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(56) Documents Cited

**EP 0603011 A2**

**WO 93/21593 A1**

(58) Field of Search

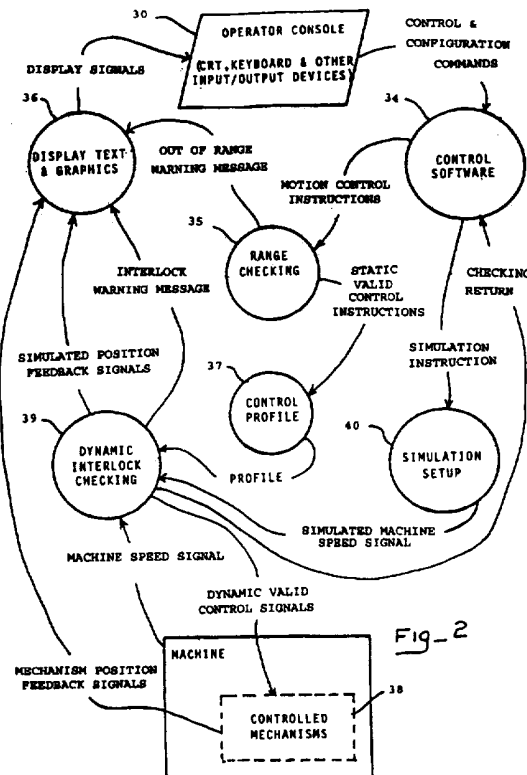
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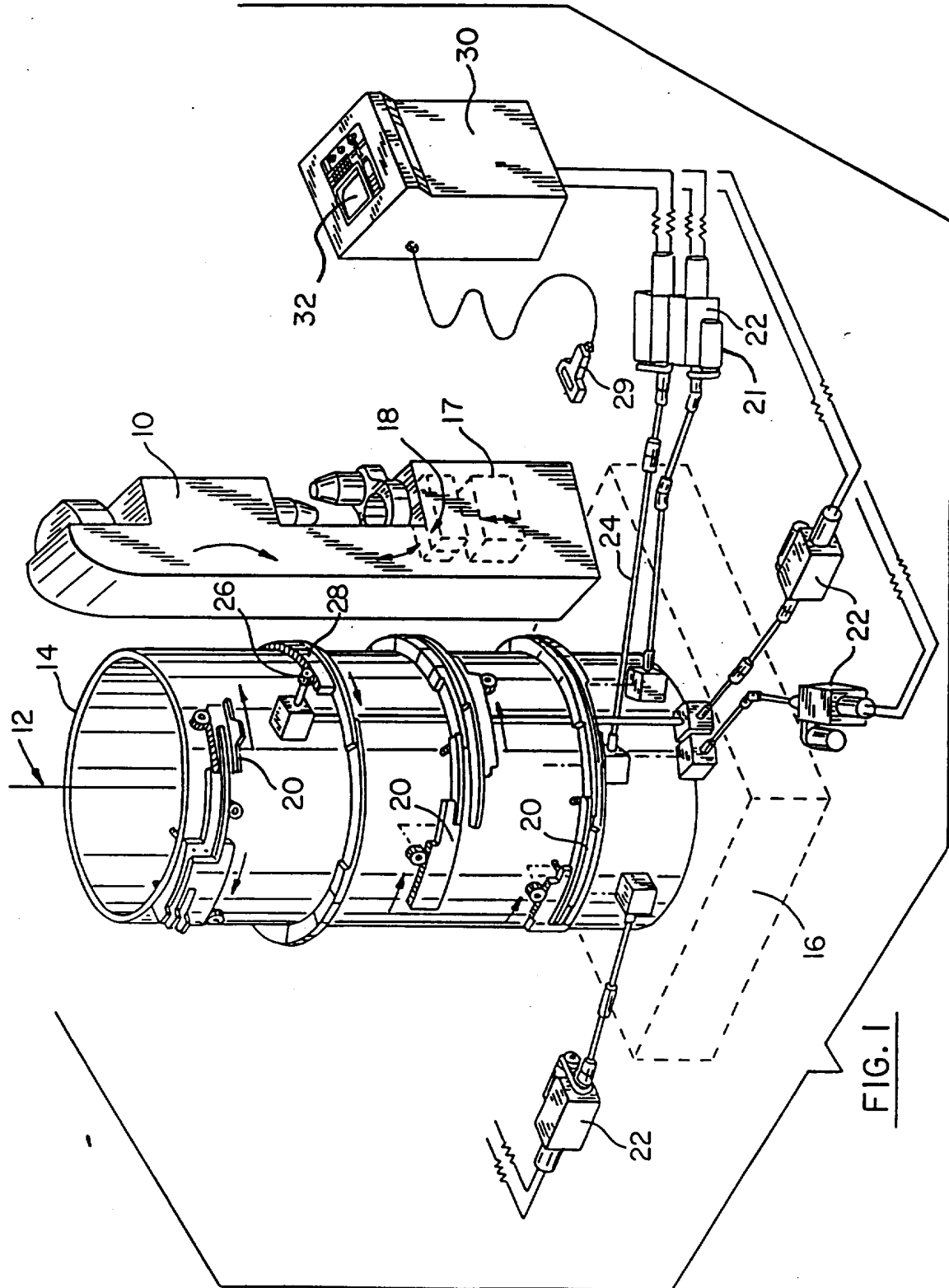
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## (54) Control for a glass forming machine

(57) A control for a glass forming machine having at least one controlled mechanism 38 which will generate position feedback signals representative of its position, comprising control profile means 37 for generating a profile for each mechanism to be controlled, means 34 for transforming the profile either into control signals for the mechanisms to be controlled or into simulated position feedback signals, a screen, and display means for receiving either the position feedback signals or the simulated position feedback signals and for generating display signals for the screen, and means for commanding operation either in a machine mode wherein the transforming means will transform the profile into the control signals and the display means will receive feedback position signals from the controlled mechanisms or in a simulation mode wherein the transforming means will transform the profile into the simulated feedback position signals and the display means will receive the simulated position feedback signals.



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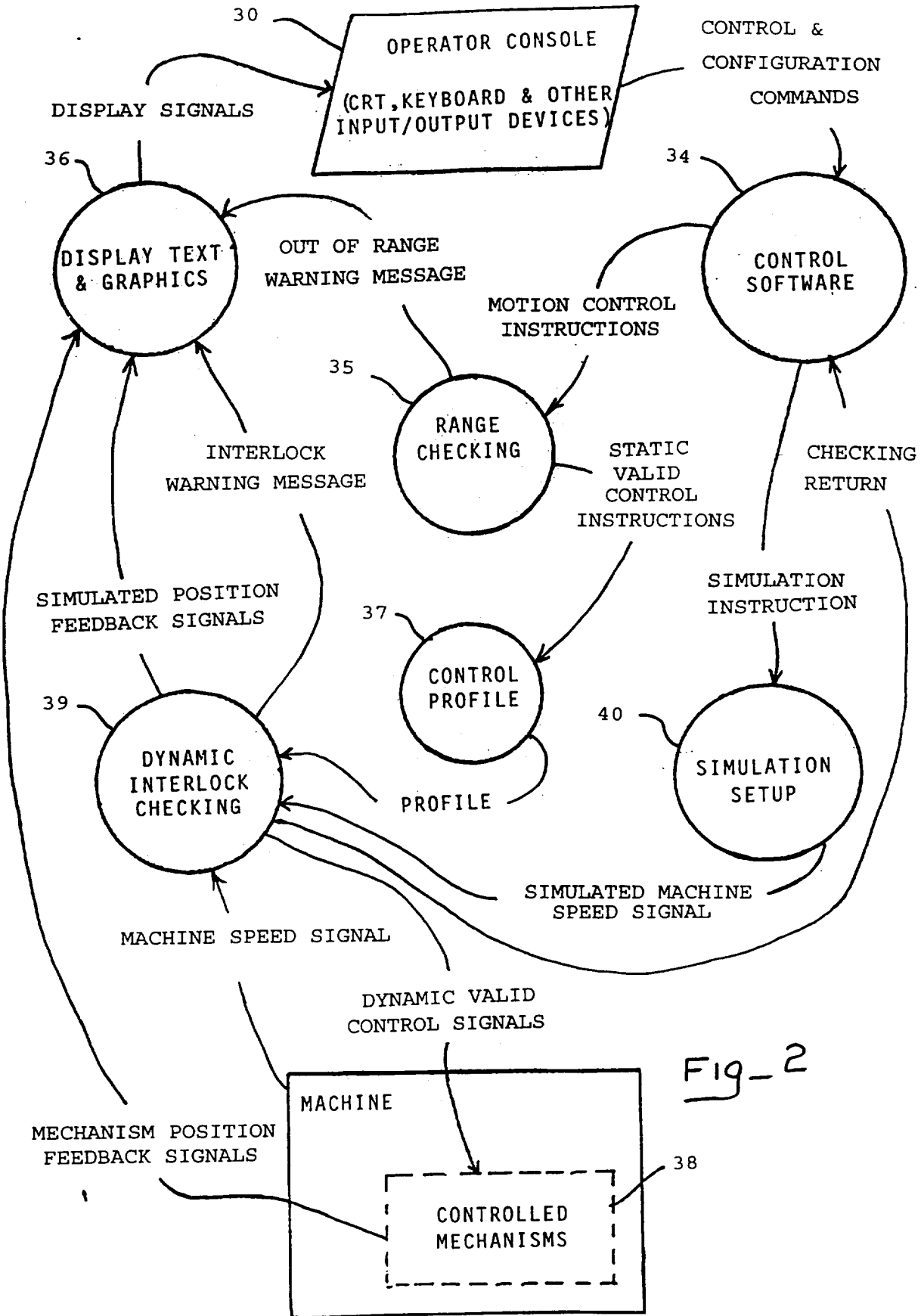


Fig-2

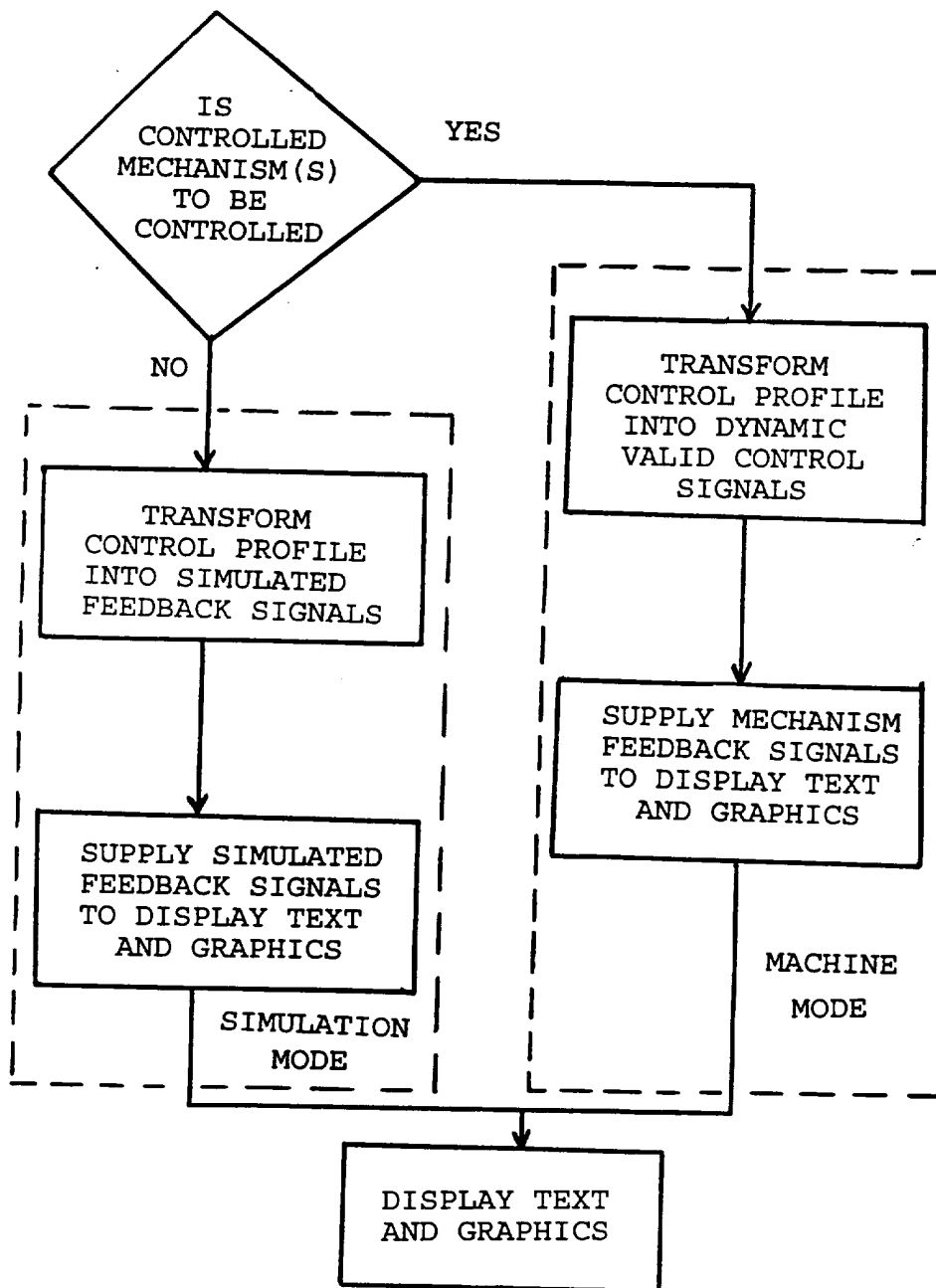


Fig-3

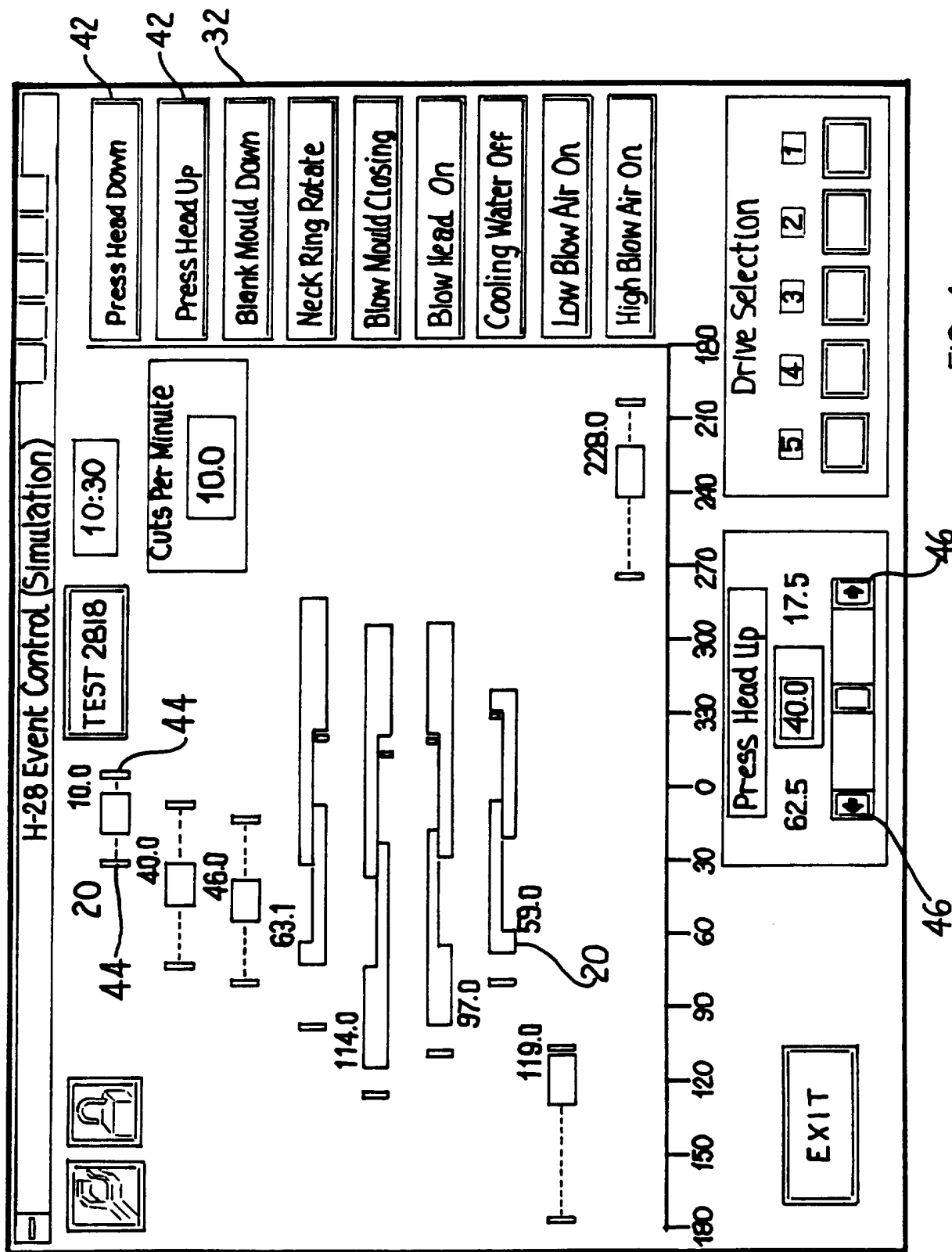


FIG. 4

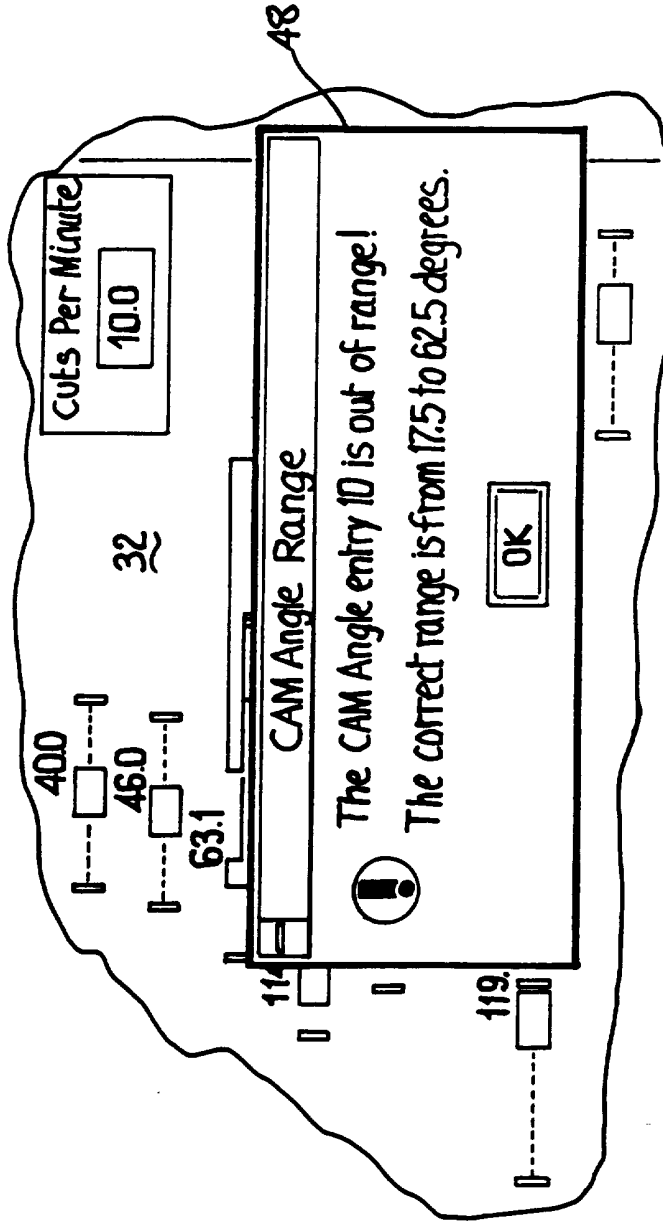


FIG. 5

## CONTROL FOR GLASS FORMING MACHINE

The present invention relates to machines such as H-28 or I.S. (Individual Section) machines which form glass  
5 containers and other ware from individual gobs of molten glass and, more particularly, to control systems for such machines.

Glass forming machines receive individual gobs of  
10 molten glass and form them in either a press and blow or a blow and blow process into the finished container. During a cycle of operation one or more devices will be displaced by an actuator (which may be profiled such as a servo or stepper motor drive) and the position of the devices will be  
15 monitored by a transducer (linear, rotary, etc.) which will supply position feedback signals to error checking software. Where displacement is within acceptable limits (distance, velocity, acceleration) the position of the device can be graphically shown on an operational screen. When an error  
20 exists, it also can be graphically displayed.

It is an object of the present invention to provide such a system that can graphically display this information whether or not machine mechanisms are actually being  
25 controlled.

Other objects and advantages of the present invention will become apparent from the following portion of this specification and from the accompanying drawings a presently  
30 preferred embodiment incorporating the principles of the invention.

Referring to the drawings:

Figure 1 is a schematic representation of an H28 machine;

35 Figure 2 is a process control and simulation

diagram for such machine;

Figure 3 is a flow chart diagram illustrating the operation of the Control Software shown in Figure 2;

Figure 4 is a graphic screen showing the location of eight control cams of the machine shown in Figure 1; and

Figure 5 is a view similar to that of Figure 3 with a warning message presented on the screen.

In an H-28 machine, a plurality of sections 10 rotate around the vertical axis 12 of a timing drum 14 which is supported by the machine base 16. Each section makes glassware each revolution. A gob of molten glass is delivered to a blank mould 17 (which is shown schematically in Figure 1 at its down position) . The blank mould then rises to its up position and the gob is pressed in the blank mould to form a parison. The blank mould is lowered to the down position while the parison is held in position and blow moulds 18 are displaced to a closed position (schematically shown in Figure 1) around the parison so that the parison can be blown into the final ware.

The operation of these devices is controlled by mechanical cams 20 which are secured to the drum for limited movement along their annular track and displacement of these cams is effected by driving stepper motors of stepper motor assemblies 22, (Figure 1) which are connected via drive trains 24 ending with a drive pinion 26 to a gear 28 on the associated cam. An operator makes desired changes via a hand held terminal 29 or from the console 30 which includes a computer and an operational screen 32. The stepper motor assembly 22 includes the stepper motor 23 and encoder 21 for supplying positional data to the computer.

To operate the machine (Figure 2) an operator using a CRT, inputs Control and Configuration Commands to the

Control Software 34. If the system is to be operated in the Machine Mode as commanded by the operator, the Control Software will issue Motion Control Instructions to Range Checking software 35 which will determine whether the  
5 instructed motion is within acceptable limits. If the instructed motion is beyond these limits the Range Checking software 35 will issue an Out of Range Warning Message to the Display Text and Graphics software 36 which will supply Display Signals to the screen 32. If the instructed motion  
10 is within these limits the Range Checking software 35 will issue Static Valid Control Instructions to the Control Profile software 37 which will issue a profile for a specific Controlled Mechanism 38 to be displaced. The Control Profile (which could also be identified as a motion  
15 profile generator) includes in memory an algorithm suitable for generating a series of pulses having different frequencies and durations for driving each of the stepping motors. If servo motors replaced the stepping motors, this algorithm would, operating either at the displacement  
20 profile level or at the velocity profile level, generate a series of digital values which once converted to analogue form would drive the servo motors.

Where two of the machine mechanism (for example, the  
25 blank mould and the blow mould) can occupy the same space and are supposed to sequentially occupy this space without striking the other mechanism, the present machine will prevent such interference. The Dynamic Interlock Checking software 39 determines the angle of the blank mould down cam  
30 and the angle of the blow mould closed cam and calculates the angle of separation. Since the blank mould down mechanism has a fixed time duration whereas the blow mould closed mechanism has a fixed angle duration, a change in Machine Speed may result in the establishment of an  
35 interference between these mechanisms. The Dynamic

Interlock Checking software 39 receives the Machine Speed Signal and calculates the minimum separation angle and compares this minimum angle with the selected angle and rejects this selected value if the actual separation is less than the minimum allowable separation.

Conversely, if the operator wants to change to a new machine speed without changing the cam angle settings, the Dynamic Interlock Checking software 39 will calculate the machine speed possible using the existing cam settings. It will then compare the new machine speed to the current machine speed. If interference is not found then the computer will output a speed change command to the table drum motor. If interference is found then the new machine speed will be rejected and an Interlock Warning Message will be sent from the Display Text and Graphics Software 36 which will issue suitable display signals to the screen. Further details of this technology are disclosed in U.S Patent No. 5,122,179.

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Where no interference is found the Dynamic Interlock Checking software 39 transforms the Profile Signals into Dynamic Valid Control Signals for the Controlled Mechanisms 38. Each stepper motor drive has a position transducer (encoder 21) which issues Mechanism Position Feedback Signals which represent the position of the cam being displaced. These signals are transformed by the Display Text and Graphics software into Display Signals which are directed to the operation console.

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Alternately, the operator may operate the system without operating the Machine (the machine may not be present) by issuing a Configuration Command to operate in the Simulation Mode. In the Simulation Mode the Dynamic Interlock Checking software 39 will not receive a Machine

Speed Signal. Instead, the Control Software 34 will issue a Simulation Instruction to the Simulation Setup software 40 which will generate a Simulated Machine Speed Signal for the Dynamic Interlock Checking software 39. With the system  
5 operating in the Simulation Mode the Profile Signals will be transformed into Simulated (software generated) Position Feedback Signals which are then supplied to the Display Text and Graphics.

10 The events 42 to be controlled are listed at the right side of the operational screen illustrated in Figure 3. For each event an associated cam must be located so that the event will take place at the correct time. A cycle equates to 360° and accordingly, time equates to degrees. In the  
15 listed events Blow Mould Closing and Blow Head On the associated cams will operate mechanical mechanisms such as a linkage, whereas, in the other listed events, the associated cams will operate valve mechanisms. Each cam 20 is graphically displayed on the screen 32 as are the programmed  
20 limits 44 of their displacement. The limits (17.5 and 62.5) for Press Head Up and the setting 40.0 for Press Head Up are graphically displayed at the bottom of the screen as are operator controls 46 for changing the setting. In the event  
25 the operator inputs a setting that is beyond the acceptable limits, a warning message 48 (Figure 4) will be graphically presented. As shown, the warning message states that the cam angle entry is out of range and the correct range is set forth.

30 Also shown at the bottom of the operational screen are five drives which correspond to the five stepping motors shown in Figure 1 (three of the eight cams are linked with the other five cams for conjoint displacement).

35 In either mode the operational screen and use

interface will appear and function almost identically. The only exception is when in simulation, the screen would display something (text or graphics) to inform the operator of the Simulation Mode. This means that if the software is  
5 downloaded into the machine computer it can operate the Controlled Mechanisms. If, on the other hand, the software downloaded into a console which is not connected to the machine, having a compatible operational screen, the operational screen will function as if the software was in  
10 fact controlling the Controlled Mechanisms, even though they are not present (or not operating). The operational screen will appear and function as if Controlled Mechanisms are being controlled. This permits an actual machine to be intellectually taken into a training room or the like.

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## CLAIMS

1     A control for a glass forming machine having at least  
one controlled mechanism which will generate position  
5 feedback signals representative of its position, comprising  
control profile means for generating a profile for each  
mechanism to be controlled,  
means for transforming said profile either into control  
signals for the mechanisms to be controlled or into  
10 simulated position feedback signals,  
a screen, and  
display means for receiving either the position  
feedback signals or the simulated position feedback signals  
and for generating display signals for said screen, and  
15 means for commanding operation either in a machine mode  
wherein said transforming means will transform said profile  
into said control signals and said display means will  
receive feedback position signals from the controlled  
mechanisms or in a simulation mode wherein said transforming  
20 means will transform said profile into said simulated  
feedback position signals and said display means will  
receive said simulated position feedback signals.

2     A control for a glass forming machine according to  
25 claim 1, wherein each controlled mechanism is displaceable  
between set limits and wherein said display means comprises  
means for displaying said limits on said screen.

3     A control for a glass forming machine according to  
30 claim 2, wherein said display means further comprises means  
for displaying the location of a controlled mechanism  
relative to said limits.

4     A control for a glass forming machine according to  
35 claim 3, further comprising means for issuing motion control

instructions for each of the controlled mechanisms, means  
for determining whether the motion instructed is beyond said  
limits and said display means further comprises means for  
displaying on said screen wherein a warning message  
5 presenting said instructed motion and the correct range of  
displacement for that Controlled Mechanism.

5 A control for a glass forming machine according to  
claim 1, wherein said transforming means can receive machine  
10 speed signals from the glass forming machine.

6 A control for a glass forming machine according to  
claim 5, further comprising means for generating simulated  
machine speed signals and delivering said signals to said  
15 transforming means, wherein when said control is operating  
in the machine mode said transforming means will receive  
machine speed signals and wherein when said control is  
operated in the simulated mode said transforming means will  
receive simulated machine speed signals.

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**Patents Act 1977**  
**Examiner's report to the Comptroller under Section 17**  
**(The Search report)**

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Application number  
GB 9523396.1

**Relevant Technical Fields**

- (i) UK Cl (Ed.N)      G3N (NG1A3, NG1A9)  
(ii) Int Cl (Ed.6)      C03B (9/41); G05B (17/02)

Search Examiner  
MR D A SIMPSON

Date of completion of Search  
23 JANUARY 1996

**Databases (see below)**

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

Documents considered relevant following a search in respect of Claims :-  
1 TO 6

(ii) WPI

**Categories of documents**

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|--|---|
| <p><b>X:</b> Document indicating lack of novelty or of inventive step.</p> <p><b>Y:</b> Document indicating lack of inventive step if combined with one or more other documents of the same category.</p> <p><b>A:</b> Document indicating technological background and/or state of the art.</p> | <p><b>P:</b> Document published on or after the declared priority date but before the filing date of the present application.</p> <p><b>E:</b> Patent document published on or after, but with priority date earlier than, the filing date of the present application.</p> <p><b>&amp;:</b> Member of the same patent family; corresponding document.</p> |
|--|---|

Category	Identity of document and relevant passages	Relevant to claim(s)
A	EP 0603011 A2 (EMHART)	
A	WO 93/21593 A1 (VHC LTD)	

**Databases:**The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).