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(54) **Control system.**

(57) A control system for machinery, such as carding machinery in the textile industry, which has a plurality of controllable drives to different components (such, in the case of carding machinery, as a scribbler and a carder with workers and a condenser and a waste fan), has manually adjustable control means for each drive by which the machinery may be set up to produce a given product. A computer-operated visual display unit (VDU) displays the actual drive states of the various drives, the computer being programmed to display, identify, store and recall any given set of drive states as a recipe.

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# CONTROL SYSTEM

This invention relates to control systems for machinery having a plurality of controllable drives such for example as carding machinery.

Carding involves multiple drives, of which some are independently driven electric motors and some are continuously variable gear arrangements driven directly or indirectly from such motors. A typical system involving a hopper feed, a scribbler, a carder and a condenser, will involve three main motors driving the scribbler cylinder, the carder cylinder and the condenser eccentric motion, several smaller motors operating such things as the scribbler flycomb, the waste fan on the condenser and driving combs and feed conveyors in the hopper feed. In addition, variable gear drives will be provided for the scribbler feedroller, the carder feedroller (driven respectively from the scribbler cylinder motor and carder cylinder motor) and the condenser (driven from the carder cylinder motor) as well as for workers on the carder, and so on.

The drive states of these drives, which is to say the speeds and directions of the motors and the ratio settings of the continuously variable gears,

determine the product and process parameters - yarn count, throughput rate and so on. In addition, various sensors will control the operation of the machinery on the occurrence of certain conditions. For example, alarm sensors may detect sliver breakage, metal and whether, for example, the taker-in rollers of the scribbler and the carder are stopped, in any of which events the whole line has to be stopped. Sensors may also detect when the required length of yarn has been wound on to the condensor drum spools, when the machinery must be stopped or operated at crawl or inching speed so that the spools may be changed.

Conventionally, a carding line such as described has been provided with individual controls for motor speed and direction and for the continuously variable gear ratio settings. Some of these at least may be grouped into a control panel for the entire line.

With the more recent development of computerised control systems it is clear that such can be advantageously applied to the control of multiple-drive machinery such as the carding arrangement described. The question is, however, what computerised control system to provide.

The obvious choice would be a system in which

the computer keyboard was used to input information about the desired drive states, the computer then directly setting the motor and continously variable gear arrangements to run at those desired states.

We have found, however, that this "ideal" system has considerable disadvantages, especially in connection with such carding arrangements as are above described.

One such disadvantage is that computer keyboard controls are unfamiliar to the machine operators, in general. Another disadvantage is that it is often desired to set up machinery by trial and error, whereas computer technology tends to suggest that the computer should be exercising precise control at all times.

Furthermore, the idea of overall computer control ordinarily entails each variable being independently and directly under computer control. We have found, however, considerable advantages in arranging a hybrid form of control in which controls are used which are familiar to the operators who will use them in the way that they have used conventional controls, but nevertheless the full advantages of computerised data display, storage and recall are available without, however, expensive and complicated interfacing between computer and machinery.

The invention comprises a control system for machinery having a plurality of controllable drives to different components thereof comprising manually adjustable control means for each of said drives whereby the machinery may be set up to produce a desired product, and including a computer-operated visual display unit (VDU) connected to display the actual drive states of the various drives, the computer being programmed to display, identify, store and recall any given set of drive states as a recipe.

For use in carding machinery, one of said controllable drives will be a carding machine drive motor. In carding machinery comprising a scribbler and a carder with independent motor drives, the two motors will be independently controllable.

The machinery may comprise a plurality of drive types including motor drives and variable ratio, for example, continuously variable gear drives.

Any drive may be controllable by an "increase/decrease" controller which can be manipulated until the actual drive state as displayed on the VDU is the desired drive state.

Although as many as necessary of the drives may be individually controllable by the system, they may all additionally be controllable together so that when a desired set up is effected, the entire machinery can be ramped up and down together. In practice this will entail only raising and lowering motor speeds in synchronism, the geared dependent drives changing speed with the main motors without usually requiring any ratio change.

The computer may additionally be programmed and connected to the drives so as to be able on command automatically to set the actual drive states to the desired drive states in a recipe stored in memory.

The system may include failure sensors inputting signals to the computer, the computer being programmed to put the drives automatically into a non-operative state on receipt of such signals - this may naturally involve ramping down all the main motor drives in synchronism.

The system may also include task completion sensors inputting signals to the computer, the computer being programmed to ready the machinery for unloading and/or recharging and to restart operation on receipt of such signals.

Process sensors may input signals to the computer representative of the actual effect in terms of product or process parameters of an adjustment of the drive states such signals resulting in an indication of the product or process parameter on the VDU whereby the drive states can be varied so as to achieve such product or process parameters.

In another aspect, the invention comprises a control system for machinery having an input for material and an output for a finished product made from such material and operating means operating on said material to convert it into said product and having control means for said operating means which control means includes programmable means and memory means holding or accepting data relating to different materials and different products and receiving information about the input of material from said input and controlling said operating means in accordance with said data and said information.

More specifically, the invention comprises a control system for carding machinery having an input for fibre and an output for carded fibre and carding means carding said fibre and control means for said carding means including a computer which can hold instructions

for producing a given carded product from a given fibre and which receives fibre throughput information from said input and which controls the operating means in accordance with the instructions and the information.

One embodiment of a control system for carding machinery according to the invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic illustration of a carding operation,

Figure 2 is a view of a control console, and

Figure 3 is a view of a VDU display screen.

The drawings illustrate a control system for a carding operation. Fibre from a hopper feed section 11 is fed to a scribbler 12, a web squeeze section 13, a carder 14 and a condenser section 15.

The hopper feed comprises a motor 21 for the loading section combs, a motor 22 for a spiked conveyor sheet in the loading section, a motor 23 for a weighing section comb and a motor 24 for a spiked conveyor sheet in the weighing section.

The scribbler cylinder is driven by a motor 31. A continuously variable gear 32 taking its drive from the motor 31 drives the scribbler feed rollers 33. A motor 34 drives the scribbler flycombs.

Drive for the web squeeze section 13 is taken from a continously variable gear 35 driven from the motor 31.

The carder cylinder is driven by a motor 41, the carder feed rollers 43 being driven from a continuously variable gear 42 as for the scribbler. Further continuously variable gears 44, 45 driven from the motor 41 drive the carder first and second workers, and another, 46 also driven from the motor 41, drives the condenser section 15, for which also a motor 47 is provided to drive the eccentric motion. A motor 48 drives the waste fan.

All of these motor and continously variable gear drives are controlled from the console 51 shown in more detail in Figure 2. The console has a computer section comprising a VDU screen 52 and keyboard 53 and a disc drive and printer section 54.

A control section 55 has manually adjustable

control means in the form of "increase" and "decrease" push buttons labelled "I" and "D" respectively for each of the drives shown in Figure 1, as indicated by the corresponding reference numbers above in indicator lamps which are on when the particular drive is functional.

With these "I" and "D" buttons the speeds of the various drives may be set up to a recipe for producing a desired product, namely yarns of a specified count. The computer at this stage is put, by suitable programming and keyboard input, into a recipe generation mode. As shown in Figure 3, the display lists the various drives. If the "I" button on the scribbler cylinder motor 31 is depressed the chosen running speed of the cylinder is increased, the speed being indicated (currently as 130 rpm) next to the indication "Scribbler cylinder" on the screen.

Actuation of the "I" and "D" push buttons adjusts a potentiometer or other appropriate control for each of the motor drives and a servomotor or like control for the continuously variable gear drives to adjust the ratio thereof, the computer simply picking up information, about the potentiometer or servomotor setting by any appropriate transducer, such as a potentiometer which gives a voltage output proportional to the setting, which voltage is digitised in an A/D

converter and fed to the computer through a suitable interface, all in accordance with conventional computer technology.

The console 51 also has line controls which control the whole line in synchronism, these controls being shown as START and STOP push buttons 61, 62, a CRAWL push button 63 and a SPEED push button 64 which ramps the whole line up to run at the settings preselected by the "I" and "D" buttons.

Additional indicator lights 71 and 72 with reset buttons 71a, 72a are provided connected to metal detectors at the scribbler and carder input rollers, which are connected to stop the line when metal is detected so that no damage is done to the machinery.

Tachometers (not shown) on the scribbler and carder cylinders send speed data to the computer input interface which appear as actual speed indications on the VDU.

Adjustments to any of the drives may be made using the "I" and "D" push buttons while the machinery is in operation.

Instead of the "I" and "D" buttons, of course, sliders or rotary knobs can be provided.

The computer is programmed so as to record a recipe, which may be given an identifying number by keyboard input, on to a magnetic disc (or other suitable memory device) so that it may be recalled to the screen, the recalled drive state data being indicated in a separate column of the display. To set up the machine to the selected recipe, the "I" and "D" push buttons are operated until the selected speed and ratio settings are equal to the recalled recipe settings.

Additional information may be input into the computer from the keyboard or otherwise from sensors or transducers, again through suitable interface means. Such information may comprise run time, stoppage time, batch weight, yarn count and so on from which may be made automatically calculations of average efficiency over a given period of time. Sensors at the condensor can be set to indicate when the condensor bobbin is full and the machine stopped or set to crawl speed so that the bobbin can be changed after which the machinery is again ramped up to speed.

Additional control means may be provided to set automatically the potentiometers or servomotors which

are set manually by the "I" and "D" buttons, such comprising for example relays actuated by control signals from the computer comparing a selected speed or ratio with a recipe speed or ratio and adjusting the selected speed or ratio to match the recipes.

In the weighing section of the hopper feed section 11 may be disposed a computer control arrangement which controls and monitors the amount of fibre supplied to the carding arrangement. Signals indicative of the rate of fibre supply can be used together with signals indicative of the speed of the condenser section 15 and the rate of waste recirculation to calculate - in the computer section of the console 51 - the count of the yarn being produced and, by inputting a predetermined batch weight, the same computer can be made to produce an estimated time for completion of a batch. With suitable programming, and, of course, a real time clock arrangement, the console computer can keep a log of important production parameters, including production rate, downtime, efficiency and so on, and take account of them in performing calculations for time to completion of a batch, or for production by a given time and so on, and it can also be arranged to print a summary of management information at predetermined times or on demand.

A spreadsheet program may also be held in the console computer in which processing parameters and variables may be interrelated to show the effects of making a change in a variable or a parameter. It may be established, for example, that a relationship E = f(s) exists where "E" is efficiency and "s" is condenser speed - for instance, efficiency may decrease as speed increases over a certain threshold because of increasing downtime. The spreadsheet program would be able to show the effect of speed changes on the time for completion of a batch taking the change in efficiency into account.

## CLAIMS

1. A control system for machinery having a plurality of controllable drives to different components thereof comprising manually adjustable control means for each of said drives whereby the machinery may be set up to produce a desired product, and including a computer-operated visual display unit (VDU) connected to display the actual drive states of the various drives, the computer being programmed to display, identify, store and recall any given set of drive states as a recipe.

2. A control system according to claim 1, adapted for use with carding machinery, one of said controllable drives being a carding machine drive motor.

3. A control system according to claim 1 or claim 2, adapted for use with carding machinery comprising a scribbler and a carder with independent motor drives, both being controllable drives.

4. A control system according to any one of claims 1 to 3, comprising a plurality of drive types including motor drives and variable ratio drives.

5. A control system according to any one of claims

1 to 4, wherein said drives comprise continuously variable gearing.

6. A control system according to any one of claims 1 to 6, comprising in which a drive is controlled by an "increase/decrease" control which can be manipulated until the actual drive state as displayed on the VDU is the desired drive state.

7. A control system according to any one of claims 1 to 6, in which the computer is programmed and connected to the drives so as to be able on command automatically to set the actual drive states to the desired drive states in a recipe stored in memory.

8. A control system according to any one of claims 1 to 7, including failure sensors inputting signals to the computer, the computer being programmed to put the drives automatically into a non-operative state on receipt of such signals.

9. A control system according to any one of claims 1 to 7, including task completion sensors inputting signals to the computer, the computer being programmed to ready the machinery for unloading and/or recharging and to restart operation on receipt of such signals.

10. A control system according to any one of claims 1 to 8, including process sensors inputting signals to the computer representative of the actual effect in terms of product or process parameters of an adjustment of the drive states such signals resulting in an indication of the product or process parameter on the VDU whereby the drive states can be varied so as to achieve such product or process parameters.

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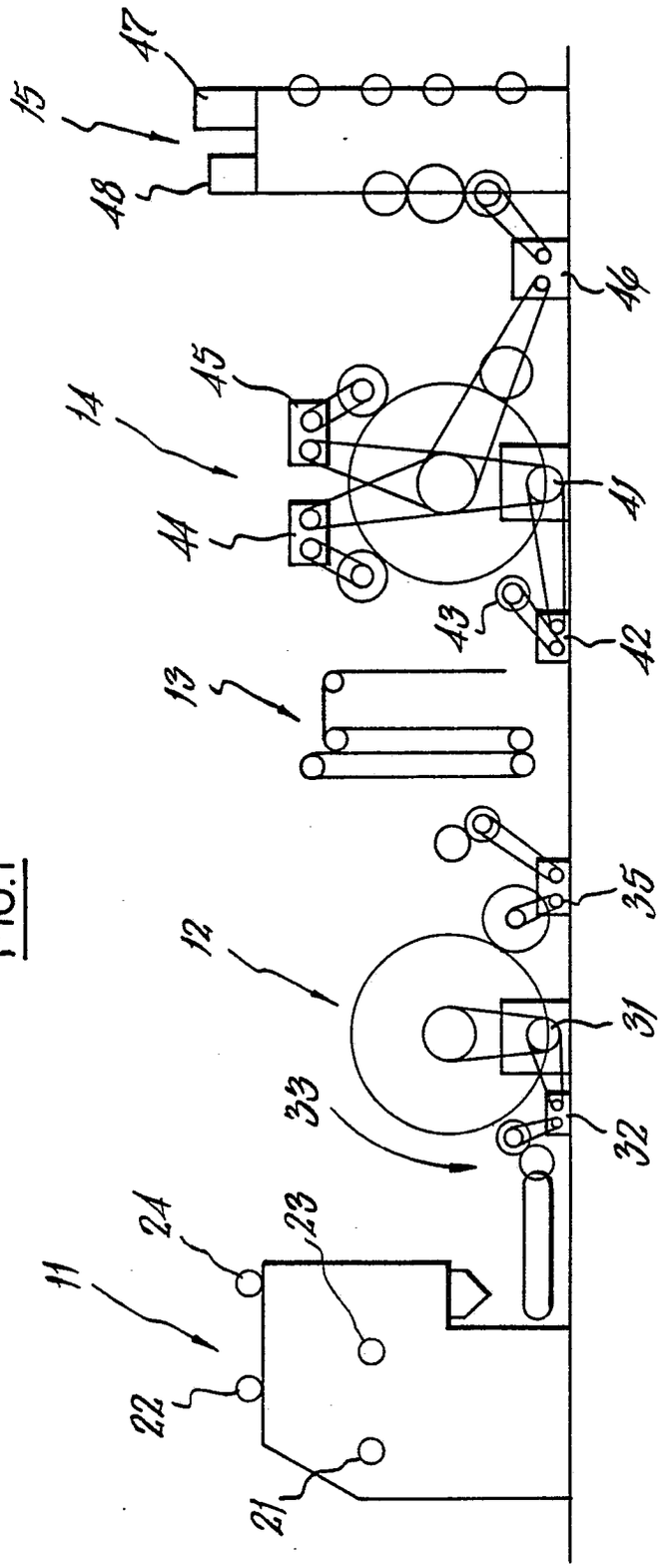


FIG.1

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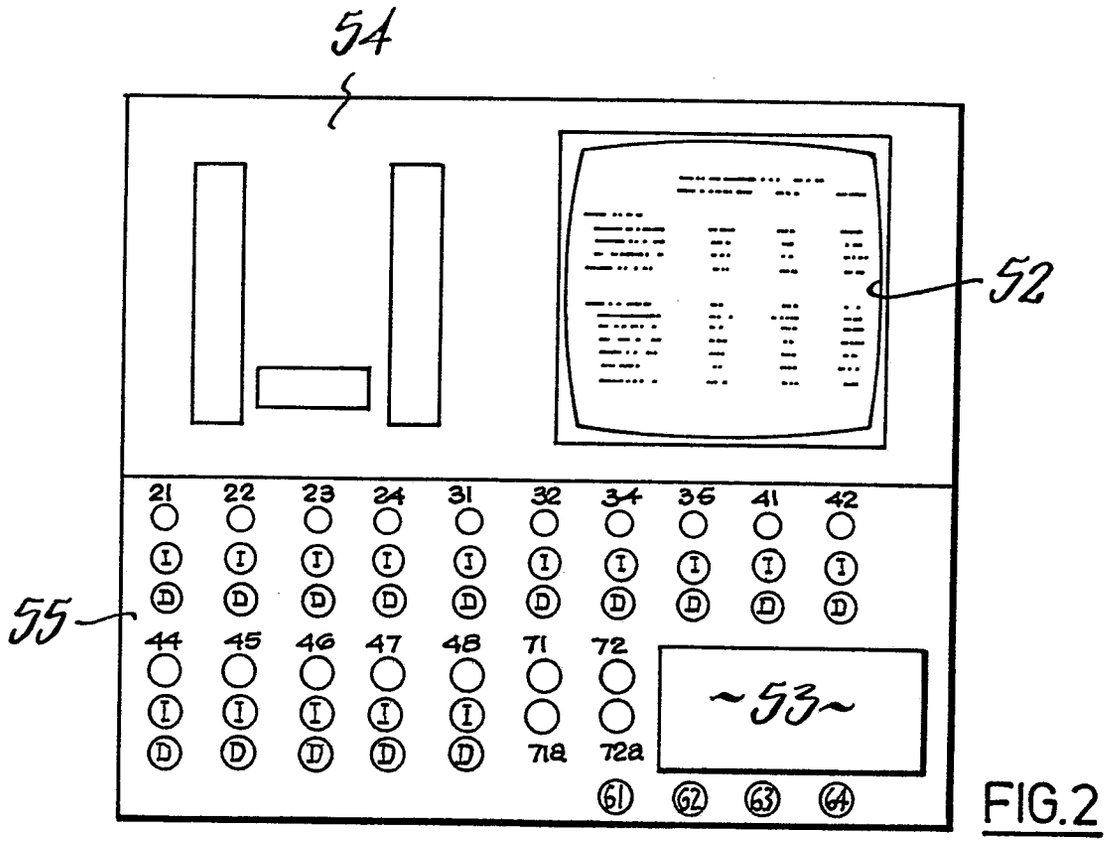


FIG.2

| BLEND No. 351 | RUN MODE | | |
|---|---|---|---|
| | PRESET | ACTUAL | RECIPE |
| SCRIBBLER | | | |
| CYLINDER | 140 | 136 | 140 |
| WORKERS | 10 | 10 | 10 |
| WEB SQUEEZE | 30 | 30 | 30 |
| CARDER | | | |
| FEEDROLLERS | 45 | 44 | 45 |
| CYLINDER | 125 | 130 | 125 |
| WORKERS | 6 | 5 | 6 |
| CONDENSER DRUM | 61 | 62 | 61 |

FIG.3