal approprié en provenance du moyen de commande par ordinateur,
et en ce qu'on utilise comme norme l'une des longueurs d'alimentation pré-réglées et la sélection de celle-ci est inefficace pour faire varier la vitesse d'alimentation en adhésif telle que réglée par le moyen de réglage de vitesse d'alimentation en adhésif actionnable par l'opérateur (SS9), mais la sélection d'un autre parmi les pré-réglages est efficace pour provoquer la variation de ladite vitesse, cette variation étant proportionnelle à la différence entre la norme et les longueurs d'alimentation pré-réglées sélectionnées.
10. Machine selon la revendication 5 et la revendication 9, dans laquelle des dispositifs de détection de pièces à travailler (E1 à E7) sont disposés au niveau de ou adjacents à l'emplacement de travail de la machine et comprenant un dispositif de détection de "présence de pièce à travailler" (E1, E2) qui sert à détecter la présence d'une pièce à travailler, et ainsi provoque le déclenchement de l'alimentation en adhésif, et également un dispositif de détection de "coin" (E3 à E7) qui sert à détecter l'approche à la fois de coins "intérieurs" et "extérieurs" (tels que définis plus haut) pour l'emplacement de travail lorsque la pièce à travailler est alimentée par celui-ci,
caractérisée en ce qu'en réponse à la détection d'un coin approchant, une entrée est fournie au moyen de commande par ordinateur, grâce à laquelle une longueur appropriée est sélectionnée parmi les longueurs d'alimentation pré-réglées, et en ce qu'on prévoit un moyen actionnable par l'opérateur (S11), grâce auquel on fournit une entrée au moyen de commande par ordinateur, grâce à laquelle le moyen de variation de vitesse d'alimentation (T) est mis hors service et le moyen de détection de "présence de pièce à travailler" (E1, E2) est mis en service pour commencer également le travail du moyen d'alimentation de pièces à travailler lorsque la présence d'une pièce à travailler est détectée par celui-ci, la vitesse de rotation de l'arbre menant principal étant réglée à la valeur maximale dans les limites de la gamme de vitesses réglée sélectivement et les diverses longueurs d'alimentation pré-réglées étant sélectionnées selon le contour du bord de la pièce à travailler tel que détecté par le dispositif de détection de "coin" (E3 à E7).

Fig. 1



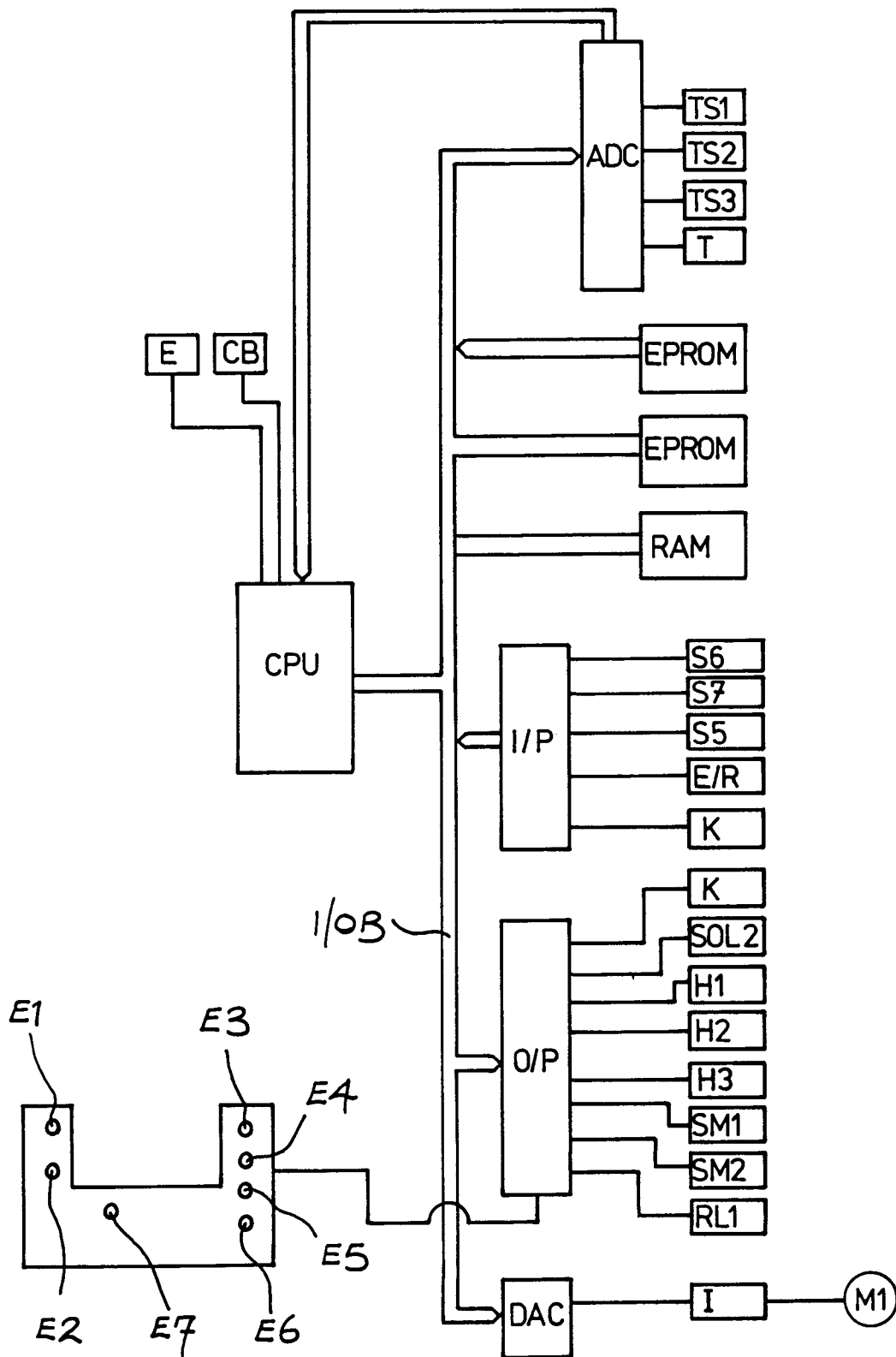


FIG-2

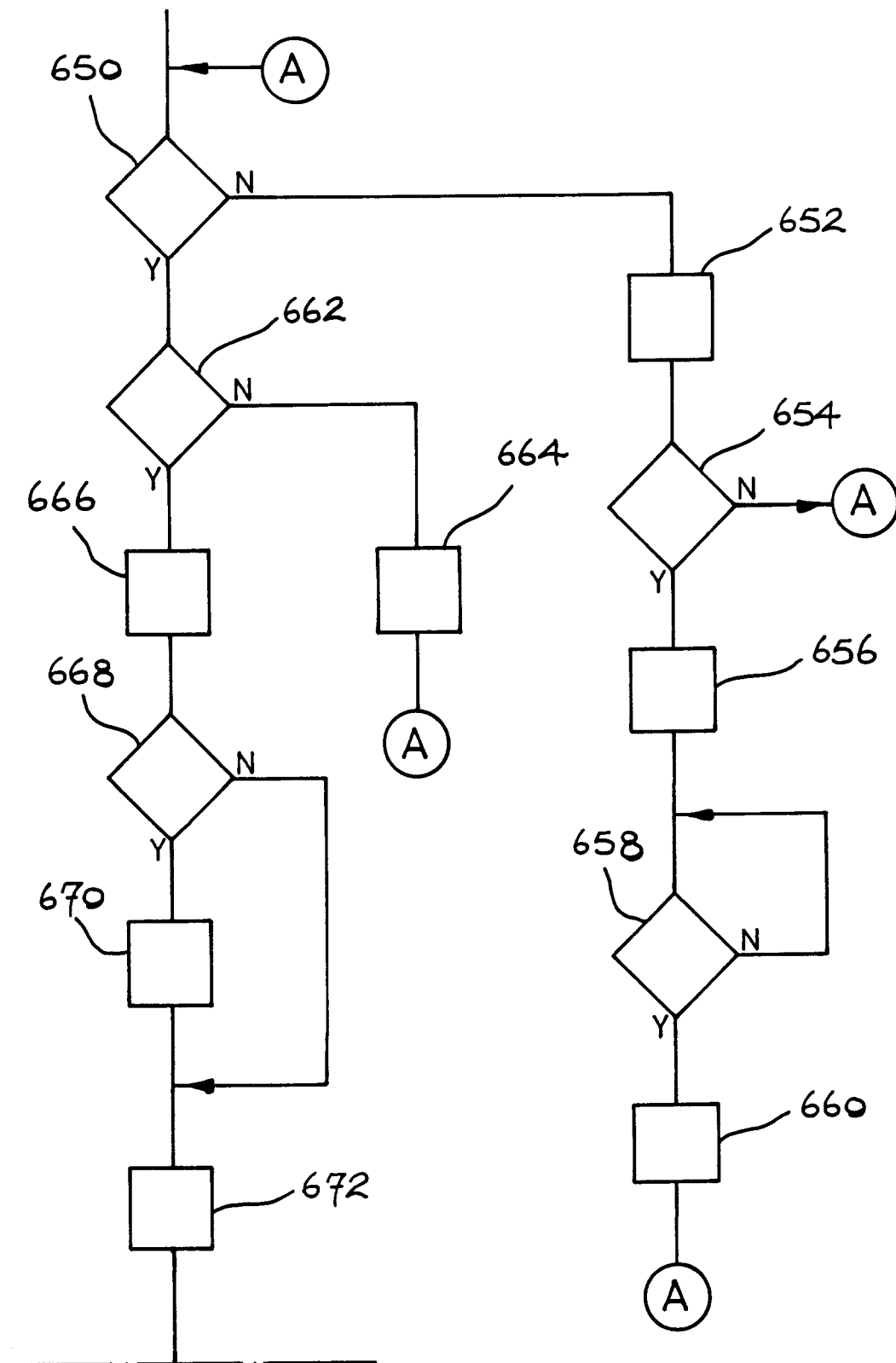


FIG-3A

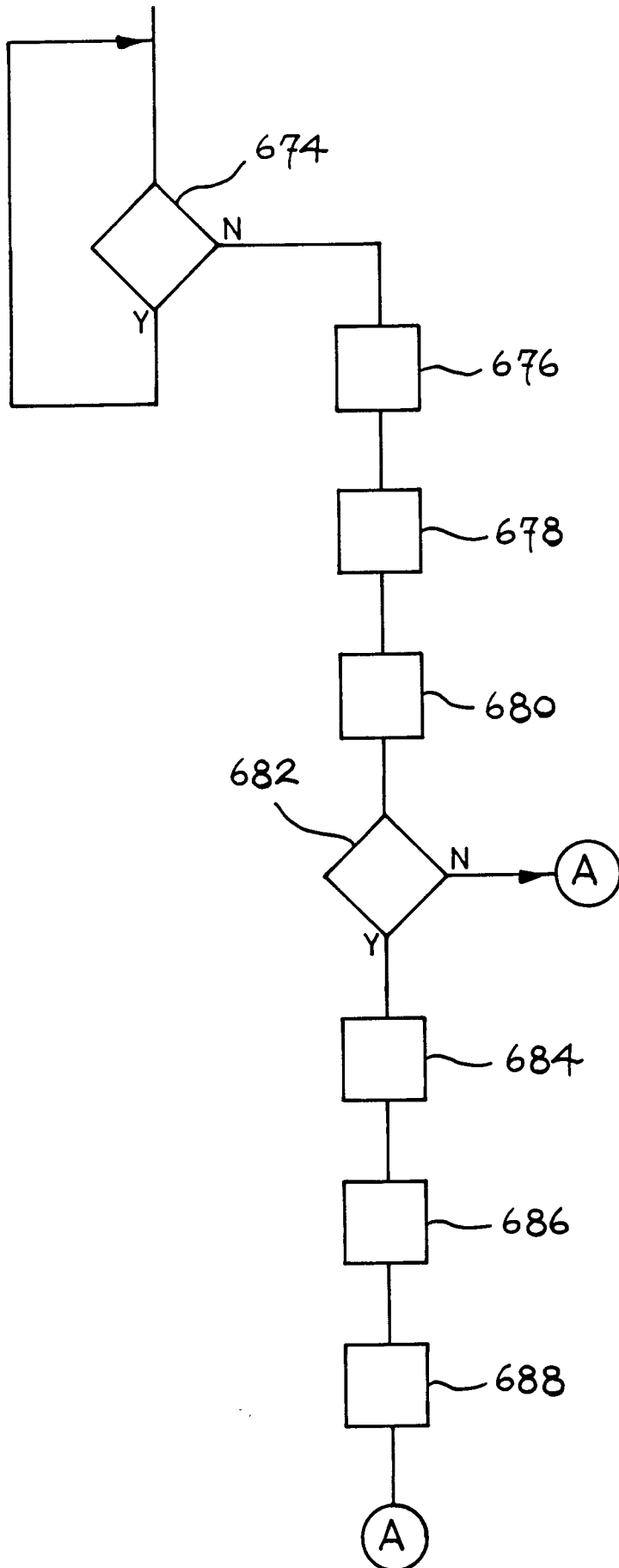


Fig-3B

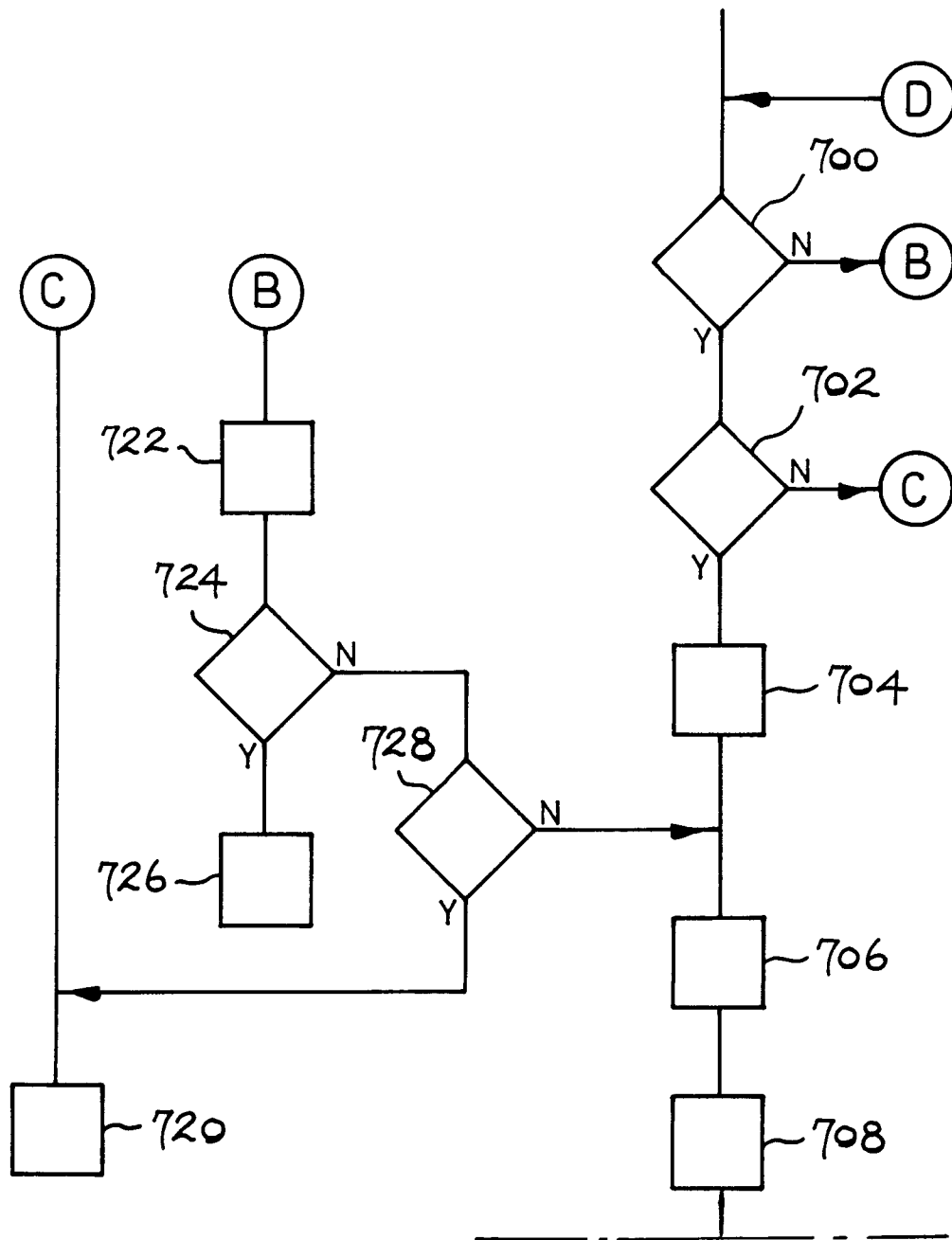


Fig- 4A

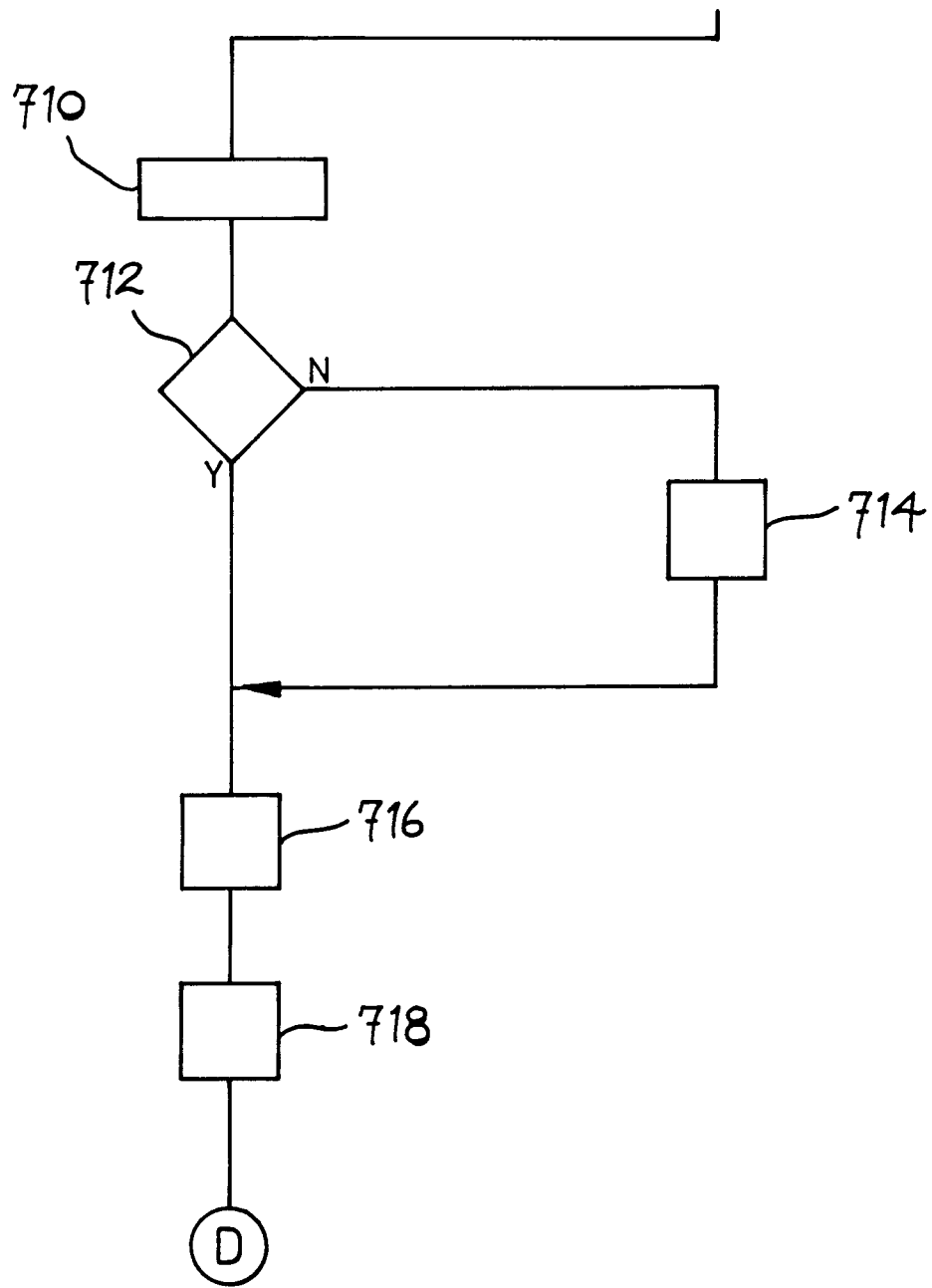


Fig- 4B

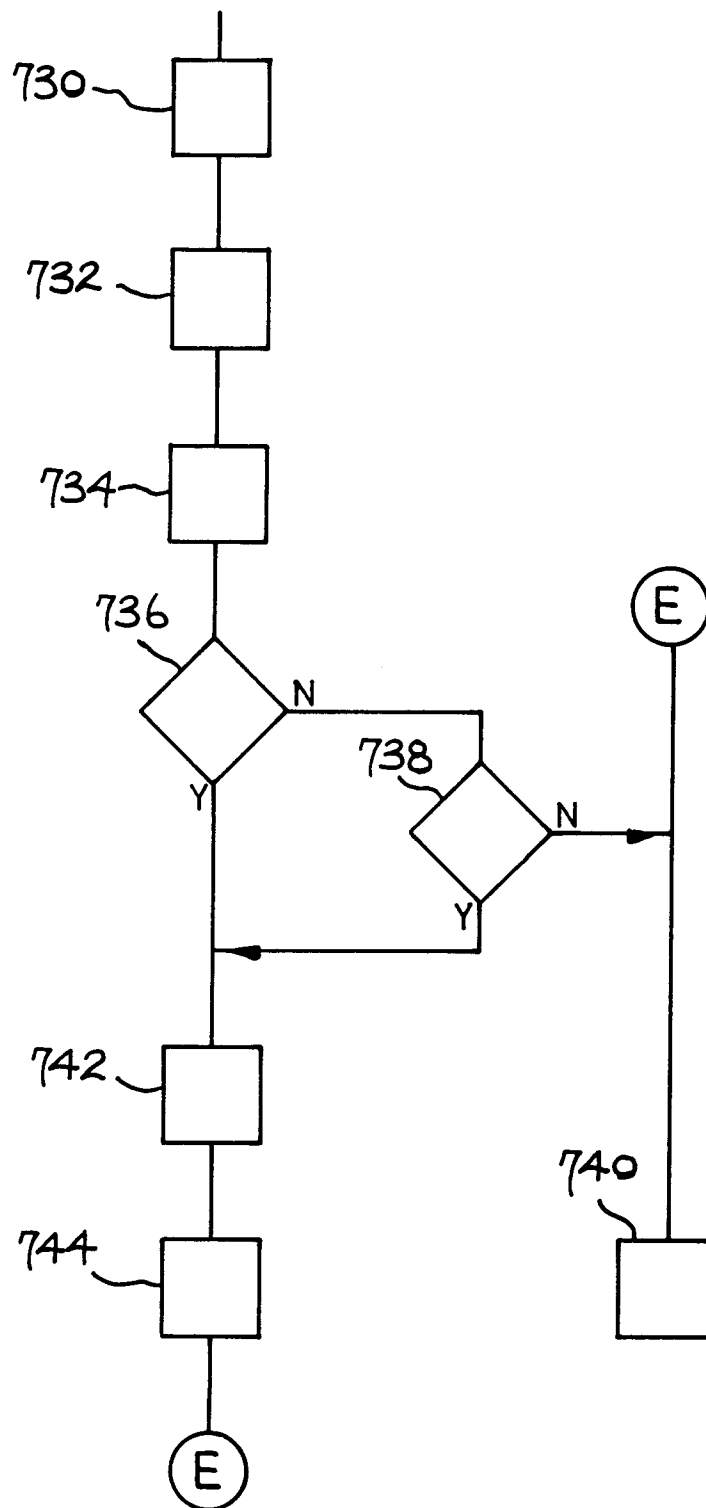


Fig. 5

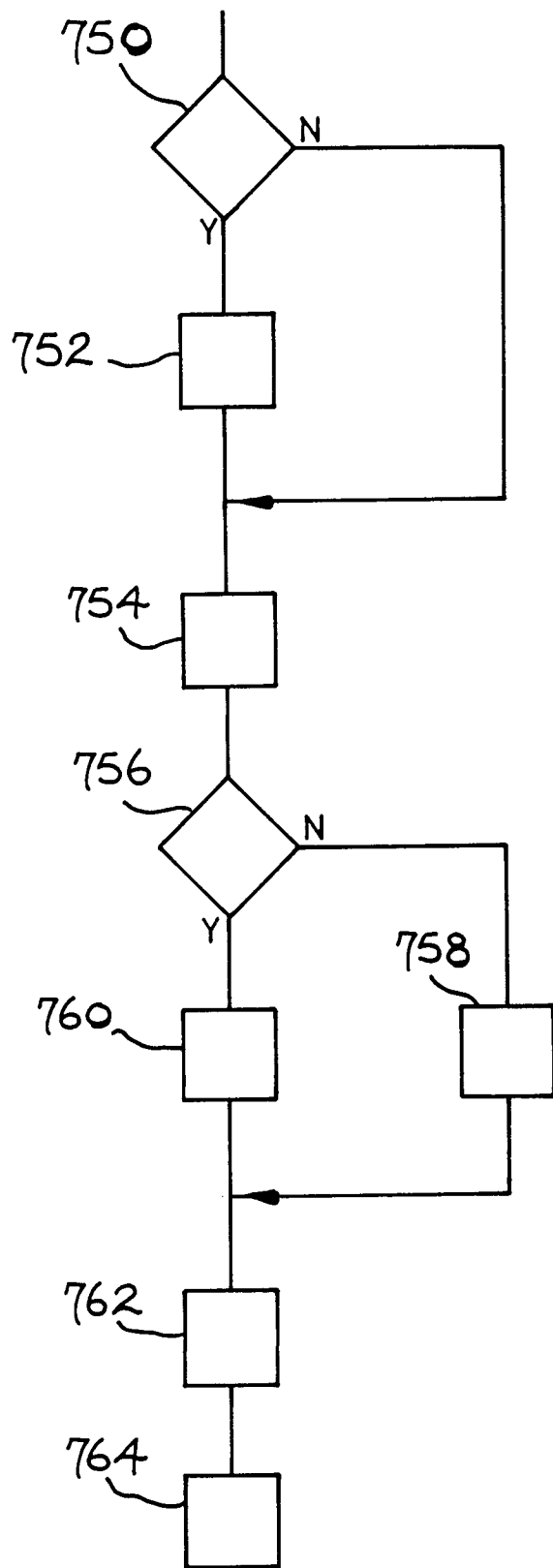


FIG. 6