United States Patent [19]

Johne et al.

[11] **3,818,827**

[45] **June 25, 1974**

[54] **CONTROL ARRANGEMENT FOR MULTIPLE COLOR PRINTING MACHINES**

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[22] Filed: **Nov. 9, 1971**

[21] Appl. No.: **196,955**

[52] **U.S. Cl.** **101/184,** 101/232

[51] **Int. Cl.** **B41f 13/24**

[58] **Field of Search** 101/183, 184, 185, 140, 101/137, 182, 177, 181, 139, 143, 232

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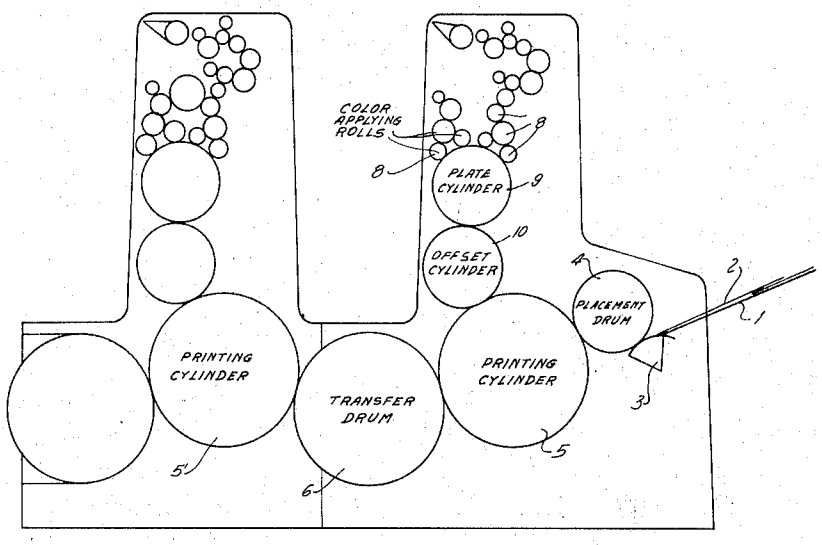
Primary Examiner—J. Reed Fisher

Attorney, Agent, or Firm—Michael S. Striker

[57] **ABSTRACT**

An arrangement for controlling the operation of multiple color printing machines adapted for printing on material in sheet form. A shift register has its output stages connected to sampling circuits which control the on and off operation of the machine in dependence on the information contents of the shift register stages. A sheet sensing station detects the position of a sheet of material and transmits the corresponding information into the shift register which is shifted by clocked signals at predetermined instants in the machine operation.

30 Claims, 11 Drawing Figures



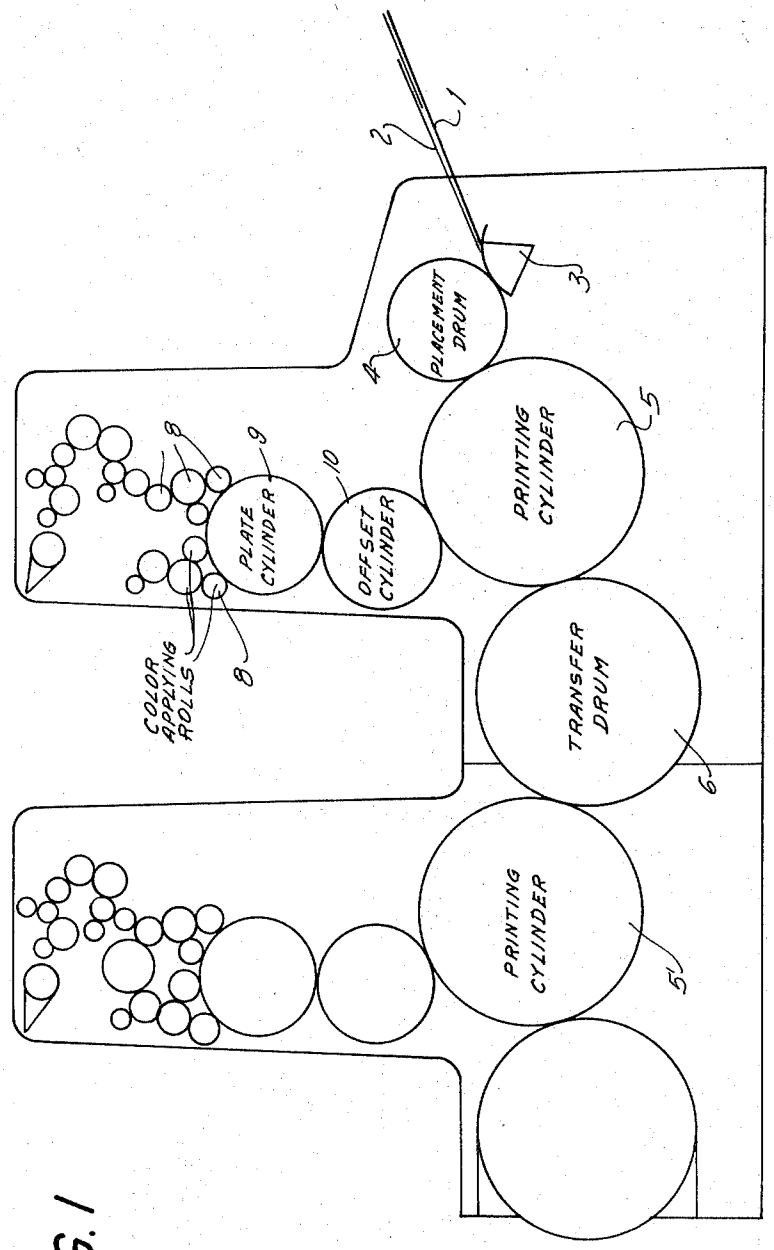

PLACEMENT DRUM
PRINTING CYLINDER
PLATE CYLINDER
OFFSET CYLINDER
COLOR APPLYING ROLLS
TRANSFER DRUM
PRINTING CYLINDER
1
2
3
4
5
5'
6
8
8
9
10

FIG. 1

FIG. 2

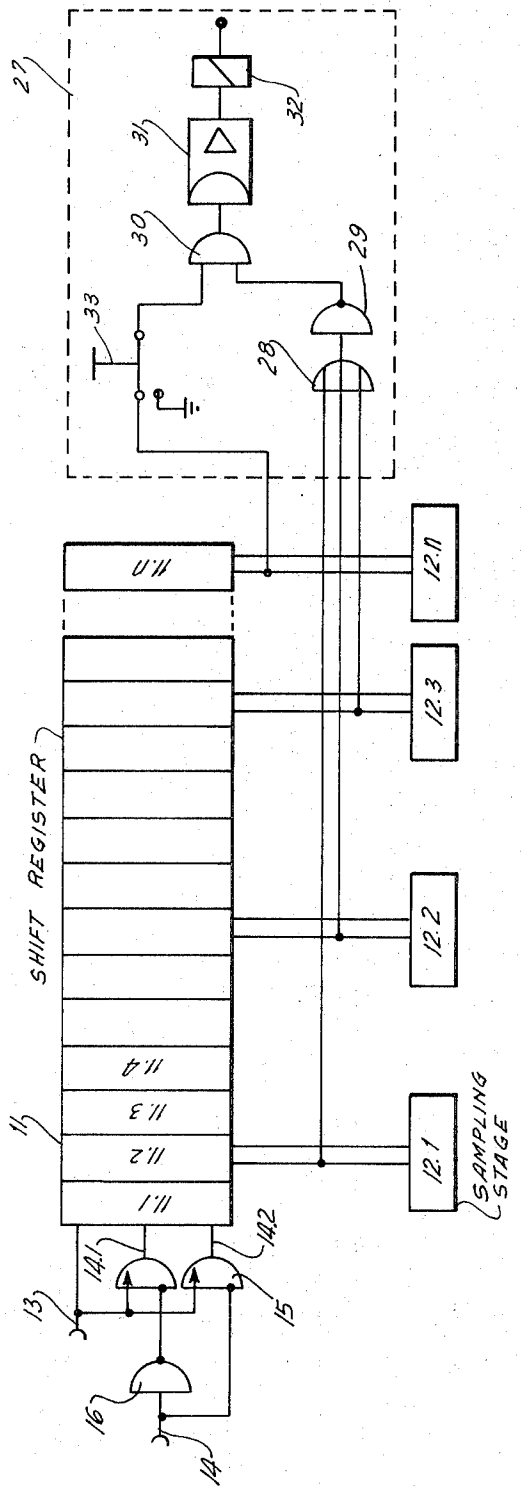

27
32
31
30
29
33
28
11'1
12.11
12.3
12.2
12.1
SAMPLING STAGE
SHIFT REGISTER
11
11.4
11.3
11.2
11.1
14.1
14.2
13
15
16
14

FIG. 3

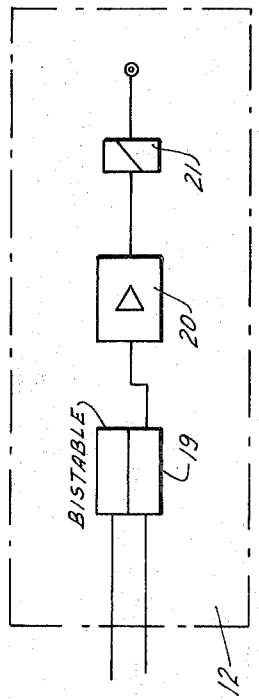

21
20
BISTABLE
19
12

FIG. 4

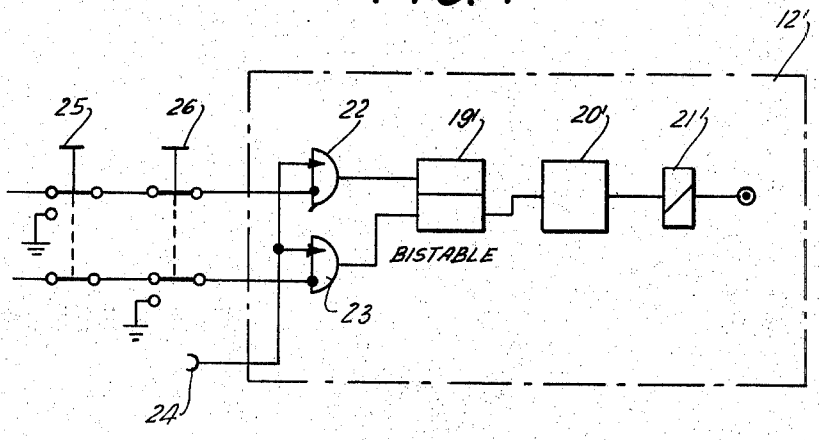

12'
25
26
22
19'
20'
21'
BISTABLE
23
24

FIG. 5

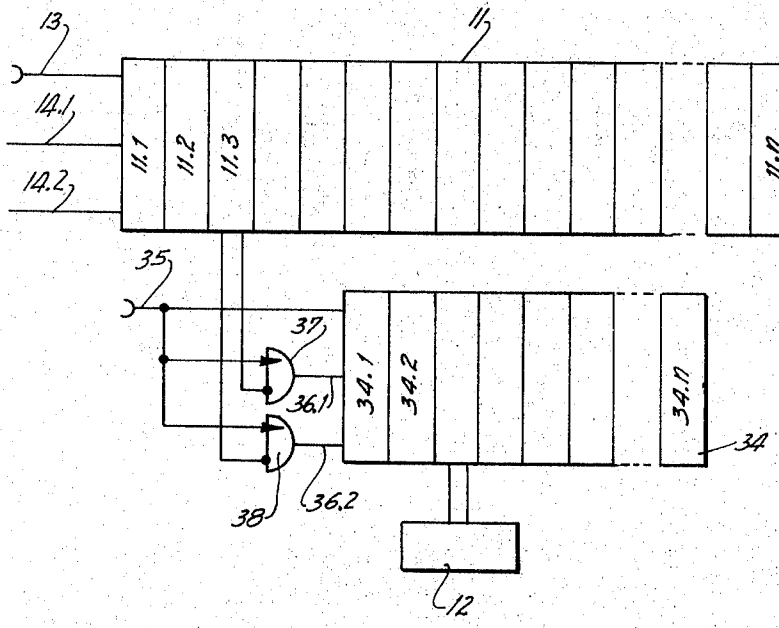
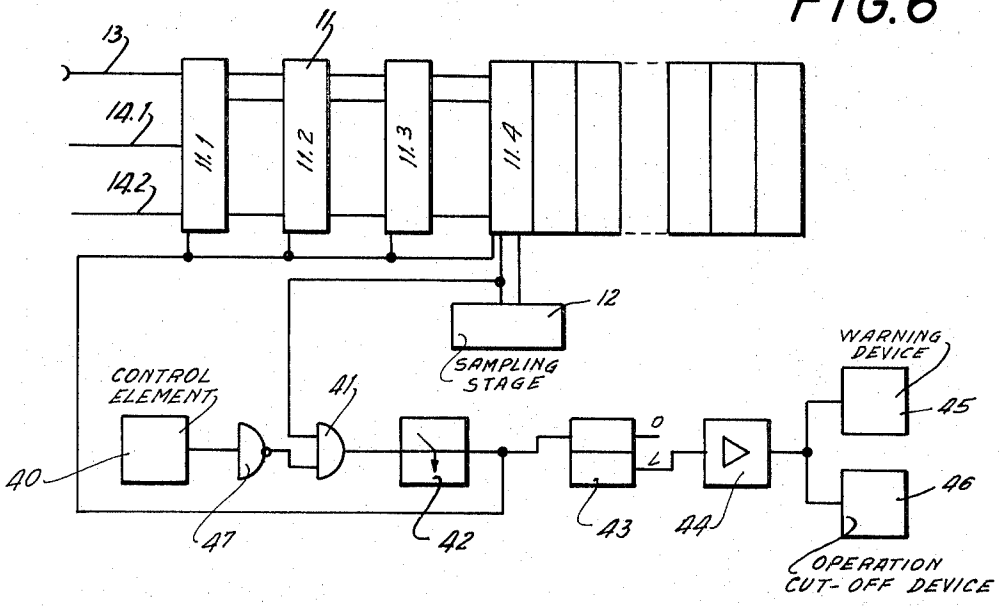

13
11
14.1
14.2
11.1
11.2
11.3
11.11
35
37
36.1
34.1
34.2
34.11
34
38
36.2
12

FIG.6


13
14.1
14.2
11
11.1
11.2
11.3
11.4
12
SAMPLING STAGE
CONTROL ELEMENT
41
40
47
42
43
44
0
WARNING DEVICE
45
46
OPERATION CUT-OFF DEVICE

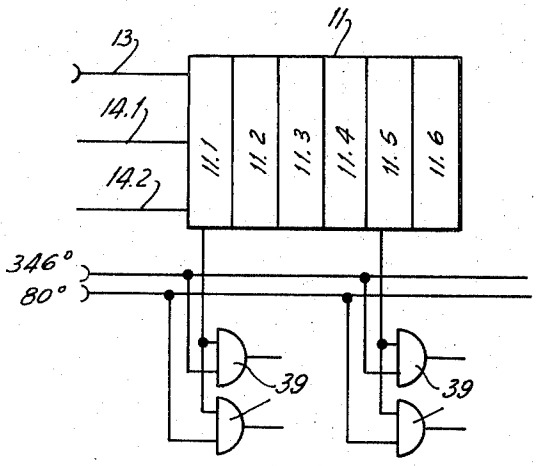

13
14.1
14.2
11
11.1
11.2
11.3
11.4
11.5
11.6
346°
80°
39
39

FIG.7

FIG. 8

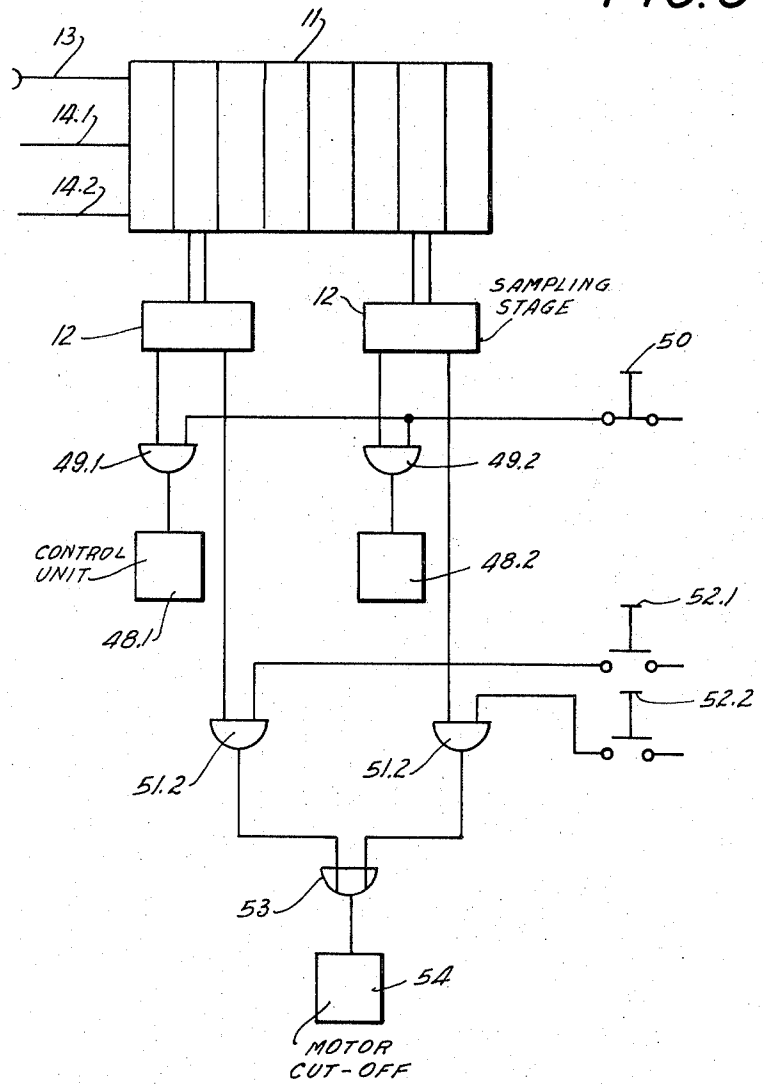

13
11
14.1
14.2
12
12
SAMPLING STAGE
50
49.1
49.2
CONTROL UNIT
48.1
48.2
52.1
52.2
51.2
51.2
53
54
MOTOR CUT-OFF

FIG. 9

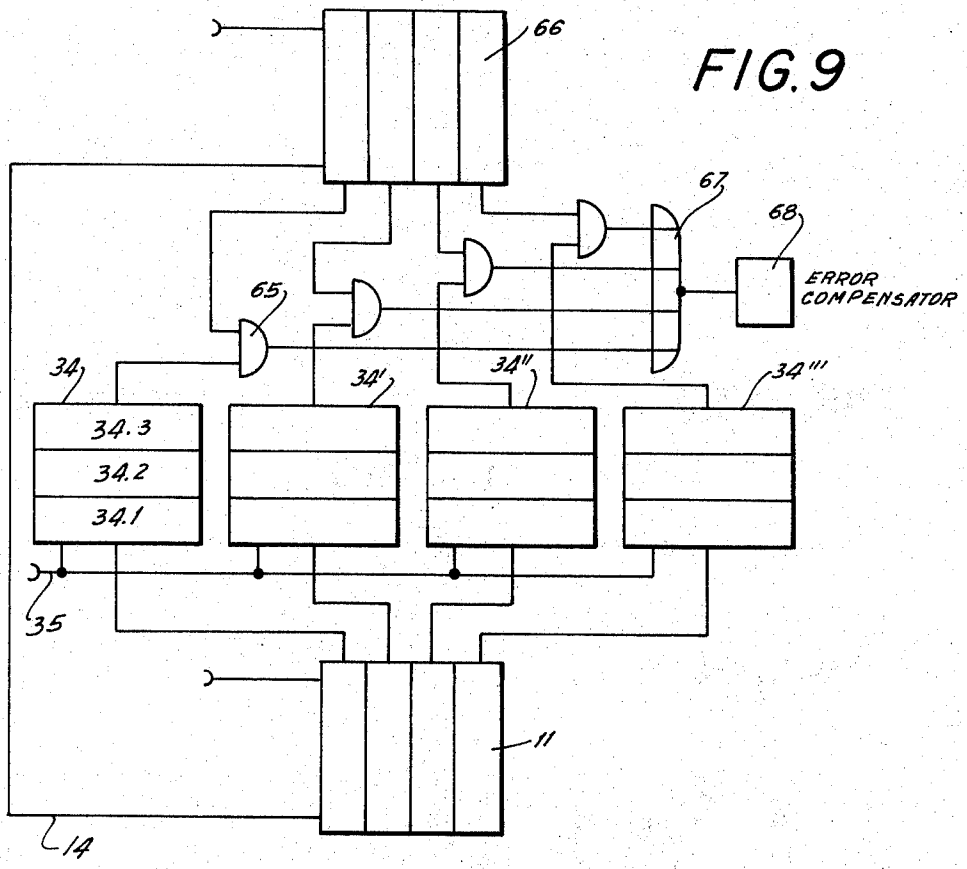
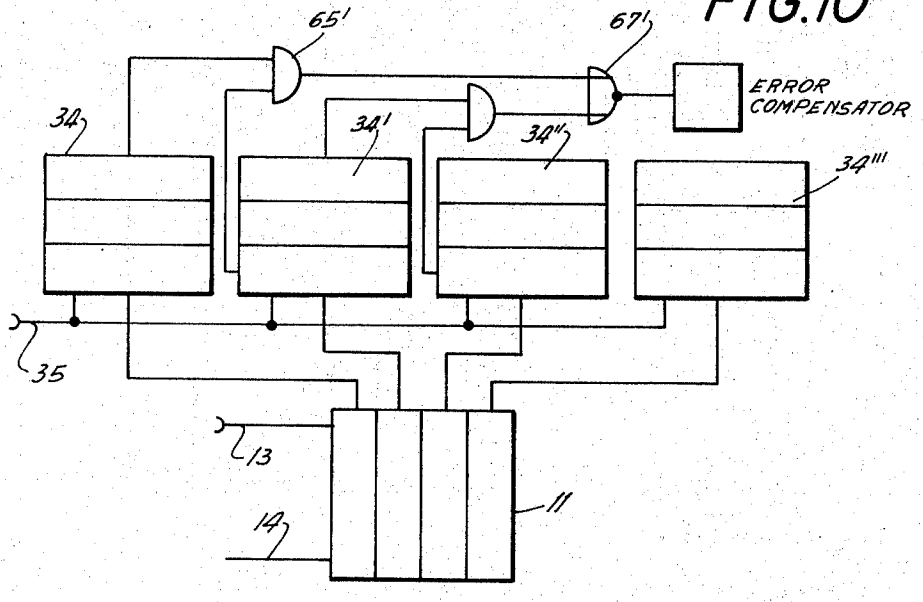

66
67
68
ERROR COMPENSATOR
65
34
34'
34''
34'''
34.3
34.2
34.1
35
11
14

FIG. 10


65'
67'
ERROR COMPENSATOR
34
34'
34''
34'''
35
13
14
11

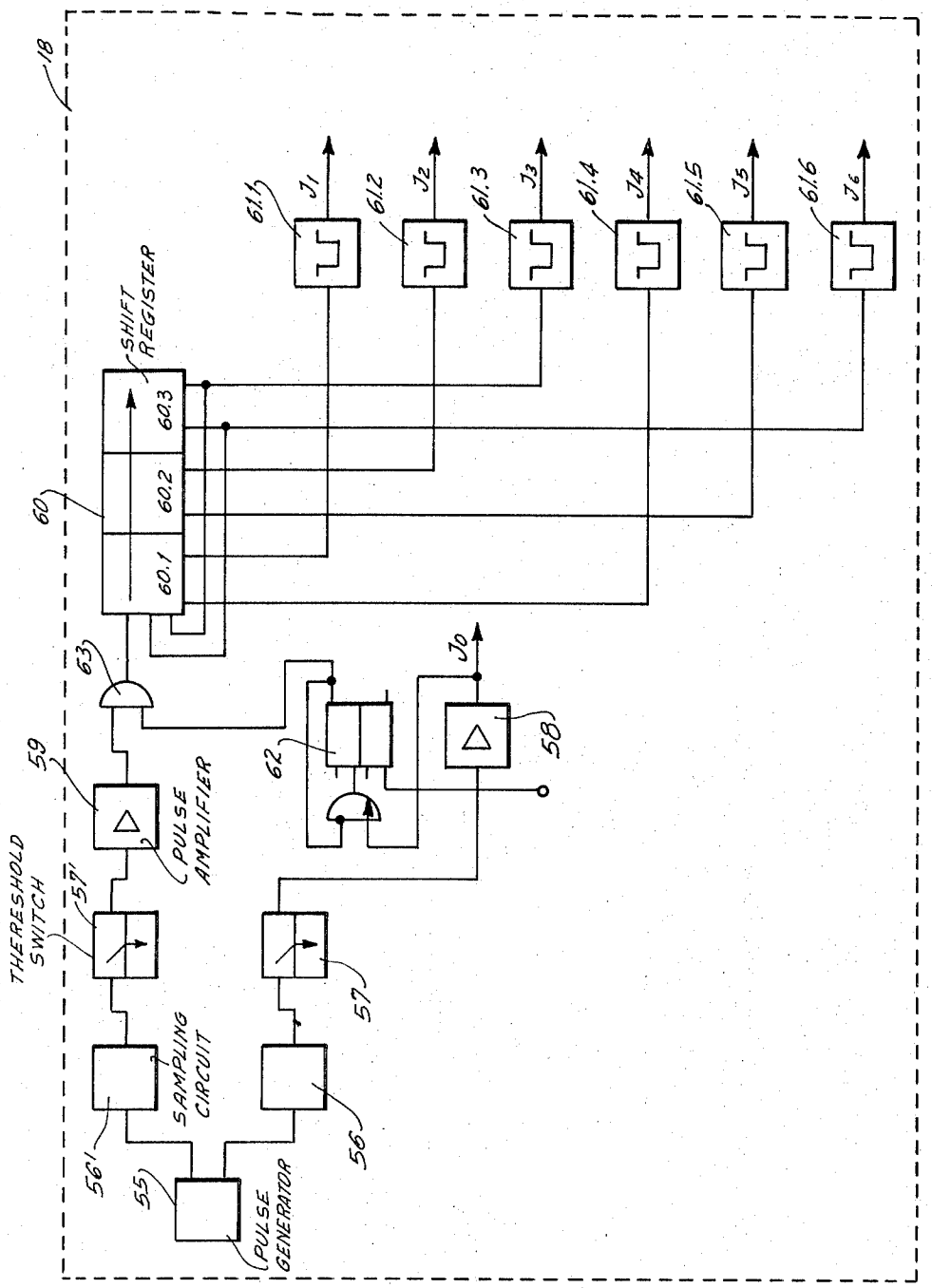

18
SHIFT REGISTER
60
60.1
60.2
60.3
61.1
61.2
61.3
61.4
61.5
61.6
J1
J2
J3
J4
J5
J6
J0
63
62
58
59
PULSE AMPLIFIER
THRESHOLD SWITCH
57'
57
SAMPLING CIRCUIT
56'
56
55
PULSE GENERATOR

FIG. 11

CONTROL ARRANGEMENT FOR MULTIPLE COLOR PRINTING MACHINES

BACKGROUND OF THE INVENTION

The present invention relates to a control system for multiple color rotary type of printing machines, and in particular to those printing machines adapted for printing sheets of material. The control system is used for actuating the printing units or individual groups of operational elements of the printing unit, in the required sequence of time while a sheet of material to be printed is passed through the machine.

It is known in the art to provide control systems for groups of functional elements of a printing machine, in which a plurality of pulse input elements are provided for the indiivdual operations such as switching the machine on and off, setting the machine into motion or holding it stationary, and switching the machine off when a defective sheet of material is within the machine. The input elements are connected with respective control relays for carrying out the required switching operations, through AND gates and switching stages. The pulse input elements have each three inputs of which one is for the command signal, as for example "print", the second input is for synchronization of a command signal, and a third input is for phase synchronization of the command signal through which the command signal is initiated at a predetermined angular position of a machine shaft. The synchronization pulses are produced from a pulse generator using a disc with markings thereon as, for example, optical markings. These markings cooperate with sensing heads which, in turn, provide pulses for further processing. In the signal processing arrangement, the train of pulses derived from the pulse generator becomes distributed, so that each pulse is directed at only one predetermined output device. The train of pulses corresponds to one predetermined rotation of a shaft, or to a predetermined phase relationship.

In the preceding commonly-known arrangements, disadvantages are incurred as a result of the considerable complexity associated with the entire control arrangement. The large number of individual elements present in this known arrangement, result in considerable failure rate and therefore no reliability in operation. The high degree of complexity in the commonly known arrangement results from the use of particularly, counter stages dependent upon the different signal processing requirements for the pulses for setting the machine into motion or holding it stationary, as well as from having to process the pulses in conjunction with the use of relays.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to reduce the degree of complexity of the control arrangement used for a multiple color rotary type of printing machine.

It is also an object of the present invention to provide a control system in which the printing units of the printing machine set forth, is actuated in a sequential manner.

It is a still further object of the present invention to provide the aforementioned control arrangement in which individual groups of operational elements of the printing units are actuated with a minimum amount of complexity and equipment.

Another object of the present invention is to provide an arrangement for controlling printing machines of the foregoing characteristics in which synchronization for the command signals is realized in an advantageous manner.

The objects of the present invention are achieved by providing a shift register composed of a multiple number of partial register stages. The shift pulse input of this shift register is connected to a pulse circuit which provides a plurality or train of sequentially following clock signals. The information inputs for the pulse circuit are, in turn, connected to a measuring and control arrangement which senses and determines the position of a sheet of material at a predetermined control station. Sampling or interrogating stages for initiating the actuation of the states of operation of the individual groups of operational elements of the printing unit are connected to the partial register stages. The sampling stage consists of an amplifier and a relay or this stage may be constructed in the form of a bistable circuit with an amplifier and a relay.

The clock signal used to shift information in the shift register is synchronized with a rotation of a machine shaft of the printing machine and may be synchronized with an integral portion of such a shaft rotation of the machine.

In another embodiment of the invention, the bistable circuit used for the sampling stage is constructed in the form of a clocked or sampled circuit. The clock signals for the sampling stages are freely selectable through predetermined angular positions of the machine shaft of the printing machine. For the clocked or sampled bistable circuits, manually operated switches for selective operation are connected in series with the signal lines for the purpose of switching on or off a predetermined printing unit or groups of functional elements of such a printing unit.

In the control system a sampling stage is provided for each of the groups of operational elements to be actuated, in conjunction with the shift register. It is also possible to provide an auxiliary shift register for each printing unit, in conjunction with the main shift register. The shifting input signal line for the auxiliary shift register is connected with the pulse circuit, and sampling stages are connected to the outputs of the auxiliary shift registers for controlling the groups of operational elements of the respective printing units. An AND gate is provided in conjunction with this embodiment for signal testing of the last partial register stage in the auxiliary register. A comparator shift register is, furthermore, provided in which the outputs of one partial register stage is connected to one input of that AND gate. All AND gates are, in such an embodiment connected to a common OR gate having an inverted output which is then transmitted for further signal processing. The comparator shift register operates in conjunction with a phase shift relative to the shift register, which corresponds to the clock signal from the auxiliary shift register multiplied by the number of partial register stages in the auxiliary shift register.

For signal testing it is also possible that the phase angle β of the shift pulse signal for the shift register has a predetermined relation to the phase angle ζ of the shifting pulse input signal for the auxiliary shift register, so that the ratio β/ζ corresponds to the phase shift ex-

perienced the partial register stages through the AND gates, and OR gates and an error compensating unit.

For lowering the speed of the printing machine after the last sheet of material has been passed through, a control stage is provided in conjunction with the shift register for comparing the signal states of all or several partial register stages. The control stage consist of an OR gate having inputs connected to the outputs of several partial register stages of the shift register. An inverter is connected to the output of the OR gate. An AND gate has one input connected to the last partial register stage of the shift register, by way of a manually operated switch for connecting or disconnecting the control stage. An amplifier is used to energize a relay for initiating the reduced speed feature.

The clock signal for shifting the register can be related also to an angle of a shaft in the machine, corresponding to the path of the sheet of material in moving between printing units. Each output of a partial register stage of the shift register, furthermore, can be connected to a multiple number of AND gates which have inputs connected to pulse circuits from which pulses are emitted representing freely selected angular positions of a shaft within the printing machine.

For the purpose of controlling a selected machine position, the sampling stages have each an AND gate which has an input from a manually operated switch for connecting or disconnecting the respective AND gate, and thereby selecting a respective sampling stage corresponding to a predetermined angular position of the machine shaft. All AND gates are connected to a common OR gate for controlling the operation of the driving motor for the machine. An AND gate, furthermore, is provided between each sampling stage and the respective printing unit, or group of functional or operating elements, and all AND gates lead to a manually operated switch for connecting and disconnecting the controlling elements.

For determining when a sheet to be printed is lost between printing units, a controlling element is provided which provides a signal through an inverter and an AND gate having an input connected to the control station which determines the position of the sheet, and in particular to the partial register stage for that purpose. A Schmitt-trigger circuit, for example, is used for resetting the inputs of the partial register stage. The Schmitt-trigger circuit is connected to a warning device, by way of a further circuit and an amplifier. At the same time, the trigger circuit also leads to a device for turning the machine off. The pulse stage for producing clock signals correspond to one rotation of the shaft within the machine, consists of a signal generator, a sampling stage, a threshold switching circuit used as a signal shaper, and an output amplifier.

The pulse stage for producing signals corresponding to an integral portion of a revolution of the machine shaft consists of a signal generator, a sampling stage, a pulse shaper in the form of a threshold switch circuit, an amplifier and a closed shift register chain. The outputs of the partial register of the closed shift register chain have each a monostable multivibrator, for sample, connected thereto.

The sampling arrangement is connected to a signal generator and an output amplifier is connected to an AND gate which, in turn, is connected between the amplifier and the closed shift register chain.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a functional schematic of a multiple color rotary type of printing machine used for printing sheets of material, in accordance with the present invention;

FIG. **2** is a logic circuit diagram of a control system used for controlling the printing machine of FIG. **1**;

FIG. **3** is a logic circuit diagram of an unclocked sampling stage used for the control system of FIG. **2**;

FIG. **4** is a logic circuit diagram of a clocked sampling for the control system of FIG. **2**;

FIG. **5** is a logic circuit diagram of a control system using an auxiliary shift register for controlling the machine of FIG. **1**;

FIG. **6** is a logic circuit diagram of a control system having a controlling stage for taking into account losses of sheet through the machine;

FIG. **7** is a logic circuit diagram in which a coupling stage is used in conjunction with the shift register for the controlling system of the machine;

FIG. **8** is a logic circuit diagram for a control system operating in conjunction with the machine position;

FIG. **9** is a logic circuit diagram of a control system with provision for error testing;

FIG. **10** is a logic circuit diagram of another embodiment of FIG. **9**; and

FIG. **11** is a logic circuit diagram showing the pulse circuit used for the control systems of FIG. **2** to **10**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawing, FIG. **1** shows a conventional rotary printing machine for sheet material. The sheet of material to be printed to is placed on feeder or placement table **1**, and is then gripped by a gripper **3** which transfers the sheet to a placement drum **4**. The sheet **2** is transferred from the placement drum **4** to the printing cylinder **5**, after which the sheet becomes moved to a transfer drum **6** and the printing cylinder **5'** of the subsequent printing unit. For the purpose of holding the sheet material, the drums and cylinders are equipped with the conventional gripping means. In the non-operative or stationary condition of the machine, the color applying rolls **8** of the color unit or mechanism are separated from the plate cylinder **9**, and the plate cylinder **9** is, in turn, separated from the offset cylinder **10**, whereas the latter is separated from the printing cylinder **5**. The means for engaging and disengaging the aforementioned groups of elements, are well known in the art. Control means can be selectively used directly over protective means, as is generally known. At the instant when the sheet **2** reaches the contact point between the printing cylinder **5** and the offset cylinder **10**, these two cylinders must be brought into their printing position. At earlier instance of time, however, the color applying rolls **8** must be brought against the plate cylinder **9**, and the plate cylinder **9** must also be brought into contact with the offset cylinder **10**. The

controlling of the individual operational elements or groups of elements, occurs in an independent manner of each other, and such control over the groups of elements is also independent of over printing mechanisms or units of the machine.

The sequential control of the operational groups of elements is performed by the control system to be described in relation to FIG. **2.** It is also possible to control only the printing unit or more or less also the aforementioned groups of operational elements.

In FIG. **2,** the control system consists of a shift register **11** with sampling or interrogating stages **12.** The shift register **11** consists of partial registers **11.1**; **11.2** . . . **11.***n*. These registers are designed in the form of, for example, bistable switching stages. The first partial register **11.1** of the shift register **11** has an input **13** for applying a shifting pulse which may be a clock pulse. The partial register **11.1** has, furthermore, two information inputs **14.1** and **14.2** which receive information from the information input **14.** The information input **14** is connected with a conventional measuring and controlling device, not shown, which establishes the position of the sheet at the controlling location. If a sheet is available at the controlling location or station at the instant of time at which measurement is taken, a 1 or 0 signal is transmitted. When no sheet of material is present at the controlling station, the reverse situation is applied and a 0 or 1 signal is transmitted respectively. The transmission of the 1 or 0 signals is dependent upon the controlling device being used. In the further embodiments, the signal for the measurement and controlling device is designated as the sheet signal.

The information input terminal **14** is connected to one input of a gate **15.** The other input of this gate **15** is connected to the terminal **13** for applying the shifting pulse to the shift register. The output of the gate **15** serves as the information input **14.2** for the shift register. The information input **14** is also inverted through the inverter **16,** and is applied to one input of a gate **17.** The other input of this gate **17** is connected to the terminal **13** to which the shifting pulse for the register is applied. The output **14.1** of the gate **17,** is connected to the shift register and serves as an information input for the register. The terminal **13** is also directly connected to the shift register for applying directly thereto shifting pulses. The shifting pulse input **13** is also connected to a pulse circuit **18,** to be described.

The shifting pulse, in the form of a clock pulse is related to the shaft of a machine which executes a cycle of operation by undergoing one revolution. If the shift register **11** has applied to it a shifting pulse, thereby, and such shifting pulse corresponds to one rotation of the machine shaft (variation **1**), then the resulting sheet signal becomes inserted into the first partial register **11.1** after one revolution. Upon the subsequent revolution, this sheet signal becomes inserted into the second partial register **11.2,** and any further resulting sheet signal would be inserted into the partial register **11.1.** Thus, after four revolutions of the shaft, for example, the sheet signal would be present in the fourth partial register **11.4.** Accordingly, the partial registers **11.1, 11.2** . . . are sequential stages of the shift register **11.**

If the shifting pulse becomes generated at integral portions of a revolution of the machine shaft, then several pulses are derived over one revolution of the shaft. For example, if a shifting pulse becomes generated at increments of 30° (variation **2**), then the sheet signal becomes inserted into the first partial register stage **11.1,** after 30° of rotation of the shaft. Upon a second rotation of 30°, so that the total rotation executed comprises 60°,the sheet signal becomes inserted into the second partial register stage **11.2,** and the newly arising sheet signal becomes inserted into the first partial register stage. Consequently, after the elapse of six clock pulses or shift pulses, corresponding to an angular rotation of 180°, the first sheet signal is present in the six partial register stage **11.6.** Should it be required, for example, to actuate a predetermined group of operational elements after a fourth rotation of the shaft (variation 1), then a sampling or interrogation stage **12** is connected to the fourth partial register stage **11.4.**

If in variation 2 or embodiment 2, a predetermined group of operational elements are to be actuated after an execution of 210° of the machine shaft, then a sampling or interrogation stage is connected to the seventh partial register stage **11.7.**

The constructional details of the sampling or interrogating stages **12,** are shown in FIGS. **3** and **4.** FIG. **3** shows a sampling stage **12** which is not subjected to synchronous or clocked pulse signals. This sampling stage includes a bistable circuit **19** having inputs connected with the outputs of a partial register stage. As amplifier **20** is connected to the output of the bistable circuit **19.** The amplifier **20** provides a **1** signal in its inoperative stage. A relay **21** connected to the output of the amplifier **20** serves to switch the printing mechanism on and off, depending upon its actuated stage. The relay may also be used for applying control functions to the groups of operational elements of the printing mechanism. The interrogating or sampling stage **12** can be used advantageously for the shift register of the second embodiment or variation **2.** It is also possible to use a sampling or interrogating stage which does not include any bistable circuits.

FIG. **4** shows a sampling stage **12'** which has clock pulses or synchronous pulses applied to it. This sampling stage includes a bistable circuit **19'**. The inputs of this bistable circuit are connected to the outputs of two gates **22** and **23.** The inverted inputs of the gates **22** and **23,** are connected to the outputs of a partial register stage, whereas the second inputs of these gates are connected to a terminal **24** to which a sampling or clock pulse is applied. The terminal **24** is also connected to a pulse circuit **18,** to be described. Connected in the signal lines leading to the sampling stage **12'**, are manually operated switches **25** and **26** which are used to apply phase corrections and for switching off the applicable group of operational elements.

This sampling stage **12'** can be advantageously used for the shift register, in accordance with variation **1** or embodiment **1.** In this case, the shift register receives a synchronously generated sheet signal. The pulse circuit **18** applies to the terminal **24** a sequence of clock signals which correspond to predetermined angular positions of the machine shaft, as for example, 346°. Should, for example, a predetermined group of operational elements become actuated by the fourth shaft rotation at **346°**, then the clock sampling stage **12'** becomes connected to the fourth partial register stage **11.4,** and the sampling pulse input terminal **24** becomes connected with the signal output of the pulse circuit **18** which produces a pulse at the 346° rotation. With this arrangement, therefore, it is evident to those

skilled in the art, that any desired phase synchronization of the sheet signal may be attained.

A control stage **27** shown in FIG. **2** is provided for the decreasing the operational speeds of the machine after the last sheet of material has passed through the printing machine. The control stage **27** consists of an OR gate **28,** an inverter **29** connected to the output of this OR gate **28,** and an AND gate **30** which has an input connected to the output of the last partial register stage **11.**n. The output of the AND gate **30** is connected to an amplifier **31** which, in turn, energizes a relay for the purpose of decreasing the operational speed. The inputs of the OR gate **28** are connected to several or all outputs of the partial registers, regardless of whether the stages are, in turn, connected to sampling or interrogating circuits.

A manually operated switch **33** is connected in the signal lines of the last partial register stage **11.***n* and is connected in series with the input to the gate **30.** This manually operated switch **33** serves to turn the control stage on and off.

FIG. **5** shows a further embodiment of the control system, in accordance with the present invention. The shift register **11** is described, in this connection, in accordance with variation **2** or the second embodiment. In this embodiment, a further shift register **34** is provided for the required partial registers per print unit. Sampling or interrogating stages **12** are also connected to the shift register **34,** as required. A terminal **35** to which a clock signal is applied, is connected to the first partial register stage **34.1.** This terminal **35** is also connected to the pulse circuit **18,** and two information inputs **36.1** and **36.2,** by way of gates **37** and **38.** These two gates **37** and **38** have, in turn, an input connected to a partial register stage of the shift register **11.** In this arrangement, the synchronization of the sheet signal is accomplished through the first shift register **11.** The further or auxiliary shift register **34** is connected to the shift register **11,** so that the latter actuates the shift register **34.** The latter can, thereby, be driven through the application of a clock signal to the terminal **35.** In this case, the clocked interrogating stage **12** can be used for this purpose. It is also possible, however, to drive the auxiliary shift register **34** through the method of variation **1** or embodiment **1** described in conjunction with the shift register **11.** For this arrangement, the further or auxiliary shift registers are identical for each printing unit or mechanism.

In view of the identical construction of the auxiliary shift register **34,** it is possible to test precisely the signal processing by using the redundancy of the circuit. Embodiments for such redundancy-testing are shown in FIGS. **9** and **10.** In the embodiment of FIG. **9,** an AND gate **65** is connected to each last partial register stage of each auxiliary shift register **34.** The second input of the AND gate is connected with an output of a comparator shift register **66.** All AND gates are connected with their outputs to an OR gate **67** which, in turn, provides an inverted output and applies this output to an error compensating unit **68.** A clock signal is applied to the comparator shift register **66,** and this clock signal is shifted in phase in relation to the clock signal applied to the shift register **11.** The phase shift corresponds to the clock signal of the auxiliary shift register **34** multiplied by the number of partial register stages of the auxiliary shift register **34.**

In the embodiment of FIG. **10,** the clock signal applied to the shift register input terminal **13** of the shift register **11,** has a phase angle β. This phase angle has a fixed relation to the phase angle ζ of the clock signal applied to the input terminal **35** of the auxiliary shift register **34.** Thus, the relationship between the two phase angles may be $\zeta = 10/8\beta$

As a result, the partial register stage of the shift register **34** must be comparable to a partial register stage of the shift register **34'** by applying a phase shift factor of 8/10 ζ. The outputs of the comparable partial register stages are connected to an AND gate **65'**. The signal processing is carried out in an analogous manner as prevailing in the embodiment of FIG. **9.**

It is possible that even though the signals are transmitted, the group of respective operational elements does not become actuated. In that case, it is essential for providing a limit switch for each group of operational elements. When such a limit switch does not become actuated, implying that the group of operational elements associated with the switch are likewise not actuated, then the signal state of the shift registers becomes clear, so that normal operation is interrupted or ceased.

FIG. **7** shows a still further embodiment of the control system. The shift register **11** is driven through a clock signal applied to the input terminal **13.** This clock signal corresponds in phase angle to the rotation of the machine shaft which corresponds to the path of the sheet from one printing unit to another printing unit. Thus, the clock signal is synchronously coupled to this machine shaft. With this arrangement, therefore, each printing unit has a predetermined partial register stage associated with it. Each partial register stage, furthermore, has a plurality of AND gates **39** connected to it. The other or second inputs of these AND gates **39** are connected with an output of the pulse circuit **18** which provides pulses having a freely selected phase angle as, for example, at a predetermined position of the machine shaft at 346°. The prescribed angular synchronization of the sheet signal can also be accomplished through a coding matrix, as is well known in the art.

The control system can be advantageously expanded through an arrangement for determining when a sheet is lost between the units. A circuit arrangement for this purpose is shown in FIG. **6.** Each printing unit in this circuit arrangement is provided with a control element **40,** the construction of which is well known in the art and for this reason, does not require further description. The output signal of the control element **40** is inverted through an inverter **47.** The output of the inverter **47** is applied to one input of an AND gate **41** which has its second input connected to a partial register stage of the shift register **11.** The AND gate **41** serves as a means for comparing the position of the sheet with respect to the output of the control element. Connected to the output of the AND gate **41,** is a switching stage **42** constructed in the form of, for example, a Schmitt-trigger circuit. The output of this trigger circuit **42** is connected to the reset input terminals of the partial register stages which are in front of the partial register stage used to determine the position of the sheet with respect to the controlling position as established by the element **40.** At the same time, the output of the trigger circuit **42** is connected to a further switching stage **43** which, in turn, has an output leading to an amplifier **44** used to energize a warning device **45**

and a device **46** for executing cutoff or terminations in operations.

In operation of the arrangement of FIG. **6**, at the instant of time that a sheet is still be present in correspondence to the signal obtained from the element **40**, the corresponding partial register stage as, for example, the fourth partial register stage **11.4**, applies a 1 signal to the respective input of the gate **41**. If, then, a 1 signal is simultaneously applied by the control element **40** through the inverter **47**, then the signal 0 is actually applied to the respective input of the gate **41** as a result of the inverter **47** which inverts the 1 signal emitted by the control element **40**. With a 1 signal applied to one input of the gate **41** and a 0 signal applied to the second input of the gate **41**, the latter provides no further signal transmission. If, however, no sheet is present at the instant of time dictated by the control element **40**, the resultant 0 signal from the control element is inverted by the element **47**, and as a result two 1 signals are applied simultaneously to the inputs of gate **41**, so that a signal is then further applied to the trigger circuit **42** which is preferably in the form of a Schmitt-trigger circuit. The signal output from the circuit **42** is then applied, on the one hand, to the partial register stages, which correspond to the particular position of the sheet at the controlling station, and on the other hand, to a further switching circuit **43** and from there to the amplifier **44**. The latter then actuates the warning device **45**, and the device **46** terminates any further conveyance of sheets. The aforementioned partial register stages which in the preceding example of partial register stages **11.1** to **11.4** become switched by the signal to the stage which would prevail when no sheet of material were present. The sampling or interrogating stages **12** of these partial register stages become thereby actuated and disconnect the associated group of operational elements at the proper instant of time. The signal condition of the aforementioned partial register stage becomes shifted upon the next application of a clock signal, and as a result the remaining subsequent groups of operational elements become actuated in sequence. Accordingly, all sheets of material which are present in the machine, with the exception of the lost sheet, become printed and discharged from the machine.

In the embodiment of FIG. **8**, the control system possesses a machine positioning system. When mounting the printing plate in place on a plate cylinder, it is desirable for example, that the machine be driven to a position which makes such mounting possible. The positioning arrangement in this embodiment can, therefore, be advantageously coupled with the control system or it can be arranged as an independent unit of the machine. The partial register stages of the shift register **11** are, as already described, provided with sampling stages or interrogating stages **12**. The first output of each sampling stage **12** is, as already described, connected to the respective group of functional elements control unit **48**. Between the sampling stage **12** and the respective control unit **48** for the group of operational elements, an AND gate **49** is inserted. The second inputs of the AND gates of all sampling stages are connected to a manually operated switch **50** for connecting the respective control unit into and out of circuit. Each sampling stage **12** is provided with a still further second AND gate **51**. The second input of each AND gate is, in this embodiment connected to a respective manually switch **52** for connecting and disconnecting the respective AND gate, and thereby selecting the sampling stage corresponding to the machine position. All AND gates **51** are connected to a common OR gate **53** which, in turn, has its output connected to a circuit which turns off the driving motor of the machine. If, for example, it is required to turn to a machine position of 346°, the manually operated switch **52** and the respective AND gate **51** is connected into circuit, so that the respective sampling stage **12** which transmits the pulse associated with 346°, becomes actuated. Upon the appearance of the pulse corresponding to 346°, the motor control unit **54** becomes actuated from the AND gate **51**, through the OR gate **53**. As a result, the motor becomes stopped, and the machine is now located in the preselected position.

FIG. **11** shows an embodiment of the pulse circuit **18**. In order to provide a clock signal I_0 for every revolution of a machine shaft, a circuit arrangement is provided in which a signal generator **55** is connected to a sampling stage **56** followed by a threshold switch circuit **57** and an output amplifier **58**. The signal generator **55** can be constructed in the form of a disc with markings or segments thereupon, and the sampling circuit **56** can be of photoelectric construction for sensing the marking or segments upon the disc of the generator **55**. The marking disc has, in this arrangement, a marking which corresponds to one revolution or rotation of the shaft. When this marking on the disc moves past the sampling arrangement **56** a pulse becomes generated which, in turn, actuates the threshold switch **57**. The pulse output of the circuit **57** becomes amplified through the output amplifier **58**, and the output of this amplifier then provides a clock signal I_0 for signal processing purposes.

To produce clock signals at integral portions of a revolution of the machine shaft, as for example, at 180°, 120°, 90°, 60°, 45°, 30°. . . 5°, the output of the signal generator **55** is connected to a further sampling stage **56'**, a threshold switch **57'**, an amplifier **59** and a closed shift register chain **60**. Connected to each partial register stage **60.1** to **60.3** of the shift register chain, in a monostable multivibrator **61.1** to **61.6**. This arrangement can also be used for providing clock signals at any freely predetermined selected position of a shaft. Thus, clock signals can be produced at angular positions of the shaft at, for example, 7°, 83°, 273°, 346°.

In a manner analogous to the arrangement described previously, a sequential series of clock signals is made available at the output of the amplifier **59** in the preceding embodiment.

These clock signals are applied through a closed shift register chain **60**. The closed shift register chain such as the unit **60**, is to be understood to be a shift register in which the outputs of the last partial register stage are connected to the inputs of the first partial register stage of that shift register. Upon application of the first pulse to the shift register, the first partial register state **60.1** changes stage, and the output of this partial register stage actuates the respective monostable multivibrator **61.1**. Thus, the first clock pulse I_1 is available at the output of the circuit **61.1** for further processing. Upon application of the second pulse, the signal causes the partial register stage **60.2** to change states, and the monostable multivibrator circuit **61.2** connected to the input of the second partial register stage, becomes actuated. Accordingly, the output of the monostable mul-

tivibrator **61.2** makes available the second clock pulse I_2. Since the circuits **61** are in the form of monostable multivibrators, the closed shift register chain can result in a distribution of sequentially following pulses with respect to one pulse connected to its respective monostable multivibrator.

The arrangement can also be used in the manner that first after the I_0 clock pulse is made available, the further clock pulses are then generated. For this purpose, the output amplifier **58** has connected to it a further switching stage **62** and an AND gate **63.** The latter is connected between the amplifier **59** and the closed shift register **60.**

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of control systems for multiple color printing machines differing from the types described above.

While the invention has been illustrated and described as embodied in control systems for multiple color printing machines, it is not intended to be limited to the details shown since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

We claim:

1. In a multiple color printing machine undergoing operating cycles and having printing means for printing on sheets moved along a path into operative proximity of said printing means, and actuating means connected to said printing means for actuating said printing means in response to actuating signals, a control system, comprising, in combination, a shift pulse generating means for generating a sequence of shift pulses occurring at predetermined time instants during said operating cycle; a sheet sensing station located along said path of said sheets for sensing the presence of a sheet at a predetermined position along said path and furnishing a sheet signal in response thereto at a sensing output; a shift register having a shift register input connected to said shift pulse generating means and having a data input connected to said sensing output and comprised of a plurality of shift register stages each having a first or second circuit state in dependence upon the number of said shift pulses received at said shift register input following said sheet signal; and a plurality of sampling means each having an input connected to one of said register stages and an output connected to a corresponding one of said actuating means, operative for sampling the stage of the respective shift register stage and furnishing an actuating signal to said corresponding one of said actuating means when the respective shift register stage is in a predetermined one of said first and second circuit stages independent of the circuit stages of the remainder of said shift register stages.

2. The arrangement as defined in claim **1,** wherein said sampling means comprises an amplifier, and a relay energized by said amplifier.

3. The arrangement as defined in claim **1,** wherein said printing means comprises a plurality of printing units each having a respective shift register and sampling means connected to the respective shift register.

4. The arrangement as defined in claim **1,** wherein said printing means includes groups of operational elements, each group having a respective shift register and a respective sampling means connected to the respective shift register.

5. The arrangement as defined in claim **1,** including signal examining means connected to at least one stage of said shift register for determining the state of such shift register state and operative for sensing when the last sheet of material has passed through said printing means for lowering the speed of said machine thereafter.

6. The arrangement as defined in claim **5,** wherein said signal examining means comprises an OR gate having inputs connected to the outputs of a plurality of stages of said shift register; an inverter connected to the output of said OR gate and inverting the signal from said OR gate; an AND-gate having one input connected to the output of said inverter; a manually operated switch connected between the other input of said AND gate and the last stage of said shift register for manually connecting and disconnecting said signal examining means; an amplifier connected to the output of said AND gate; and a relay connected to the output of said amplifier and energized by said amplifier for lowering the operating speed of said machine.

7. The arrangement as defined in claim **1,** including sheet loss detector means for detecting the loss of a sheet of material in said printing machine; a signal inverter connected to the output of said sheet loss detecting means for inverting the output signal of said detecting means; an AND gate having one input connected to the output of said inverter, the second output of said AND gate being connected to one stage of said shift register; and resetting means connected to the output of said AND gate and triggered by the output of said AND gate, said trigger circuit means applying a reset signal to said shift register.

8. The arrangement as defined in claim **7,** wherein said resetting means comprises a Schmitt-trigger having an input connected to the output of said AND gate and having an output connected to said shift register for applying to the latter said reset signal when said Schmitt-trigger is triggered by the output of said AND gate.

9. The arrangement as defined in claim **8,** including a switch connected to the output of said resetting means and actuated by said resetting means; an amplifier connected to the output of said switch for amplifying the output signal of said switch upon being actuated by said resetting means; warning means connected to the output of said amplifier and energized for providing a warning signal upon detection of the loss of a sheet of material through triggering of said resetting means; and means connected to the output of said amplifier for stopping the motion of said sheets of material along said path toward said printing machine.

10. The arrangement as defined in claim **1,** wherein said multiple color printing machine has a shaft executing one revolution for each of said operating cycles;

and wherein the time interval between sequential ones of said shift pulses corresponds to the time interval required for one revolution of said shaft.

11. The arrangement as defined in claim **10,** wherein said shift pulse generating means comprises a signal generator; a sampling circuit connected to the output of said signal generator; a threshold switching circuit connected to the output of said sampling circuit; and an amplifier connected to the output of said threshold switching circuit.

12. An arrangement as defined in claim **10,** wherein said interval between successive ones of said shift pulses is equal to a predetermined fraction of said time interval required for one revolution of said shaft.

13. An arrangement as defined in claim **1,** wherein the first of said shift register stages is switched from said first to said second circuit state in response to the first of said shift pulses following said sheet signal; and wherein each of said register stages switches from said first to said second state in response to a shift pulse when the previous one of said register stages is in said second circuit state.

14. The arrangement as defined in claim **13,** wherein said sampling means comprises a bistable circuit stage; an amplifier connected to the output of said bistable circuit stage; and a relay connected to said amplifier and energized by said amplifier.

15. An arrangement as defined in claim **1,** wherein each of said shift register stages has a first and second output; wherein each bistable circuit means of said plurality of sampling means has a first and second input; further comprising first connecting means connecting said first and second output of said corresponding one of said shift register stages to the first and second input of the respective bistable circuit stage.

16. An arrangement as defined in claim **15,** wherein said first connecting means comprises a first AND-gate having a first input connected to the output of said shift pulse generating means, a second input connected to said first output of said corresponding one of said shift register stages, and a first AND-gate output connected to said first input of said bistable circuit stage; and a second AND-gate having a first input connected to the output of said shift pulse generating means, a second input connected to said second output of said corresponding one of said shift register stages, and a second AND-gate output connected to said second input of said bistable circuit stage.

17. An arrangement as defined in claim **16,** wherein said first connecting means further comprise a manually operated switch connected to said first and second input of said bistable circuit stage for selectively enabling and disabling said printing means.

18. An arrangement as defined in claim **13,** further comprising means for positioning said printing arrangement at a predetermined point in said operating cycle comprising an AND-gate having a first input connected to a selected one of said plurality of sampling means, a second input and an AND-gate output; a manually operated switch connected to said second input of said AND-gate for manually energizing and deenergizing said second input; and means connected to said output of said AND-gate and operative for stopping said multiple color printing machine when said multiple color printing machine is in said predetermined point of said operating cycle.

19. An arrangement as defined in claim **18,** further comprising means for inhibiting the application of said actuating signal to said actuating means upon energization of said second input of said AND-gate.

20. An arrangement as defined in claim **19,** wherein said means for inhibiting comprises a plurality of additional AND-gates each having a first input connected to the output of one of said sampling means, a second input, and an AND-gate output; a manually operated switch connected to said second input of said AND-gate of said means for positioning for deenergizing said second input when energizing said second input of one of said AND-gates in said inhibiting means; and means connecting the outputs of said additional AND-gates to the corresponding ones of said actuating means.

21. An arrangement as set forth in claim **1,** further comprising an auxiliary shift register having a shift input connected to said shift pulse generating means to receive shift pulses, a data input connected to a selected one of said shift register stages, and a plurality of auxiliary shift register stages; and wherein each of said sampling means is connected to the output of a corresponding one of said auxiliary shift register stages.

22. An arrangement as set forth in claim **2,** further comprising a comparator shift register having a plurality of shift register stages; and further including at least one further auxiliary shift register so as to form a plurality of auxiliary shift registers, each having a plurality of auxiliary shift register stages including a last stage; further comprising a plurality of AND-gates, each having a first input connected to a stage of said comparator shift register and a second input connected to said last stage of a corresponding one of said auxiliary shift registers, and an AND-gate output; an OR-gate having a plurality of inputs, each connected to one of said outputs of said AND-gates; and means interconnecting said shift pulse generating means and said comparator shift register in such a manner that the shift pulses applied to said comparator shift register have a predetermined pulse shift relative to the shift pulses applied to said first-mentioned shift register.

23. The arrangement as defined in claim **21,** wherein the phase angle of shift pulses applied to said first-mentioned shift register differs by a predetermined phase angle from the phase angle of shift pulses applied to said auxiliary shift register.

24. An arrangement as defined in claim **23,** further comprising a plurality of AND-gates each having inputs connected to neighboring ones of said auxiliary registers and an AND-gate output; and an OR-gate having a plurality of inputs each connected to one of said outputs.

25. An arrangement as defined in claim **1,** further comprising means connected to said register means for sensing when the last of said sheets has passed through said printing means and for lowering the speed of said machine thereafter.

26. The arrangement as defined in claim **1,** wherein said shift pulse generating means comprises a signal generator; a sampling circuit connected to the output of said signal generator; a threshold switch circuit connected to the output of said sampling circuit for shaping the signal output of said sampling circuit; an amplifier connected to the output of said threshold switch circuit for amplifying the signal output of said threshold switch circuit; a closed shift register chain having a shift

register with output of the last stage connected to the input of the first stage, said closed shift register being connected to the output of said amplifier; and a plurality of monostable multi-vibrators connected to the output stages of said closed shift register chain, said pulses from said shift pulse generating means having a period corresponding to a predetermined angular position of a shaft within said machine.

27. The arrangement as defined in claim **26,** including an auxiliary sampling circuit connected to the output of said signal generator; a further switch connected to the output of said further sampling means; and a further AND gate having one input connected to the output of said first-mentioned amplifier and having a second input connected to the output of said auxiliary switch, the output of said further AND gate being connected to the input of said closed shift register chain.

28. In a multiple color printing machine undergoing operating cycles and having printing means, actuating means connected to said printing means for actuating said printing means in response to actuating signals, a first shift register having a plurality of first shift register stages, each for furnishing an actuating signal to a corresponding one of said actuating means at predetermined time instants in said operating cycles, and an auxiliary register connected to the output of at least one of said first register stages, said auxiliary register having a plurality of auxiliary register stages, an error detection arrangement, comprising, in combination, a comparator shift register having a plurality of shift register stages; an AND-gate having a first input connected to a selected one of said auxiliary register stages, a second input connected to the output of a selected one of said comparator register stages, and an AND-gate output; and means for shifting the contents of said comparator shift register in synchronism with the contents of said auxiliary shift register, but with a phase angle with respect thereto corresponding to the number of said auxiliary register stages connected between said selected first register stage and said selected one of said plurality of auxiliary register stages; and means connected to the output of said AND-gate for furnishing an error detection signal in the absence of a signal at said output.

29. In a multiple color printing machine undergoing operating cycles and having printing means for printing on sheets moved along a path into operative proximity of said printing means, actuating means connected to said printing means for actuating said printing means in response to actuating signals, sheet sensing means located along said path of said sheets for sensing the presence of a sheet at a predetermined position along said path and furnishing a sheet signal in response thereto and a shift register having a plurality of shift register stages including a first shift register stage, and means shifting said sheet signal through said plurality of shift register stages from said first stage to said last stage at predetermined instants in said operating cycle, an arrangement for decreasing the operational speeds of the machine after the last of said sheets has passed through said machine, comprising, in combination, an AND-gate having a first input connected to the output of shift register stage, a second input, and an AND-gate output; means connecting said second input of said AND-gate to selected ones of said shift register stages; means lowering the speed of said printing machine in response to a signal at said AND-gate output.

30. An arrangement as defined in claim **29,** wherein said means connecting said second input to selected ones of said shift register stages comprises an OR-gate having a plurality of inputs, each connected to one of said selected shift register stages and an OR-gate output connected to said second input of said AND-gate.

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