June 29, 1965 D. W. FATH ETAL 3,191,530

DETECTOR SYSTEM FOR PLURAL UNIT PRINTING PRESS

Filed Nov. 18, 1963 8 Sheets-Sheet 1

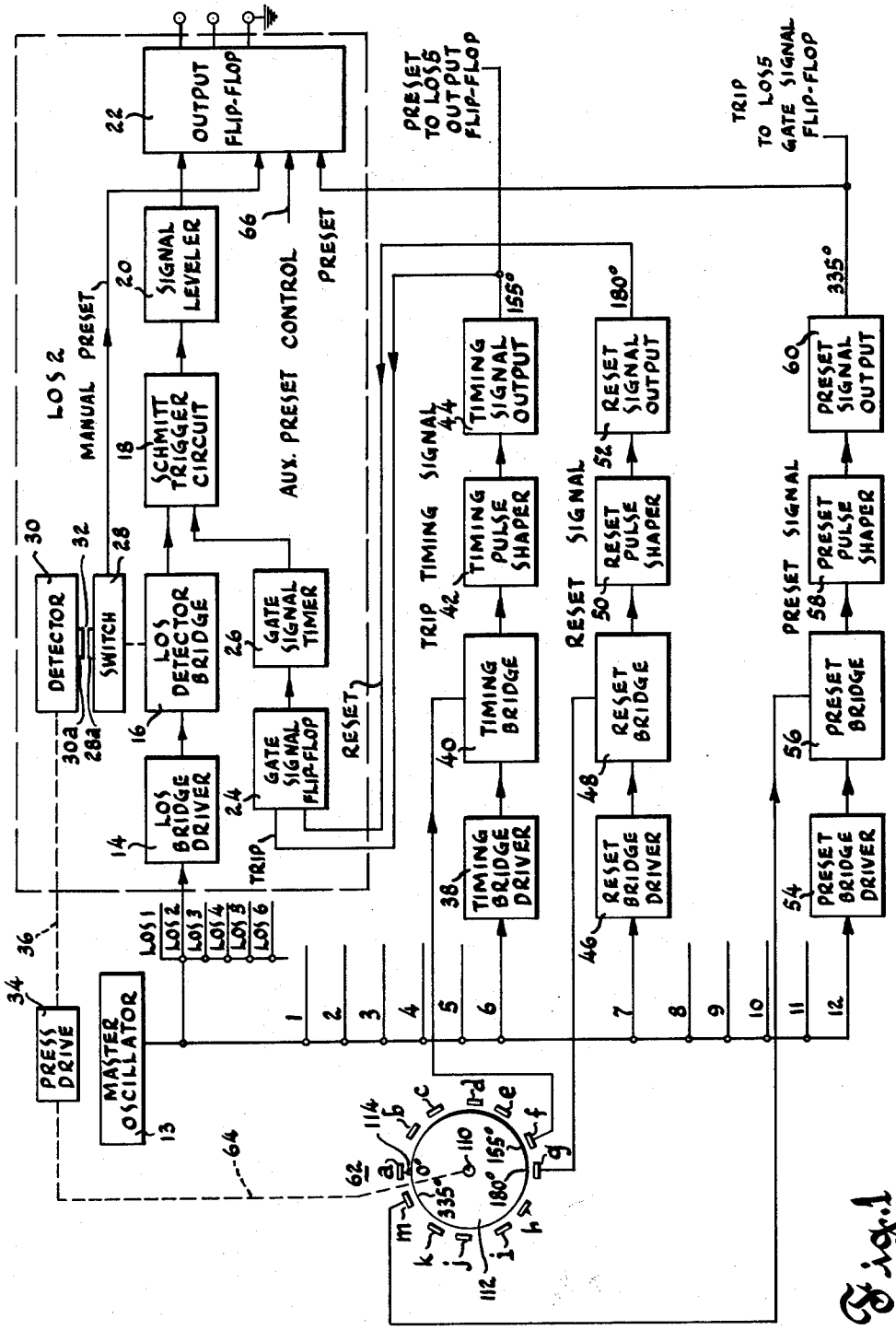


Fig. 1

DETECTOR SYSTEM FOR PLURAL UNIT PRINTING PRESS

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Fig. 2

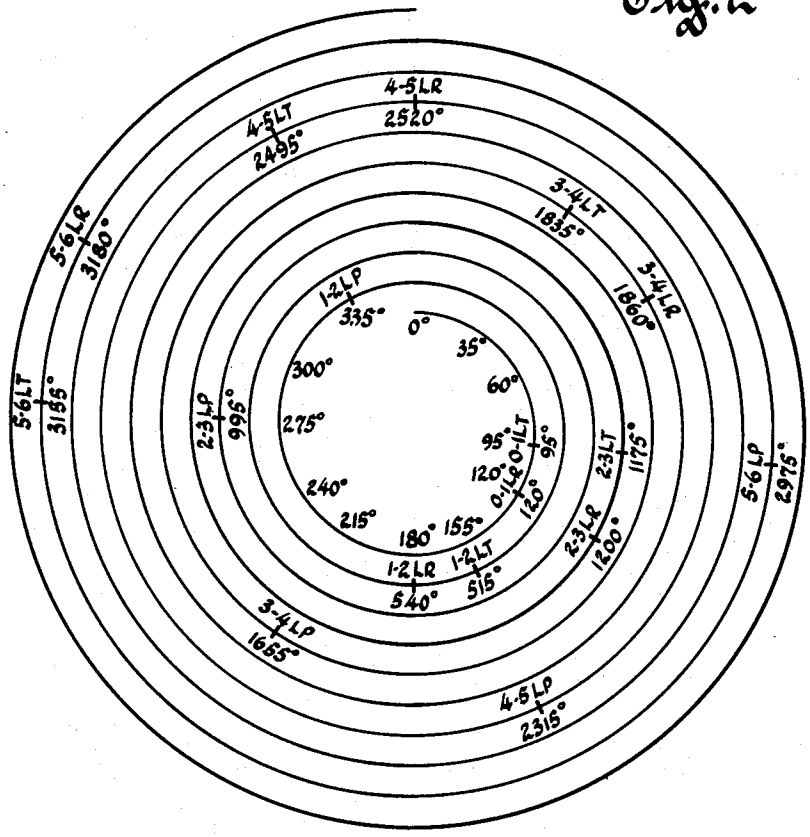
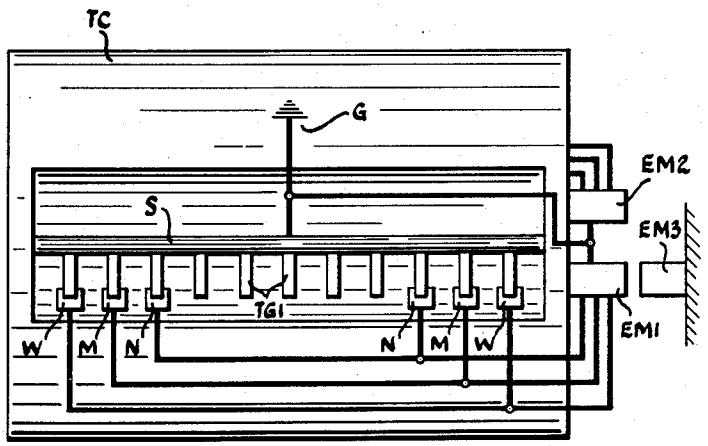


Fig. 3b



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DETECTOR SYSTEM FOR PLURAL UNIT PRINTING PRESS

Filed Nov. 18, 1963 8 Sheets-Sheet 3

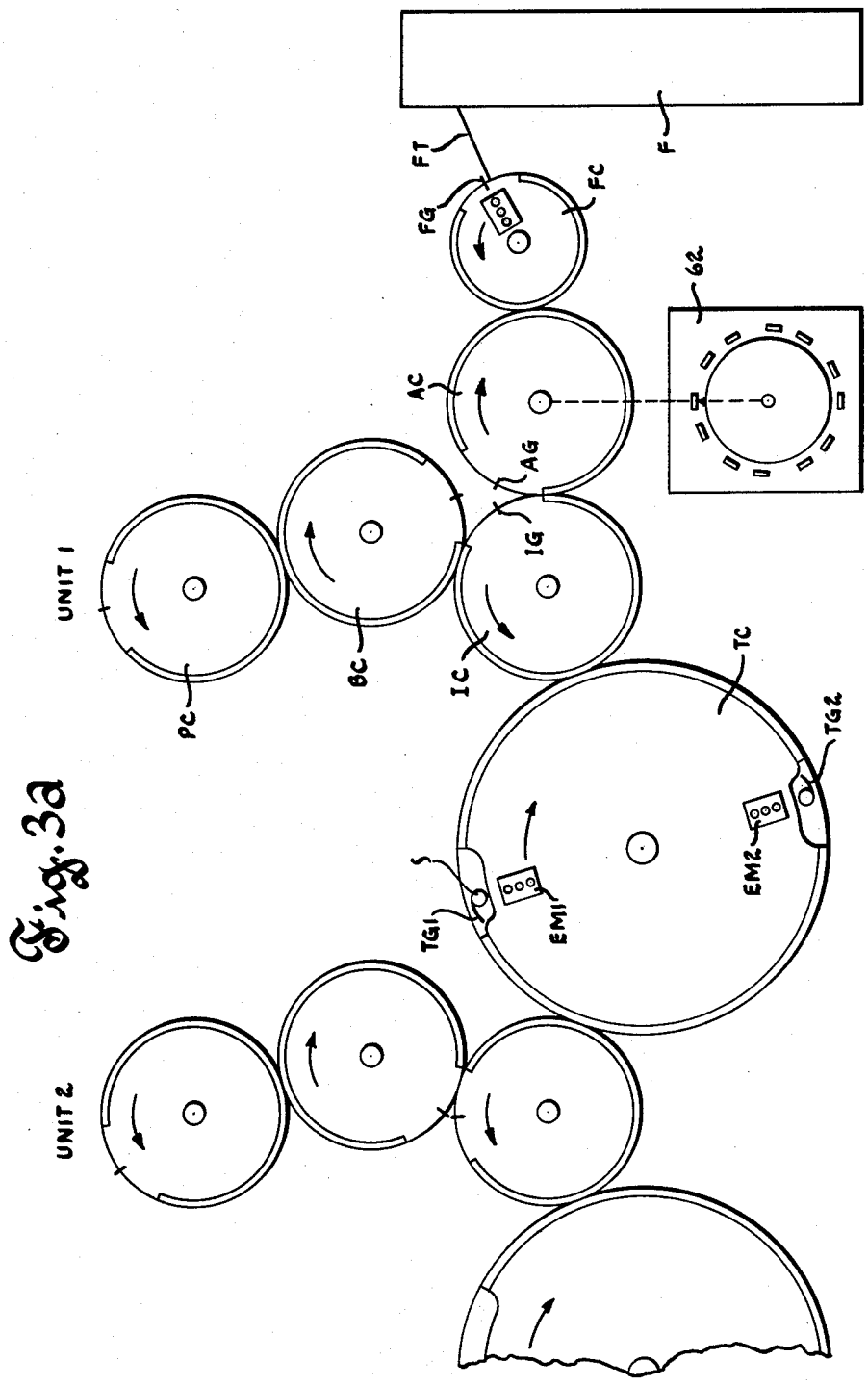


Fig. 3a

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DETECTOR SYSTEM FOR PLURAL UNIT PRINTING PRESS

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Fig. 4a

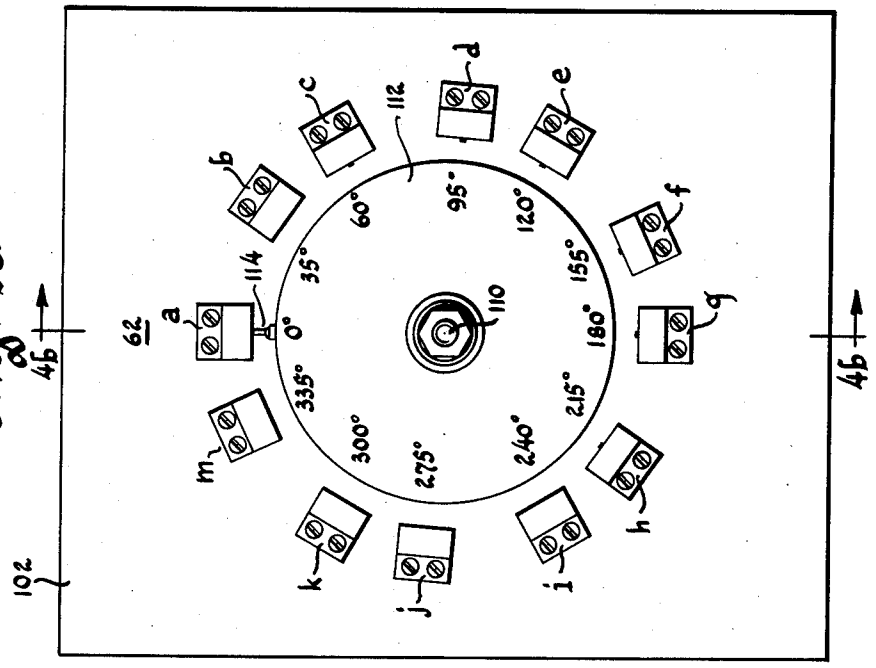
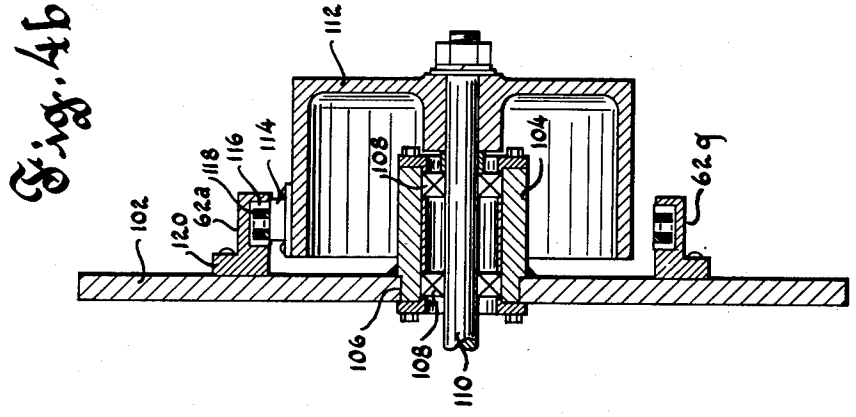


Fig. 4b



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DETECTOR SYSTEM FOR PLURAL UNIT PRINTING PRESS

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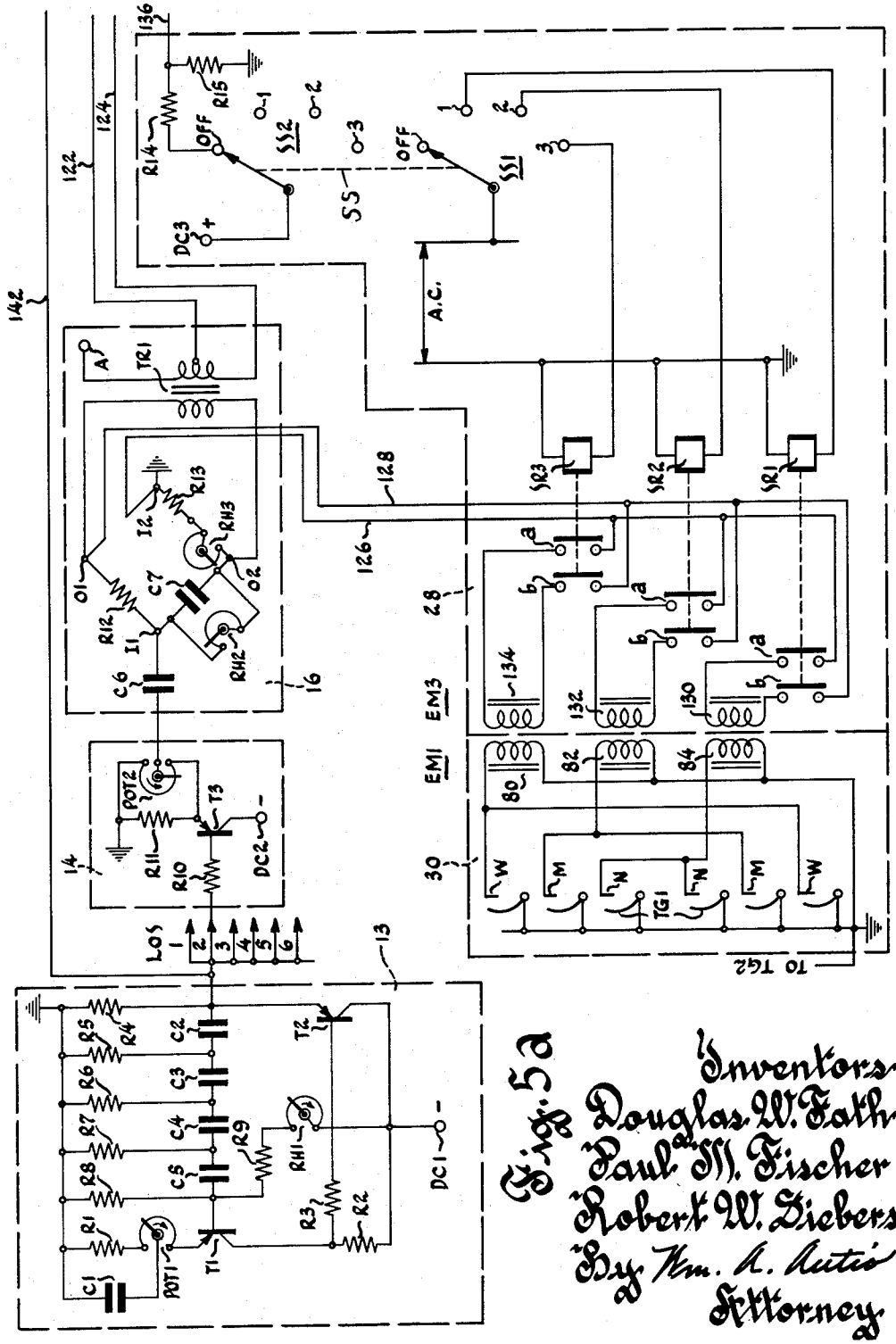
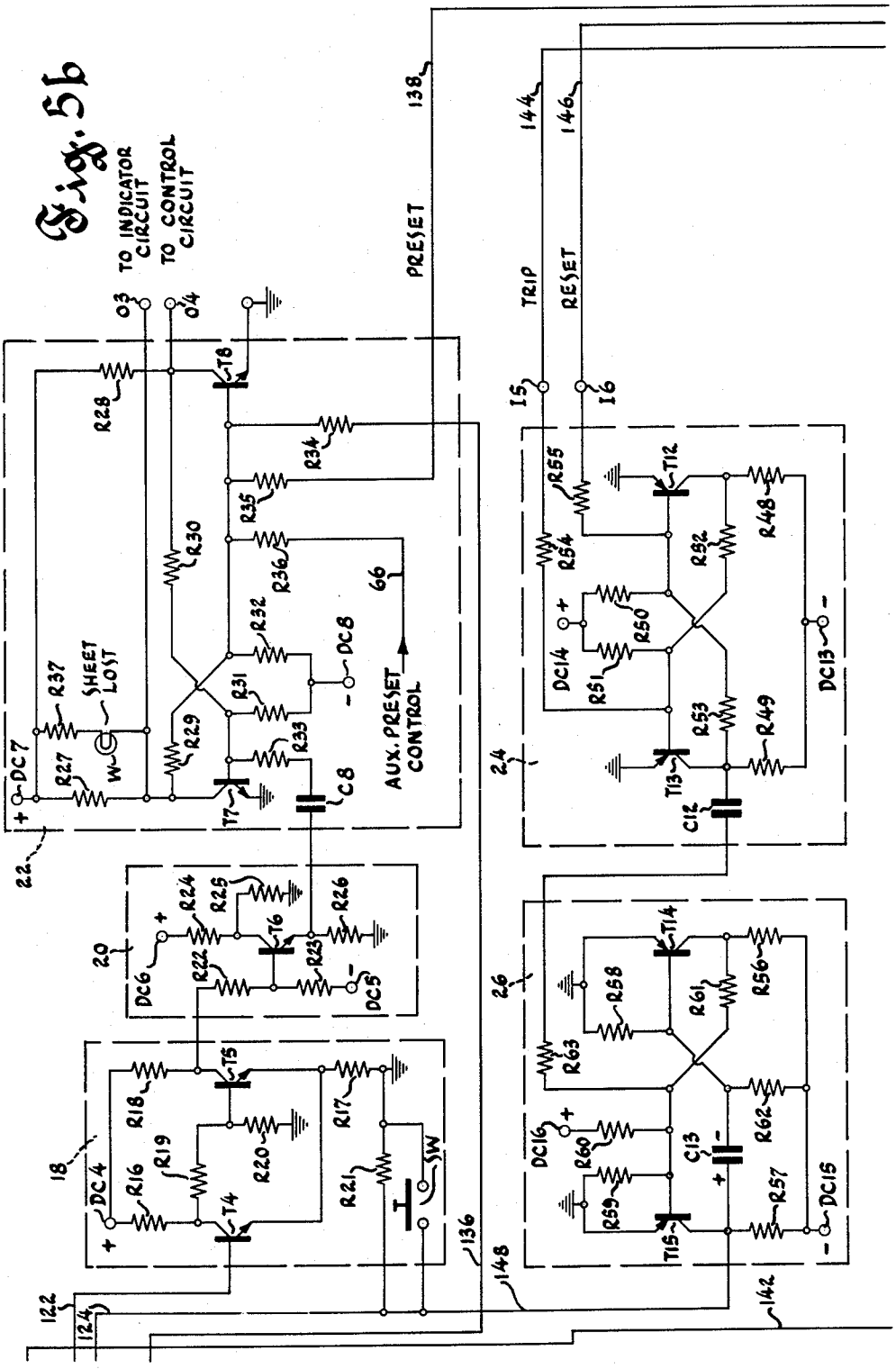


Fig. 5a

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DETECTOR SYSTEM FOR PLURAL UNIT PRINTING PRESS

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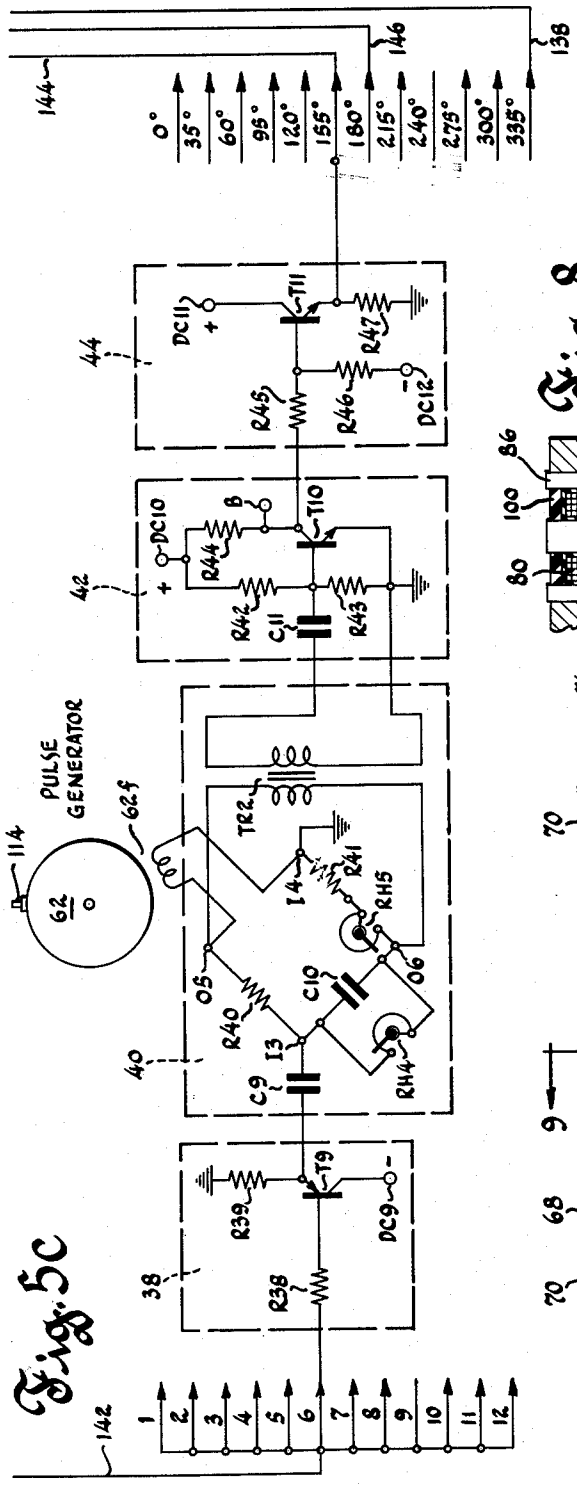


Fig. 5C

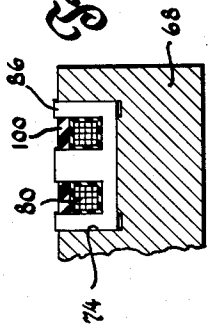


Fig. 8

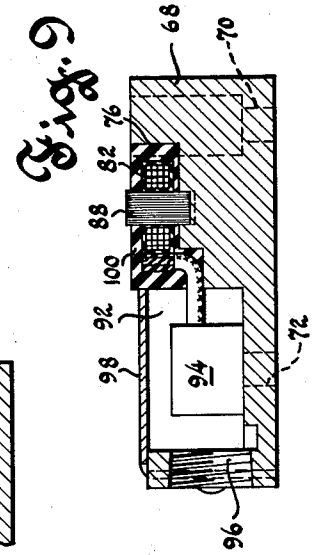


Fig. 9

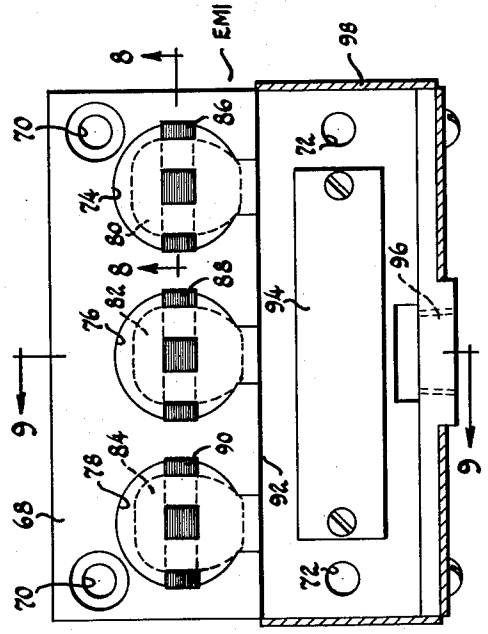
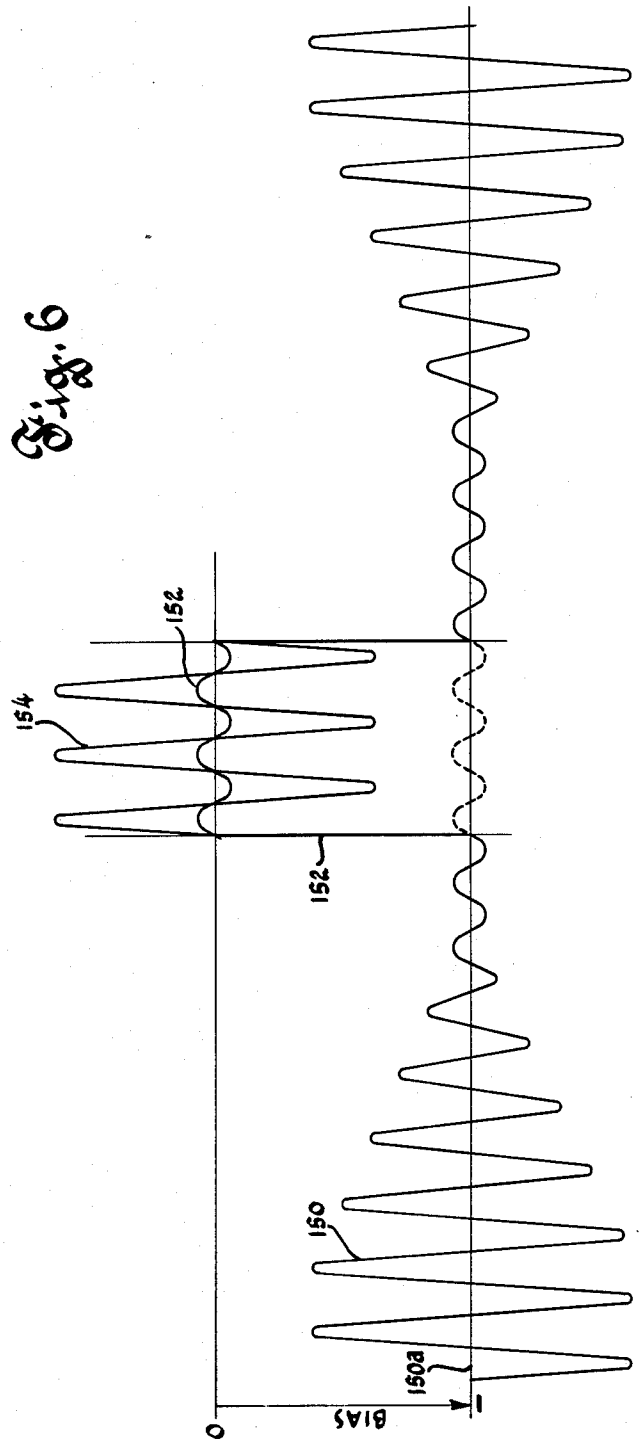


Fig. 7

DETECTOR SYSTEM FOR PLURAL UNIT PRINTING PRESS

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Fig. 6



United States Patent Office 3,191,530 Patented June 29, 1965

3,191,530

DETECTOR SYSTEM FOR PLURAL UNIT PRINTING PRESS

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Filed Nov. 18, 1963, Ser. No. 324,433
15 Claims. (Cl. 101—184)

This invention relates to detector systems and more particularly to systems for detecting articles at one or more points as they are passing through a processing machine and for providing a control signal in response to detection of an abnormal condition of an article.

While not limited thereto, the invention is especially applicable to printing presses or the like for detecting the absence of or misplacement of sheets at predetermined points of their travel through a plural unit printing press.

Printing presses which automatically feed sheets of paper thereinto to be printed are normally provided with sheet registering devices for precisely positioning each sheet relative to the press cylinders as the sheets are fed in succession into the press. Such precise positioning of the sheets is especially required in plural unit multi-color presses so that the different colors printed by the respective press units are exactly superimposed on each sheet. Such precise positioning of the sheets is called "registering" of the sheets. It will be apparent that exact register of the sheets must be maintained as the sheets pass through the press units in order to prevent printing of blurred copies which would occur if the sheets slipped or became displaced as they pass from one press unit to the next one. It will also be apparent that in the event a sheet becomes severely displaced, or is lost, that is falls out of the press as it is being transferred from one press unit to another, or becomes jammed, such condition must be detected in order that a proper control function can be performed on the press. Such detection is particularly important in presses of the offset type wherein the ink is transferred from the plate cylinder to a blanket cylinder from which it is applied to the sheet as the latter passes between the blanket cylinder and an impression cylinder. A displaced or lost sheet could cause smearing of ink onto the impression cylinder unless the blanket and impression cylinders are separated when the abnormal condition is detected. A jammed sheet could damage the cylinder surfaces. It has, therefore, been found desirable to provide means for detecting abnormal conditions of the aforementioned type and to provide an electrical control signal which may be utilized to perform proper control functions such as separating the cylinders, stopping the feeding of sheets and the like.

Accordingly, a general object of the invention is to provide an improved detector system.

A more specific object of the invention is to provide an improved system for detecting registration of articles passing in succession through a processing machine and for providing control signals when predetermined register conditions are detected.

Another specific object of the invention is to provide a detecting system of the aforementioned type with radiant energy coupling between portions thereof moving with the machine and stationary portions of the system whereby to avoid physical connection therebetween for transmitting detection signals.

Another specific object of the invention is to provide a detection system of the aforementioned type with enabling signals timed and synchronized with predetermined detection points and machine operation and means to prevent response of the system to extraneous signals at other times.

Other objects and advantages of the invention will hereinafter appear.

According to the invention, there is provided a loss of sheet detector system for a plural unit, multi-color printing press of the offset type. Presses of this type are normally provided with sets of gripper fingers on those cylinders which advance the sheets from a feeder through the press units. These sets of gripper fingers normally grip the leading edge of the sheets to maintain the sheets in proper registration as the rotating cylinders advance the sheets through the press. The invention is provided with a plurality of loss of sheet detector circuits which utilize sets of these gripper fingers also for detecting misplacement of the sheets at points ahead of the respective press units. These loss of sheet detector circuits are energized from an alternating current source such as an oscillator and are coupled to the associated sets of gripper fingers by electromagnetic induction air gaps whereby a signal is developed whenever a gripper finger engages a respective contact indicating that a sheet is displaced from proper registration. When the sheet is in correct registration, it maintains the gripper fingers insulated from the contacts and no signal is produced. The signal is produced by a gripper finger engaging its contact to short circuit an electromagnetic coil rotated past a stationary electromagnetic coil, the latter being connected in one branch of a balanced bridge circuit. Since the bridge is balanced for the condition wherein the gripper fingers do not make contact and the rotating coil is adjacent to the stationary coil, the bridge would become unbalanced to produce an unwanted signal when the coils separate although the gripper fingers are open. To avoid such unwanted or extraneous signals, the loss of sheet detector circuits are provided with means maintaining them ineffective except when the gripper fingers close. For this purpose, a timing drum or pulse generator is driven in synchronism with the press. A plurality of timing signal circuits supplied from the oscillator are operated at predetermined times by the pulse generator to provide timing pulses which condition the loss of sheet circuits for response to loss of sheet signals at only those times when the associated gripper fingers close. In this manner, an output signal is produced only when a lost sheet is sensed and the system will not be affected by the aforementioned or other extraneous conditions.

These and other objects and advantages of the invention and the manner of obtaining them will best be understood by reference to the following detailed description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a schematic and block diagram illustration of the detector system constructed in accordance with the invention;

FIG. 2 is a timing diagram graphically depicting operating characteristics of the detector system when applied to a printing press;

FIG. 3*a* is a schematic side elevational view of a portion of a plural unit printing press with which the invention may be used;

FIG. 3*b* is a schematic top view of a portion of FIG. 3*a*;

FIGS. 4*a* and 4*b* are front elevational and cross-sectional views respectively of the timing signal drum or pulse generator shown schematically in FIG. 3*a*;

FIGS. 5*a*, 5*b* and 5*c* when connected to one another show system circuit details of the detector system of FIG. 1;

FIG. 6 graphically depicts operating characteristics of the system of FIGS. 5*a*–*c*;

FIG. 7 is a front elevational view of an electromagnet used in the system of FIG. 5*a*;

FIG. 8 is a cross-sectional view taken along line 8—8 of FIG. 7; and

FIG. 9 is a cross-sectional view taken along line 9—9 of FIG. 7.

It will become apparent as the description proceeds that the invention contemplates a system which operates automatically in synchronism with a processing machine or the like for sensing misplacement or absence at predetermined points in the machine of articles advancing in succession through the machine. For exemplary purposes, the invention will hereinafter be described as being applied to a plural unit, sheet printing press of the offset type. In such use, the system will sense a sheet a plurality of times as it passes through the press. The predetermined points selected for sensing the sheets are preferably points sufficiently ahead of the respective press units to enable the control signal to effect pressure release between or separation of the cylinders in the next press unit, that is, the press unit that the sheet which has been sensed as being out of proper registration is about to enter. As hereinafter described in connection with FIG. 3*a*, these sensing points comprise the gripper fingers of the feed cylinder which initially receives the sheets and is ahead of press unit 1 and the transfer cylinders which are ahead of press units 2, 3, 4, 5 and 6. In this manner, each press unit may be protected from entry of a misplaced sheet.

Referring to FIG. 1, there is shown schematically and in block diagram a loss of sheet detector system for a plural unit press. To avoid complicating the drawings, only one loss of sheet circuit LOS2 for the first transfer cylinder between press units 1 and 2 has been shown in block diagram in FIG. 1. Since the loss of sheet circuits LOS1 and LOS3 through LOS6 for press units 1 and 3 through 6 are similar to loss of sheet circuit LOS2 shown, suitable circuit multiples have been shown in the upper left-hand portion of FIG. 1 for connection thereto, respectively, to avoid unnecessary duplication. The sequence in which loss of sheet circuits LOS1 through LOS6 operate will become apparent as the description proceeds. Also, to avoid complicating the drawing, the "trip" timing signal circuit, the "reset" timing signal circuit and the "preset" timing signal circuit only for loss of sheet circuit LOS2 have been shown in block diagram in FIG. 1. These three timing signal circuits for circuit LOS2 are similar to one aonther except that they are connected to different positions of a timing signal pulse generator and to different parts of loss of sheet circuit LOS2. Since the three timing signal circuits for each loss of sheet circuit LOS1 and LOS3 through LOS6 are similar to those shown, suitable circuit multiples have been shown at the left-hand portion of FIG. 1 for connecting them to a master oscillator.

The circuits are provided in FIGS. 1 and 5*c* with degree markings indicative of the relative time positions of the output signals of the timing signal circuits. As shown in FIG. 1, there are connections 1 through 12 for a total of twelve timing signal circuits although only eleven of these circuits are required for providing three signals (trip, reset and preset) to each of six loss of sheet circuits. As will be apparent from the timing diagram of FIG. 2, the 240 degree connection 9 is not required when only six loss of sheet circuits are used but this connection is also shown in FIGS. 1 and 5*c* because the system is adaptable for use with additional loss of sheet circuits to accommodate additional press units if desired.

As shown in FIG. 1, a master oscillator 13 is connected to supply an alternating current voltage of 7,000 cycles per second or the like to six loss of sheet circuits LOS1 through LOS6 and to twelve timing signal circuits including a trip timing signal circuit, a reset timing signal circuit and a preset timing signal circuit.

Each loss of sheet circuit in FIG. 1 such as circuit LOS2 comprises an LOS (loss of sheet) bridge driver circuit 14, an LOS detector bridge circuit 16, a Schmitt trigger circuit 18, a signal leveler circuit 20 and an output flip-flop circuit 22. Each loss of sheet circuit also comprises a gate signal flip-flop circuit 24 and a gate signal timer circuit 26 for controlling Schmitt trigger circuit 18. Bridge circuit 16 is connectable through a selector switch 28 to a stationary electromagnetic device 28*a* which is activated by a detector 30 comprising a movable electromagnetic device 30*a*, there being a small air gap 32 between the stationary and movable electromagnetic devices. Detector 30 is mounted on a press cylinder or the like so that it is driven by press drive 34 in synchronism with the press as depicted by broken line 36.

The trip timing signal circuit comprises a timing bridge driver circuit 38, a timing bridge circuit 40, a timing pulse shaper circuit 42 and a timing signal output circuit 44. The reset timing signal circuit comprises a reset bridge driver circuit 46, a reset bridge circuit 48, a reset pulse shaper circuit 50 and a reset signal output circuit 52 similar to the corresponding parts of the trip timing signal circuit. The preset timing signal circuit comprises a preset bridge driver circuit 54, a preset bridge circuit 56, a preset pulse shaper circuit 58 and a preset signal output circuit 60 similar to the corresponding parts of the trip timing signal and reset timing signal circuits.

Trip timing bridge circuit 40, reset bridge circuit 48 and preset bridge circuit 56 are connected to different angular positions of a timing pulse generator 62. Timing pulse generator 62 is driven by press drive 34 in synchronism with the press as depicted by broken line 64 and is provided with twelve stationary electromagnetic devices 62*a* through 62*m*. These electromagnetic devices are arranged in a circle at respective angular positions corresponding to 0, 35, 60, 95, 120, 155, 180, 215, 240, 275, 300 and 335 degrees and are connected to the timing signal circuits associated with connections 1 through 12, respectively. Pulse generator 62 is also provided with a rotor hereinafter described having an armature of magnetizable material mounted thereon so that the armature passes in close proximity to the electromagnetic devices when the rotor rotates with the press cylinder. As shown in FIG. 1, electromagnetic device 62*f* at the 155 degree position is connected to timing bridge circuit 40 whereby the timing signal circuit provides a "trip" pulse each time the armature swings past the 155 degree position of the pulse generator.

The drive arrangement is synchronized so that the movable electromagnetic device 30*a* in detector 30 swings past stationary electromagnetic device 28*a* connected to switch 28 at the same time as the armature swings past electromagnetic device 62*f*. In this manner, the trip timing signal circuit operates gate signal flip-flop circuit 24 to condition trigger circuit 18 in loss of sheet circuit LOS2 so that the latter can respond to a loss of sheet signal, if present, only at the time that a loss of sheet signal can be detected. At other times, such response is prevented by means hereinafter described so that the loss of sheet circuit will not respond to any extraneous signals that might be present.

Electromagnetic device 62*g* in the pulse generator is connected to reset bridge circuit 48 whereby the reset timing signal circuit provides a reset signal pulse each time the armature swings past the 180 degree position of the pulse generator. In this manner, gate signal flip-flop circuit 24 in the loss of sheet circuit is reset to its original non-responsive state 25 degrees after it has been operated by the trip timing signal.

Electromagnetic device 62*m* in the pulse generator is connected to preset bridge circuit 56 whereby the preset timing signal circuit provides a preset signal pulse each time the armature swings past the 335 degree position. In this manner, output flip-flop circuit 22 in the loss of sheet circuit is restored or flopped to its original condition 180 degrees before possible arrival of a loss of sheet signal thereto from detector bridge circuit 16. In the event no

loss of sheet signal had theretofore flipped output flip-flop circuit **22**, the preset signal pulse always insures that the output flip-flop circuit is in condition to respond to a loss of sheet signal.

As indicated by legends in FIG. 1, the trip timing signal circuit is also connected to provide a "preset" timing signal to loss of sheet circuit LOS5 output flip-flop circuit. The preset timing signal circuit is also connected to provide a "trip" timing signal to loss of sheet circuit LOS5. In other words, some of the timing signal circuits perform more than one function in that they control more than one loss of sheet circuit depending upon the number of loss of sheet circuits connected in the system as more clearly shown in the timing diagram in FIG. 2. Also, switch circuit **28** is connected to output flip-flop circuit **22** to afford manual presetting of the latter as hereinafter described in connection with FIGS. 5*a* and 5*b*. In addition, input conductor **66** represents one or more auxiliary preset controls for output flip-flop circuit **22**.

Referring to FIG. 3*a*, there is shown a portion of a plural unit printing press of the offset, multi-color type. While the press may have from one to six units or more such as four or six or the like, only a portion of the possible total units have been shown to avoid unnecessary duplication. As shown schematically in FIG. 3*a*, the press is provided at the right-hand end thereof with a feeder F wherein the sheets of paper to be printed are contained in a stack. The feeder feeds the sheets one at a time in the left-hand direction along a downwardly inclined feed table FT to a feed cylinder FC. As each sheet approaches the feed cylinder, it may be registered, that is, it may be positioned laterally so that it will enter the press in the correct lateral position. The feed cylinder moves the sheet to an advance cylinder AC which then moves the sheet into the first unit of the press.

Each unit of the press comprises a plate cylinder PC, a blanket cylinder BC and an impression cylinder IC which are shown as being of the same diameter and are driven in unison. Each unit of the press also comprises ink transfer rolls or the like, not shown, adjacent to and above the plate cylinder for applying printing ink to the printing plate. A transfer cylinder TC is provided for each unit of the press for moving the sheet from one unit to the next and away from the last unit of the press to a delivery device at the extreme left-hand end of the press. As shown in FIG. 3*a*, the transfer cylinder is between and slightly lower than the impression cylinder of one unit and the impression cylinder of the next unit. The delivery device moves the sheets from the last transfer cylinder to a delivery stack.

The diameter of the transfer cylinder is shown in FIG. 3*a* as being twice as large as the diameter of the impression cylinder. The advance cylinder is shown as having the same diameter as the impression cylinder. The feed cylinder has a smaller diameter than the impression cylinder.

As shown in FIG. 3*a*, advance cylinder AC is connected to drive a timing drum or timing pulse generator **62**, shown also in FIG. 1, in unison therewith for purposes hereinafter described. The advance, plate, blanket and impression cylinders and pulse generator are driven at the same speed so that they rotate the same number of revolutions. The transfer cylinders are driven at one-half speed of the pulse generator so that the pulse generator rotates two revolutions for each revolution of the transfer cylinders. The feed cylinder being of smaller diameter than the advance cylinder may be driven with intermittent motion so that it stops for a period of dwell while a sheet of paper is being fed thereto and then rotates to move the sheet to the advance cylinder.

The sheets of paper travel over the feed cylinder, under the advance cylinder and are printed as they pass between the blanket and impression cylinders of the first press unit. The sheets then are moved under the first transfer cylinder and between the blanket and impression cylinders of the second press unit for a second printing or printing of a second color thereon. In a similar manner, the sheets move between the blanket and impression cylinders of each press unit in succession and beneath the transfer cylinders of adjacent press units to the delivery device.

The feed, advance, impression and transfer cylinders are normally provided with rows of gripper fingers for gripping the leading edge of the sheet so that the sheet will not slip when the cylinders rotate and advance the sheet through the press. As shown in FIG. 3*b*, the gripper fingers of each row are secured to a rotatable shaft mounted in a groove in the periphery of the associated cylinder parallel to the axis of the cylinder. This shaft may be operated by the press or cylinder drive or in response to rotation of the associated cylinder by gears, cams or the like. When so operated, it separates the tips of the fingers from the cylinder and presses the tips of the fingers tightly against the cylinder when the cylinder starts to carry the gripper fingers away from the point where the leading edge of a sheet may enter therebetween. Thus, the fingers grip the leading edge of the sheet and pull it around the cylinder as the latter rotates.

As aforementioned, feed cylinder FC is driven intermittently in the counterclockwise direction by a Geneva movement drive or the like. During the dwell period of the feed cylinder, a sheet is fed along the inclined feed table to gripper fingers FG thereof. These gripper fingers grip the sheet and the feed cylinder then rotates counterclockwise and pulls the sheet over its upper left-hand portion to the advance cylinder. The cylinders are driven in synchronism so that gripper fingers AG of the advance cylinder arrive at the proper position at the same time as the leading edge of the sheet arrives thereat. Fingers AG then pull the sheet around the lower side of the advance cylinder, as the latter rotates clockwise, to gripper fingers IG of the impression cylinder. At this point, fingers AG release the sheet and fingers IG of the impression cylinder grip the leading edge of the sheet and pull it around the upper side of the impression cylinder as the latter rotates counterclockwise. During this movement, the blanket cylinder prints the sheet.

The transfer cylinder is provided with two rows of gripper fingers TG1 and TG2 located 180 degrees apart since the transfer cylinder rotates only half a revolution for each revolution of the impression cylinder. When the leading edge of the sheet arrives at substantially the common tangential point between cylinders IC and TC, it is released by gripper fingers IG and is gripped by fingers TG1 on the transfer cylinder. Alternate sheets are gripped by fingers TG2 on the transfer cylinder. As the transfer cylinder rotates in the clockwise direction, it pulls the sheet around the lower side thereof to the impression cylinder in the second press unit. In a similar manner, the sheet is printed in each succeeding press unit and transferred to the next press unit by the transfer cylinder between adjacent units. The last transfer cylinder receives the sheet from the last press unit impression cylinder and moves it to the delivery device which delivers the sheet to the stack.

The aforementioned gripper fingers may be used not only to hold the sheets in their proper place as they are transported through the press but also to detect at desired points along the press whether the sheets are in proper position and to initiate a control function in the event a sheet is displaced from its proper position or is askew such that at least one gripper finger fails to grip it.

As illustrated in FIG. 3*b*, which is a view of transfer cylinder TC from a direction perpendicular to its axis, a row of gripper fingers TG1 are rigidly secured to and electrically connected to a supporting shaft S which is connected to electrical ground G. Although gripper fingers TG1 are mounted in spaced apart relation throughout the length of shaft S, only a few pairs of gripper fingers at opposite ends of the shaft are used for loss of sheet detection purposes to accommodate the different widths of sheets

that are printed. To this end, a pair of electrical contacts W (indicative of a wide sheet) are mounted beneath the tips of the outermost pair of gripper fingers and are electrically connected to a first coil of a three-coil electromagnetic device EM1 more clearly shown in FIGS. 3*a*, 5*a*, 7, 8 and 9. In a similar manner, another pair of electrical contacts M (indicative of medium width sheet) are mounted on the cylinder beneath the tips of the next pair of gripper fingers and are electrically connected to a second coil of electromagnetic device EM1. Likewise, a third pair of electrical contacts N (indicative of narrow sheet) are mounted beneath the tips of the third pair of gripper fingers and are electrically connected to the third coil of electromagnetic device EM1. The other sides of the three coils of electromagnetic device EM1 are connected to ground. With this arrangement, a selector switch may be used to select the appropriate pair of contacts N, M or W for use depending upon the width of sheets that are to be sensed by the respectively associated pair of gripper fingers as more fully hereinafter described in connection with FIG. 5*a*.

Similar contacts associated with the other row of gripper fingers TG2 on the transfer cylinder of FIG. 3*b* are connected in the aforedescribed manner to the three coils of a like electromagnetic device EM2 which is spaced 180 degrees from device EM1. It will be apparent from FIGS. 3*a* and 3*b* that immediately after the gripper fingers close against the contacts or simultaneously therewith electromagnetic device EM1 (or device EM2 as the case may be) swings past stationary electromagnetic device EM3 which is similar to devices EM1 and EM2. If a sheet is between the gripper fingers and their contacts when they close, they will remain electrically insulated from one another by the sheet and no control signal will be provided. However, if the sheet is lost or is askew so that a gripper finger makes electrical contact with either contact of a selected pair N, M or W thereof, the associated coil on electromagnetic device EM1 will be short-circuited. As a result, movement of electromagnetic device EM1 past electromagnetic device EM3 with a small air gap separation therebetween will cause device EM3 to develop a control signal in LOS detector bridge circuit 16 in FIG. 1, as hereinafter more fully described in connection with FIGS. 5*a*, 5*b* and 5*c*.

Certain details of electromagnetic device EM1 are shown in FIGS. 7, 8 and 9. As shown therein the electromagnetic device is provided with a base 68 comprising an aluminum casting or the like. Base 68 is provided with two pairs of mounting holes 70 and 72, holes 70 being counter sunk from the upper surface so that the securing bolts do not extend above the surface of the electromagnetic device. Base 68 is provided with three substantially circular recesses 74, 76 and 78 for accommodating coils 80, 82 and 84 and their associated E-shaped cores 86, 88 and 90, respectively. These three circular recesses are arranged in alinement along one side of the upper surface of the base and have openings therefrom into an elongated channel 92 extending parallel therewith along the other side of the upper surface of the base. This elongated channel is provided for the purpose of accommodating a terminal block 94 mounted therein and having terminals to which the coils are connected. A hole 96 extends into channel 92 through which conductors may be provided for connecting the terminals of terminal block 94 to an external circuit. An angular cover 98 is secured over channel 92 and the adjacent edges of the base to enclose terminal block 94, this cover having a slot therein to leave hole 96 uncovered. As shown in FIGS. 8 and 9, the coils and their associated cores are embedded or potted in their respective recesses with plastic material 100 or the like so that only the three tips of each E-shaped core extend slightly above the upper surface of the base.

For purposes of describing the invention, it may be assumed that feed cylinder FC in FIG. 3*a* has mounted thereon immediately adjacent gripper fingers FG an electromagnet like that shown in FIGS. 7, 8 and 9 and has associated therewith a stationary electromagnet of like type so that the electromagnet on the feed cylinder passes in close proximity to the associated stationary electromagnet once for each revolution of the feed cylinder immediately after the gripper fingers close. Also each transfer cylinder has mounted thereon a pair of electromagnets and has associated therewith a stationary electromagnet as hereinbefore described.

Pulse generator 62 shown schematically in the left-hand portion of FIG. 1 is shown in more detail in FIGS. 4*a* and 4*b*. This pulse generator is of the synchronous type in that it is driven in synchronism with press rotation. The pulse generator consists primarily of a rotatable drum having an armature mounted thereon and a plurality of electromagnets mounted in distributed relation around the drum at predetermined angular positions. As shown in FIGS. 4*a* and 4*b*, the pulse generator is provided with a stationary mounting plate 102 rigidly secured to the press frame or the like. A bushing 104 is rigidly secured in a hole 106 in the center of the mounting plate and extends to the right-hand side of the plate. Bearings 108 are mounted in the hole in bushing 104 and a shaft 110 extends through the bushing and bearings to the other side of mounting plate 102. A drum 112 is rigidly secured to the right-hand end of shaft 110 as seen in FIG. 4*b* so that the drum rotates when the shaft is driven from its left-hand end. A single armature 114 comprising a bar of magnetizable material is rigidly secured to the periphery of drum 112. Twelve electromagnets 62*a* through 62*m* are mounted onto mounting plate 102 around drum 112. These electromagnets are mounted so that there is a small magnetic air gap relation between each electromagnet and armature 114 as the latter sweeps past the electromagnets during drum rotation.

As shown in FIG. 4*b*, each such electromagnet comprises an E-shaped core 116 of magnetizable material such as laminated iron sheets or the like and a coil 118 wound around the center leg of the core. These coils and cores are mounted in recesses in respective mounting blocks 120 which are secured by bolts or the like to mounting plate 102. The manner in which the electromagnets or rather the coils thereof are connected to timing bridges in the system will become apparent as the description proceeds.

Certain details of the system that is shown in block diagram in FIG. 1, are shown in FIGS. 5*a*, 5*b* and 5*c*. FIGS. 5*a* and 5*b* diagrammatically show details of the master oscillator and loss of sheet circuit LOS2. FIG. 5*c* shows details of the pulse generator and of the trip timing signal circuit. As shown in FIG. 5*a*, master oscillator 13 is of the resistance-capacitance phase-shift type. Oscillator 13 comprises a transistor T1 of the P-N-P conductivity type having its emitter connected through a level control potentiometer POT1 and a resistor R1 to electrical ground, there being a capacitor C1 connected across potentiometer POT1 and resistor R1. Potentiometer POT1 is provided to afford negative feedback adjustments to afford sinusoidal output and amplitude control. The collector of transistor T1 is connected through a resistor R2 to a source of negative direct current voltage DC1.

The oscillator is provided with an emitter follower output circuit to reduce loading on the oscillator and for impedance matching to the three stages of RC coupling hereinafter described. This emitter follower circuit comprises a transistor T2 having its collector connected to negative source DC1. The base of transistor T2 is connected through a current limiting resistor R3 to the collector of transistor T1. The emitter of transistor T2 is connected through a load resistor R4 to ground potential and is also connected to the six loss of sheet circuits and to the twelve timing signal circuits. The resistance capacitance phase-shift oscillator circuit comprises three capacitors C2, C3 and C4 and three resistors R5, R6 and R7 for shifting the phase of the output voltage of transistor T1 in approximately 60 degree steps for a total phase

shift of 180 degrees and applying this phase shifted voltage as positive feedback causing transistor T1 to generate an alternating current signal. The phase shift of transistor T1 is 180 degrees and the R-C circuits shift the phase another 180 degrees to afford positive feedback to the base of transistor T1. The emitter of transistor T2 is connected through capacitor C2 and resistor R5 to ground potential. The junction of capacitor C2 and resistor R5 is connected through capacitor C3 and resistor R6 to ground potential. The junction of capacitor C3 and resistor R6 is connected through capacitor C4 and resistor R7 to ground potential, and the junction of capacitor C4 and resistor R7 is connected through a coupling capacitor C5 to the base of transistor T1. The output voltage wave form of the oscillator is sinusoidal with very little distortion due to the addition of negative feedback controlled by an adjustable level control potentiometer POT1. A bias control circuit which comprises a resistor R8 connected between the base of transistor T1 and ground potential and a resistor R9 and a rheostat RH1 connected in series between the base of transistor T1 and the aforementioned source of negative direct current voltage DC1 is provided to afford optimum output and to adjust for transistor parameter variations.

Bridge driver 14 in the loss of sheet circuit in FIG. 5*a* comprises a transistor T3 of the P-N-P conductivity type. The output voltage of master oscillator 13 is connected through a current limiting resistor R10 to the base of transistor T3. The collector of transistor T3 is connected to a source of negative direct current voltage DC2. The emitter of transistor T3 is connected through a resistor R11 and the resistor of a potentiometer POT2 in parallel to ground potential. The movable tap of potentiometer POT2 is connected to detector bridge 16.

Detector bridge circuit 16 comprises a Maxwell type bridge having a pair of input terminals I1 and I2 and a pair of output terminals O1 and O2. The movable tap of potentiometer POT2 in the bridge driver circuit is connected through a coupling capacitor C6 to input terminal I1, input terminal I2 being connected to ground potential. Input terminal I1 is connected through a resistor R12 to output terminal O1. Input terminal I1 is also connected through a capacitor C7 and a rheostat RH2 in parallel to output terminal O2. Input terminal I2 is connected through a resistor R13 and a rheostat RH3 in series to output terminal O2. Output terminals O1 and O2 are connected across the primary winding of an isolating transformer TR1. One end of the secondary winding of transformer TR1 and an intermediate point thereon are connected through conductors 122 and 124 to trigger circuit 18 in FIG. 5*b*, the other end of the secondary winding being connected to a terminal A for testing the output voltage of the detector bridge. Input terminal I2 and output terminal O1 are connected through a pair of conductors 126 and 128, respectively, to switch circuit 28.

The row of gripper fingers TG1 hereinbefore described in connection with FIG. 3*b* is shown diagrammatically in the lower portion of FIG. 5*a*. The gripper fingers are connected to ground potential. The three coils 80, 82 and 84 hereinbefore described in connection with FIGS. 7, 8 and 9 are also shown in the lower portion of FIG. 5*a*. The pair of contacts W for detecting wide sheets are connected to one another and then through coil 80 to ground potential. The pair of contacts M for detecting medium width sheets are connected to one another and then through coil 82 to ground potential and the pair of contacts N for detecting narrow sheets are connected to one another and then through coil 84 to ground potential.

Switch circuit 28 in FIG. 5*a* comprises means for selectively connecting any one of the three coils of stationary electromagnetic device EM3 shown in FIG. 3*b* through conductors 126 and 128 to detector bridge circuit 16 and for applying a manual reset control voltage to output flip-flop circuit 22 in FIG. 5*b*. This means comprises a selector switch SS having two levels of contacts SS1 and SS2. Each such switch level is provided with a movable brush contact and four stationary contacts including an off-position OFF and operating positions 1, 2 and 3. The movable contacts of the two switch levels are mechanically interconnected for movement in unison as indicated by the broken line. One side of an alternating current voltage source A.C. is connected to the movable contact of switch level SS1. The other side of such alternating current source, which is grounded, is connected through the operating coils of selector relays SR1, SR2 and SR3 to stationary contacts 1, 2 and 3, respectively, of switch level SS1. Relay SR1 is provided with a pair of normally open contacts *a* and *b* for connecting coil 130 of electromagnetic device EM3 to conductors 126 and 128. Relay SR2 is similarly provided with a pair of normally open contacts *a* and *b* for connecting coil 132 of electromagnetic device EM3 to conductors 126 and 128 and relay SR3 is provided with a like pair of contacts *a* and *b* for connecting coil 134 of electromagnetic device EM3 to conductors 126 and 128. The off stationary contact of switch level SS1 is left disconnected.

A source DC3 of positive direct current voltage is connected to the movable contact of switch level SS2. Stationary contact OFF of switch level SS2 is connected through a voltage divider comprising resistors R14 and R15 in series to ground potential. The junction of resistors R14 and R15 is connected through a conductor 136 to output flip-flop circuit 22 in FIG. 5*b* as hereinafter described. Stationary contacts 1, 2 and 3 of which level SS2 are left disconnected.

Referring to FIG. 5*b* Schmitt trigger circuit 18 comprises a pair of transistors T4 and T5 of the N-P-N conductivity type. A source of positive direct current voltage DC4 is connected through a resistor R16 to the collector of transistor T4 and the emitter thereof is connected through a resistor R17 to ground potential. Source DC4 is also connected through a resistor R18 to the collector of transistor T5 and the emitter of the latter is connected through resistor R17 to ground potential. The collector of transistor T4 is connected through a resistor R19 to the base of transistor T5 and the base of transistor T5 is connected through a resistor R20 to ground potential. Conductor 122 extending from the center tap of the transformer secondary winding in detector bridge circuit 16 in FIG. 5*a* is connected to the base of transistor T4. Conductor 124 extending from detector bridge circuit 16 in FIG. 5*a* is connected through a resistor R21 to the junction between resistor R17 and ground potential. A manually operable switch SW of the normally open type is connected across resistor R21 for removing a reverse bias voltage from transistor T4 upon closure thereof.

The collector of transistor T5 in trigger circuit 18 is connected through a resistor R22 to the base of a transistor T6 of the N-P-N conductivity type in signal leveler circuit 20. The base of transistor T6 is connected through a resistor R23 to a source of negative direct current voltage DC5. A source of positive direct current voltage DC6 is connected through a resistor R24 to the collector of transistor T6, such collector being connected through a resistor R25 to ground potential. The emitter of transistor T6 is connected through a resistor R26 to ground potential and is also connected to output flip-flop circuit 22 as hereinafter described.

Output flip-flop circuit 22 comprises a pair of transistors T7 and T8 of the N-P-N conductivity type connected in a circuit whereby they can be rendered alternately conducting. A source of positive direct current voltage DC7 is connected through a resistor R27 to the collector of transistor T7 and is connected through a resistor R28 to the collector of transistor T8. The emitters of transistors T7 and T8 are connected to ground potential. The collector of transistor T7 is connected through a resistor R29 to the base of transistor T8 and the collector of transistor T8 is connected through a resistor R30

to the base of transistor T7. The base of transistor T7 is connected through a resistor R31 to a source of negative direct current voltage DC8 and the base of transistor T8 is connected through a resistor R32 to source DC8. The emitter of transistor T6 in signal leveler circuit 20 is connected through a coupling capacitor C8 and a resistor R33 to the base of transistor T7 in output flip-flop circuit 22. Conductor 136 which extends from the voltage divider in FIG. 5*a* is connected through a resistor R34 to the base of transistor T8. The base of transistor T8 is also connected through a resistor R35 to a conductor 138 whereby a presetting signal is applied to output flip-flop circuit 22 as hereinafter described. An auxiliary preset control voltage may be applied through conductor 66 and a resistor R36 to the base of transistor T8. The collector of transistor T7 is connected to an output terminal O3 which may be connected to an indicator circuit or the like. The collector of transistor T8 is connected to an output terminal O4 which may be connected to a control circuit or the like to perform a desired control function whenever a lost sheet is detected as hereinafter described. The collector of transistor T7 is connected through an indicator lamp W and a resistor R37 to positive source DC7.

Master oscillator 13 of FIG. 5*a* is connected through a conductor 142 to a plurality of timing signal circuits in FIG. 5*c*. It may be assumed that the timing signal circuit shown in FIG. 5*c* in detail is the trip timing signal circuit of FIG. 1. The other timing signal circuits are similar thereto and have been represented in FIG. 5*c* by suitable circuit multiples to show how they are connected and to avoid unnecessary duplication.

Timing bridge driver circuit 38 in FIG. 5*c* is provided with a transistor T9 of the P-N-P conductivity type. Conductor 142 is connected through a current limiting resistor R38 to the base of transistor T9. As shown by the circuit multiples 1 through 12 in the upper left-hand portion of FIG. 5*c*, conductor 142 is similarly connected to the timing bridge driver circuits of the other eleven timing signal circuits. Resistor R39 is connected from ground potential to the emitter of transistor T9 and the collector thereof is connected to a source of negative direct current voltage DC9.

Timing detector bridge circuit 40 in FIG. 5*c* is similar to loss of sheet detector bridge circuit 16 in FIG. 5*a* except that it is operated by a single coil and one armature from pulse generator 62 rather than by a selected one of three coils. Timing detector bridge circuit 40 is provided with an impedance bridge of the Maxwell type having a pair of input terminals I3 and I4 and a pair of output terminals O5 and O6. The emitter of transistor T9 in timing bridge driver circuit 38 is connected through a coupling capacitor C9 to input terminal I3, and input terminal I4 is connected to ground potential. Input terminal I3 is connected through a resistor R40 to output terminal O5 and is connected through a capacitor C10 and a rheostat RH4 in parallel to output terminal O6. Input terminal I4 is connected through a resistor R41 and a rheostat RH5 in series to output terminal O6. Input terminal I4 is also connected through the coil of electromagnetic device 62*f* of pulse generator 62 to output terminal O5 and output terminals O5 and O6 are connected across the primary winding of an isolating transformer TR2. One end of the secondary winding of transformer TR2 is connected directly to pulse shaper circuit 42 and the other end of the secondary winding is connected to a coupling capacitor C11 in pulse shaper circuit 42.

Pulse shaper circuit 42 comprises a transistor T10 of the N-P-N conductivity type. A source of positive direct current voltage DC10 is connected through two resistors R42 and R43 in series to the emitter of transistor T10 and to ground potential and to the lower end of the secondary winding of transformer TR2, the upper end of the secondary winding being connected through a coupling capacitor C11 to the junction between resistors R42 and R43 and to the base of transistor T10. Source DC10 is also connected through a resistor R44 to the collector of transistor T10 and to a test terminal B. The collector of transistor T10 is connected to timing signal output circuit 44.

Timing signal output circuit 44 comprises a transistor T11 of the N-P-N conductivity type. A source of positive direct current voltage DC11 is connected to the collector of transistor T11. The collector of transistor T10 in timing pulse shaper circuit 42 is connected through a current limiting resistor R45 to the base of transistor T11 and the base of transistor T11 is connected through a resistor R46 to a source of negative direct current voltage DC12. The emitter of transistor T11 is connected through a resistor R47 to ground potential and is also connected through a conductor 144 to a "trip" signal input terminal I5 in gate signal flip-flop circuit 24 in FIG. 5*b*. It will be apparent from the legends in the upper right-hand portion of FIG. 5*c* that conductor 144 conducts 155 degree pulses to gate signal flip-flop circuit 24. In a similar manner, conductor 146 conducts 180 degree pulses from the reset timing signal circuit shown in FIG. 1 to reset signal input terminal I6 of gate signal flip-flop circuit 24. In like manner conductor 138 conducts 335 degree pulses from the preset timing signal circuit shown in FIG. 1 to output flip-flop circuit 22 in FIG. 5*b*.

In FIG. 5*b*, gate signal flip-flop circuit 24 comprises a pair of transistors T12 and T13 of the P-N-P conductivity type. The emitters of transistors T12 and T13 are connected to ground potential and the collectors thereof are connected through resistors R48 and R49, respectively, to a source of negative direct current voltage DC13. A source positive direct current voltage DC14 is connected through a resistor R50 to the base of transistor T12 and is connected through a resistor R51 to the base of transistor T13. The collector of transistor T12 is connected through a resistor R52 to the base of transistor T13 and the collector of transistor T13 is connected through a resistor R53 to the base of transistor T12. Input terminal I5 is connected through a resistor R54 to the base of transistor T13 and input terminal I6 is connected through a resistor R55 to the base of transistor T12. The collector of transistor T13 is connected through a coupling capacitor C12 to gate signal timer circuit 26.

Gate signal timer circuit 26 comprises a pair of transistors T14 and T15 of the P-N-P conductivity type. The emitters of transistors T14 and T15 are connected to ground potential and the collectors thereof are connected through resistors R56 and R57, respectively, to a negative direct current voltage source DC15. Resistor R58 is connected to ground potential and to the base of transistor T14 and resistor R59 is connected to ground potential and to the base of transistor T15. A positive direct current voltage source DC16 is connected through a resistor R60 to the base of transistor T15 normally to bias this transistor to its off condition. The collector of transistor T14 is connected through a resistor R61 to the base of transistor T15. The collector of transistor T15 is connected through a capacitor C13 to the base of transistor T14 and the base of transistor T14 is connected through a resistor R62 to negative direct current source DC15. The aforementioned coupling capacitor C12 in gate signal flip-flop circuit 24 is connected through a resistor R63 to the base of transistor T15 and the collector of transistor T15 is connected through a conductor 148 to and through resistor R21 in trigger circuit 18 to ground potential.

The operation of the system in FIGS. 5*a*, 5*b* and 5*c* will now be described. In master oscillator 13 in FIG. 5*a*, transistor T1 is forward biased to the desired operating point by resistor network R8 and R9 and rheostat RH1 connected between ground potential and a negative voltage current source DC1. The voltage drop across resistor R8 is applied across the emitter-base junction of transistor

T1 to cause base current to flow which causes collector and emitter current to flow. Thus, current flows from ground potential through resistor R1, potentiometer POT1, through the transistor T1 and resistor R2 to negative source DC1. The output voltage of transistor T1 is directly coupled from the collector thereof through resistor R3 to the base of output transistor T2. This renders the base of transistor T2 negative relative to ground potential to cause transistor T2 base current to flow whereby to cause current to flow from ground potential through resistor R4 and the emitter and collector of transistor T2 to negative source DC1.

Transistor T2 is connected as an emitter follower amplifier for the output circuit of the oscillator. The emitter follower output circuit is provided to reduce loading on oscillator transistor T1 and for impedance matching to the three stages of RC coupling. The output voltage of transistor T2 which is displaced in phase 180 degrees relative to the input voltage of transistor T1 is applied from the emitter thereof through the phase-shift circuit comprising capacitors C2, C3 and C4 and resistors R5, R6 and R7 to provide a 180 degree phase-shifted voltage through coupling capacitor C5 to the base of transistor T1. The three capacitor-resistor combinations shift the phase in approximately 60 degree steps to provide a total phase shift of 180 degrees which is fed back to transistor T1. The phase-shifted voltage is applied as positive feedback to transistor T1 which has sufficient voltage gain to cause the latter to generate an alternating current signal. The frequency of the alternating current signal is inversely proportional to the RC constants of the feedback network and will be that frequency which just results in a phase-shift of 180 degrees. It may be assumed that component values are selected so that the oscillator provides an output alternating voltage of 7,000 cycles per second or the like.

Potentiometer POT1 is a level control for the oscillator and affords adjustment of the negative feedback applied to transistor T1. It will be apparent that if potentiometer POT1 is turned in the clockwise direction, a greater amount of the total emitter resistance will be shunted by the by-pass capacitor C1 to cause a decrease in negative feedback which causes the gain of the circuit to increase. If potentiometer POT1 is turned in the counterclockwise direction, more emitter resistance is not shunted by the by-pass capacitor C1 which increases the negative feedback causing a decrease of gain in the oscillator output.

Rheostat RH1 is a bias control for the oscillator. It will be apparent that if rheostat RH1 is turned in the clockwise direction to increase the resistance thereof, the bias voltage on the base of transistor T1 will be decreased to lower the operating point of the oscillator. On the other hand, if rheostat RH1 is turned in the counterclockwise direction to decrease its resistance, the bias voltage on the base of transistor T2 will be increased to raise such operating point. Since the adjustment of rheostat RH1 has some effect on the gain of transistor T1, it is preferable to adjust both potentiometer POT1 and rheostat RH1 to obtain the desired operating conditions.

Since master oscillator 13 is connected to supply a plurality of circuits which requires that such circuits have high input impedances, and since low impedances are required to drive the bridge circuits such as LOS2 detector bridge circuit 16, a bridge driver circuit 14 of the emitter follower type is interposed therebetween. In bridge driver circuit 14, current flows from ground potential through resistor R11 and the resistor of potentiometer POT2 in parallel and then through transistor T3 to negative source DC2. Application of an alternating voltage from the master oscillator through current limiting resistor R10 to the base of transistor T3 causes a proportional alternating voltage of adjustable magnitude to be applied from the movable tap of potentiometer POT2 through coupling capacitor C6 to input terminal I1 of LOS detector bridge circuit 16. The detector bridge is of a Maxwell type which has high sensitivity and wherein the balance or null is independent of the frequency of the alternating voltage applied thereto. This bridge circuit responds fast to produce relatively constant amplitude output voltage which is independent of the speed of the press cylinder, that is, the speed with which electromagnet EM1 passes by electromagnet EM3.

Assuming that selector switch SS in the right-hand portion of FIG. 5*a* is set at stationary contact 1, the coil of relay SR1 is energized across alternating current source AC. Relay SR1 closes its contacts *a* and *b* to connect coil 130 through conductors 126 and 128 to detector bridge circuit 16. The alternating voltage applied to input terminal I1 of the detector bridge causes current flow in two branches to ground. Thus, current flows through resistor R12, conductor 128, contact *b*, coil 130, contact *a*, and conductor 126 to ground. Current also flows in a second branch through rheostat RH2 and capacitor C7 in parallel and then through rheostat RH3 and resistor R13 to ground. When the detector bridge is balanced, no current flows from output terminals O1 and O2 through the primary winding of transformer TR1. The detector bridge is adjusted or balanced for minimum alternating current output at test point A by adjusting coarse adjustment rheostat RH3 and fine or vernier adjustment rheostat RH2. Such adjustment is made when potentiometer POT2 is set at its maximum counterclockwise position and when gripper fingers TG1 are open, when switch SW in FIG. 5*b* is closed and when electromagnet EM1 is directly opposite and in line with electromagnet EM3. After the bridge circuit has been balanced as aforementioned, potentiometer POT2 is turned to its minimum clockwise position and the loss of sheet output flip-flop circuit is reset from level SS2 of selector switch SS by turning the latter momentarily to its off position. Thereafter a gripper finger is connected to its contact and potentiometer POT2 is turned counterclockwise to increase its output voltage to the bridge circuit enough to just insure triggering of circuit 18 as indicated by sheet lost indicator lamp W in output flip-flop circuit 22. Switch SW in FIG. 5*b* may now be reopened to set the system for automatic gating as hereinafter described.

Whenever either gripper finger of the pair N thereof shorts out, that is, closes on its stationary contact to indicate that a sheet is lost or misplaced, winding 84 is short circuited. As a result, when winding 84 sweeps past winding 130, the latter causes bridge circuit 16 to become unbalanced thereby to cause a pulse of current to flow in the primary winding of transformer TR1. The pulse that is applied to the primary winding of transformer TR1 consists of a series of cycles of alternating voltage of the oscillator frequency. A proportional spurt of alternating voltage cycles is applied from the secondary winding of transformer TR1 through conductors 122 and 124 to the base of transistor T4 and through resistor R21 to ground in trigger circuit 18. However, such signals cannot operate trigger circuit 18 because transistor T4 is held inoperative by the small voltage across resistor R17 plus the larger reverse bias voltage across resistor R21 unless such bias voltage is removed by a timing signal as hereinafter described.

The operation of the timing signal circuit in FIG. 5*c* will now be described. An alternating voltage is continuously applied from oscillator 13 in FIG. 5*a* through conductor 142 to timing bridge driver circuit 38 in FIG. 5*c*. Because the oscillator supplies a plurality of timing signal circuits, bridge driver 38 is provided with an emitter follower circuit to provide a high input impedance and to provide a low output impedance therefrom to timing bridge circuit 40. The oscillator voltage is applied through current limiting resistor R38 to the base of transistor T9 to render the transistor conducting from ground potential through resistor R39 and through transistor T9 to negative voltage source DC9. The alternating input voltage causes a proportional output voltage to be ap-

plied from the emitter of transistor T9 through coupling capacitor C9 to input terminal I3 of timing detector bridge circuit 40. This timing detector bridge circuit is similar to loss of sheet detector bridge circuit 16 in FIG. 5*a*. Timing detector bridge circuit 40 is adjusted for minimum output at test point B by adjusting coarse adjustment rheostat RH5 and fine or vernier adjustment rheostat RH4 when armature 114 of pulse generator 62 is displaced from coil 62*f*. Therefore, when armature 114 is near or in line with coil 62*f* as it passes thereby during rotation of the pulse generator, the bridge is unbalanced to cause current flow through the primary winding of transformer TR2. As a result, an alternating voltage is applied from the secondary winding of isolation transformer TR2 through coupling capacitor C11 across resistor R43 in pulse shaper circuit 42.

Since the pulse of alternating voltage derived from bridge circuit 40 is displaced from ground potential level, one function of pulse shaper circuit 42 is to bring this pulse back to ground potential reference level. Pulse shaper circuit 42 also rectifies the alternating current pulse and amplifies it considerably and clips it to give it a desired shape. The output signal from pulse shaper circuit 42 comprises a series of substantially square wave positive pulses.

Transistor T10 in pulse shaper circuit 42 is normally biased on. Current flows from positive direct current source DC10 through resistors R42 and R43 to ground. The voltage drop across resistor R43 due to such current flow normally maintains transistor T10 in its conducting condition whereby current flows from source DC10 through resistor R44 and transistor T10 to ground. While transistor T10 conducts, the impedance across its collector-emitter junction is substantially zero so that ground potential is applied from the collector thereof to timing signal output circuit 44. When an alternating current pulse is applied from timing detector bridge circuit 40 to the base of transistor T10 as aforementioned, such pulse drives transistor T10 to cutoff for the duration of the pulse. As a result, the output voltage at the collector of transistor T10 increases to a positive value for the duration of the input pulse whereby a rectified and shaped positive output pulse is applied through resistor R45 to the base of transistor T11 in timing signal output circuit 44. Transistor T11 is normally biased to its non-conducting condition by negative voltage applied from source DC12 through resistor R46 to the base thereof. However, when the aforementioned series of shaped positive pulses is applied through resistor R45 to the base of transistor T11, transistor T11 is rendered conducting. Current flows from positive source DC11 through transistor T11 and resistor R47 to ground. As will be apparent, timing signal output circuit 44 is an emitter follower current amplifier which applies positive pulses from the junction between the emitter of transistor T11 and resistor R47 through conductor 144 to input terminal I5 of gate signal flip-flop circuit 24 in FIG. 5*b*. One such series of positive output pulses is supplied through conductor 144 each time armature 114 of pulse generator 62 sweeps past coil 62*f*. As shown by the circuit multiples in the left-hand and right-hand portions of FIG. 5*c*, twelve timing signal circuits similar to that shown therein are provided for producing timing pulses at different angular positions of the pulse generator and consequently at different angular positions of press rotation.

The purpose of the loss of sheet detector circuit shown in FIGS. 5*a* and 5*b* is to produce a positive electrical signal each time the absence of a sheet or the displacement of a sheet of paper causes the gripper fingers to short out. Electromagnets EM1 and EM2 shown in FIGS. 3*b* and 5*a* rotate with the transfer cylinder and once per revolution each of these electromagnets is directly opposite electromagnet EM3 and separated therefrom by a small air gap. Armature 114 of the pulse generator also rotates with the press and once per revolution of advance cylinder AC is directly opposite one of the coils such as 62*f* of a timing signal circuit. These rotations are synchronized so that a timing signal is produced only at the time that gripper fingers close and a loss of sheet detector electromagnet is passing by its associated stationary electromagnet. The purpose of the timing signal pulse is to render the loss of sheet circuit operable only in response to closure of the gripper fingers indicative of a lost sheet. At other times, the loss of sheet circuit is maintained incapable of responding to extraneous signals, such as for example, signals produced by unbalancing of loss of sheet detector bridge circuit 16 when electromagnet EM1 moves away from electromagnet EM3.

Referring to gate signal flip-flop circuit 24 in FIG. 5*b*, it may be assumed that transistor T13 is normally in its conducting state whereby current flows from ground potential through transistor T13 and resistor R49 to negative source DC13. Such conduction of transistor T13 places the collector thereof at substantially ground potential whereas the collector of transistor T12 in its non-conducting state is near the potential of negative source DC13. As a result, relatively less current flows from positive source DC14 through resistors R50, R53 and R49 to negative source DC13 and relatively more current flows from positive source DC14 through resistors R51, R52 and R48 to negative source DC13. Consequently the voltage applied from the junction of resistors R51 and R52 to the base of transistor T13 is negative relative to ground to maintain transistor T13 conducting. On the other hand, the voltage applied from the junction of resistors R50 and R53 to the base of transistor T12 is positive relative to ground potential to maintain transistor T12 non-conducting. Under these conditions, wherein the collector of transistor T13 is at substantially ground potential, no output voltage is applied from gate signal flip-flop circuit 24 to gate signal timer circuit 26.

When the aforementioned positive voltage timing pulse is applied from the timing signal circuit in FIG. 5*c* through conductor 144 and input terminal I5 and resistor R54 to the base of transistor T13, the latter is rendered non-conducting. This causes the collector of transistor T13 to go negative and a negative voltage is applied from the junction of resistors R50 and R53 to the base of transistor T12 to render the latter conducting. A negative voltage pulse is also applied from the collector of transistor T13 through coupling capacitor C12 and resistor R63 to the base of transistor T15 in gate signal timer circuit 26.

Gate signal timer circuit 26 is a one-shot multivibrator circuit wherein transistor T14 is normally biased to its conducting condition by the voltage drop across resistor R58 caused by current flow from ground potential through resistor R58 and resistor R62 to negative source DC15. Transistor T15 is normally biased to its off condition by a voltage applied from positive direct current source DC16 through resistor R60 to the base of transistor T15. Since transistor T15 is biased to its non-conducting condition as aforementioned, current flows from ground potential in trigger circuit 18 through resistor R21 and conductor 148 and resistor R57 to negative source DC15. Under this condition, the voltage on conductor 148 and on the base of transistor T4 is substantially four volts negative, this voltage being caused by the drop across resistor R21. The voltage on the emitter of transistor T4 is about one volt positive caused by the drop across resistor R17. As will be apparent, the voltage drop across resistor R21 biases the base of transiscuit in FIG. 5*c* is to remove this negative bias so that trigger circuit 18 will not respond to an input signal. The purpose of the timing signals derived from the cir-

cuit in FIG. 5c is to remove this negative bias so that trigger circuit 18 can respond to a loss of sheet signal at predetermined times.

When the aforementioned negative pulse is applied from gate signal flip-flop circuit 24 through resistor R63 to the base of transistor T15, the latter is rendered conducting and transistor T14 is held in the off condition for the duration of such pulse. As a result, current flows from ground potential through transistor T15 and then in a first branch through resistor R57 and in a second branch through capacitor C13 and resistor R62 to negative source DC15. Such conduction of transistor T15 also causes the voltage on conductor 148 to go to ground potential so that the negative bias is removed from the base of transistor T4 in the trigger circuit. The aforementioned current flow in the second branch charges capacitor C13 in the direction depicted by the positive and negative symbols. Capacitor C13 and resistor R62 constitute a timing circuit for stretching the output pulse from transistor T15 of the gate signal timer circuit to the desired gating interval. At the end of the desired output pulse of gate signal timer circuit 26, transistor T15 is again rendered non-conducting and transistor T14 is rendered conducting and at this time the negative bias will be reapplied to the base of transistor T4 in trigger circuit 18.

Referring to trigger circuit 18 in FIG. 5b, let it be assumed that a loss of sheet signal is applied to the base of transistor T4 during the time that the negative bias voltage is removed therefrom by operation of gate signal timer circuit 26. As a result, the trigger circuit is operated by the loss of sheet signal to provide an output signal as shown graphically by the waves in FIG. 6. Wave 150 shows the form of the output signal of LOS2 detector bridge circuit 16 as electromagnet EM1 passes by electromagnet EM3. It will be recalled that the LOS2 detector bridge was balanced for the condition when electromagnet EM1 was directly opposite and in line with electromagnet EM3. Therefore, as shown by the left-hand portion of wave 150, the detector bridge is unbalanced when the electromagnets are displaced from one another and provide an output signal which gradually decreases in amplitude as electromagnet EM1 approaches electromagnet EM3. As shown by the right-hand portion of wave 150, the detector bridge output signal gradually increases in amplitude as electromagnet EM1 leaves electromagnet EM3. Wave 150 oscillates about an axis 150a which is negative relative to zero or ground potential. This negative position of such axis is provided by the aforementioned negative bias normally applied to the base of transistor T4 in trigger circuit 18.

The dotted line midportion of wave 150 depicts the base voltage of transistor T4 if the negative bias were to remain thereon when electromagnet EM1 passes by electromagnet EM3 and a gripper finger does not make electrical engagement with its stationary contact in FIG. 5a.

Wave 152 in FIG. 6 shows the effect of the gating signal (removal of the negative bias) on the input to the trigger circuit. When the gating signal applied from gate signal timer 26 removes the negative bias voltage from the base of transistor T4, the bias voltage on the base of transistor T4 increases to zero value for the duration of the gating signal as shown by wave 152. However, this small signal is not sufficient to operate trigger circuit 18 because the emitter of transistor T4 is connected through resistor R17 to ground potential.

Wave 154 shows the effect of a loss of sheet signal on the input signal to trigger circuit 18. When a sheet is misplaced and a gripper finger TG1 in FIG. 5a makes electrical engagement with contact N to short circuit coil 84, the LOS2 detector bridge circuit 16 becomes unbalanced to provide a signal indicated by wave 154 on the base of transistor T4 in trigger circuit 18.

Normally, transistor T5 conducts due to forward biasing from a positive source DC4 through resistors R16, R19 and R20 to ground. A voltage is applied from the junction of resistors R19 and R20 to maintain the base of transistor T5 positive relative to the emitter thereof. As a result, transistor T5 conducts and current flows from source DC4 through resistor R18, transistor T5 and resistor R17 to ground. The voltage drop across resistor R17 maintains the emitter voltage of transistor T4 slightly above ground potential so that transistor T4 will not conduct until the base input voltage thereof reaches or exceeds the slightly positive emitter voltage. During the normal conduction of transistor T5, the collector of the latter has a small positive voltage whereby current flows through resistors R22 and R23 of signal leveler circuit 20 to negative source DC5. A negative voltage is applied from the junction of resistors R22 and R23 to the base of transistor T6 to maintain the latter non-conducting.

When the loss of sheet signal depicted by curve 154 in FIG. 6 is applied to the base of transistor T4 during the application of the gating signal thereto, transistor T4 is rendered conducting. Current flows from positive source DC4 through resistor R16, transistor T4 and resistor R17 to ground. Transistor T4 regeneratively turns off transistor T5. That is, conduction in transistor T4 causes the collector thereof to shift to the voltage level of the emitter of transistor T5. Such collector voltage causes the voltage at the base of transistor T5 to become less positive than its emitter voltage whereby to turn transistor T5 off. As a result, the output voltage of the trigger circuit taken from the collector of transistor T5 goes positive to cause transistor T6 in signal leveler circuit 20 to conduct. When the loss of sheet signal terminates, trigger circuit 18 assumes its original condition wherein transistor T5 conducts and transistor T4 does not conduct.

It will be apparent from the foregoing that trigger circuit 18 provides a positive output voltage pulse whose reference level is slightly above ground potential. The purpose of signal leveler circuit 20 is to bring the trigger circuit output pulse back to ground reference level and to amplify the same whereby to provide a proper signal for driving output flip-flop circuit 22. In signal leveler circuit 20, current flows from positive source DC6 through resistors R24 and R25 to ground. When transistor T6 is rendered conducting as aforementioned, current also flows from source DC6 through resistor R24, transistor T6 and resistor R26 to ground. As a result, a positive output pulse proportional to the voltage drop across resistor R26 to ground is applied from the emitter of transistor T6 to output flip-flop circuit 22.

In output flip-flop circuit 22 in FIG. 5b, either transistor T7 or T8 conducts at all times. Let it be assumed that when the flip-flop circuit is operated in response to an input pulse, transistor T7 conducts and transistor T8 does not conduct. When the flip-flop circuit is preset or reset, transistor T8 conducts and transistor T7 does not conduct. The flip-flop circuit may be manually preset by turning selector switch SS in FIG. 5a momentarily to its "off" position as aforementioned. This causes a positive voltage to be applied from source DC3 in FIG. 5a through the movable contact and stationary contact OFF of selector switch level SS2, resistor R14, conductor 136 and resistor R34 to the base of transistor T8 to render the latter conducting. As a result, current flows from positive source DC7 through resistor R28 and through transistor T8 to ground. Since the voltage drop across transistor T8 while conducting is negligible, ground potential appears at the collector of transistor T8 so that no effective output voltage is applied to output terminal O4. This ground potential also causes current flow through resistors R30 and R31 to negative source DC8. A negative voltage is applied from the junction of resistors R30 and R31 to the base of transistor T7 to maintain the latter non-conducting. Current flows from positive source DC7 through resistors R27, R29 and R32 to negative source

DC8. This current flow causes a positive voltage to be applied from the junction of resistors R29 and R32 to the base of transistor T8 to maintain the latter conducting after selector switch SS in FIG. 5*a* is turned from "OFF" position.

The output signal derived from signal leveler circuit 20 consisits of a series of substantially square wave positive voltage pulses having a ground reference level. This signal is applied through coupling capacitor C8 and resistor R33 to the base of transistor T7 to render the latter conducting whereby to provide an output signal from flip-flop circuit 22. Normally, when transistor T7 does not conduct, positive voltage is applied from source DC7 through resistor R27 to indicator output terminal O3. When transistor T7 is rendered conducting as aforesaid, the voltage at output terminal O3 drops to ground. Conduction of transistor T7 causes sufficient current flow through resistor R37, lamp W and through transistor T7 to ignite lamp W thereby to indicate a lost sheet condition. However, lamp W is preferably employed to indicate the conducting condition of transistor T7 and a suitable indicator circuit or alarm may be connected to output terminal O3 to indicate the lost sheet condition. For this purpose, the shift in voltage from positive to ground on output terminal O3 in response to a signal from signal leveler circuit 20 may be employed to operate a transistor amplifier or the like to activate a visual or audible alarm or alarm-operating relay.

The aforementioned conduction of transistor T7 in the output flip-flop circuit causes transistor T8 to stop conducting. When transistor T7 starts conducting, its collector goes to ground potential. Accordingly, the positive voltage previously applied from the junction of resistors R29 and R32 to the base of transistor T8 shifts to a negative value to stop transistor T8 from conducting. As a result, the ground potential which previously appeared at output terminal O4 shifts to a positive value to provide a positive output voltage which may operate a control circuit or the like to perform some useful function when a lost sheet has been detected. For example, such output voltage may stop the feeding of sheets into the press or separate and relieve pressure from the printing cylinders so that their surfaces will not be damaged by a misplaced sheet. For this purpose, the positive output signal at output terminal O4 may be used to operate transistor logic circuits or the like to initiate the desired control functions.

After the 155 degree trip signal has been applied (at 155 degrees of the second revolution or 515 degrees) to gate trigger circuit 18 for operation, as pulse generator 62 continues its rotation, a 180 degree reset signal is applied (at 180 degrees of the second revolution or 540 degrees) from the timing signal circuit connected to conductor 7 in FIG. 5*c* through conductor 146 to input terminal I6 of gate signal flip-flop circuit 24 in FIG. 5*b*. This positive reset signal is applied through resistor R55 to the base of transistor T12 to render the latter non-conducting. As a result, the collector voltage of transistor T12 shifts from ground to negative voltage. This causes a negative voltage to be applied from the junction of resistor R51 and resistor R52 to the base of transistor T13 to render the latter conducting. Transistor T13 then continues to conduct and transistor T12 remains non-conducting until another trip signal is applied to input terminal I5 on the next revolution of the pulse generator.

In the event a loss of sheet signal has operated circuit LOS2 as hereinbefore described, it will be necessary to restore output flip-flop circuit 22 in FIG. 5*b* to its original condition. For this purpose, a 335 degree preset signal is applied from the timing signal circuit connected to conductor 12 in FIG. 5*c* through conductor 138 and resistor R35 to the base of transistor T8 in FIG. 5*b*. This causes transistor T8 to conduct and to render transistor T7 non-conducting whereby to restore output flip-flop circuit 22 to its original condition.

As shown in FIG. 5*b*, an auxiliary preset control voltage may be applied through conductor 66 and resistor R36 to the base of transistor T8. This connection may be used to preset the output flip-flop circuit or to maintain the latter ineffective and unresponsive to gripper finger closure in certain applications where loss of sheet circuit control is not desired. As will be apparent, application of a positive voltage to conductor 66 will maintain the output flip-flop circuit inoperative.

The functional details of the master oscillator and one loss of sheet detector circuit and one timing signal circuit having been described in connection with FIGS. 5*a–c*, reference may now be had to FIGS. 1, 2 and 3*a* in connection with a description of operation of the entire system and the manner in which improper registrations of each sheet are detected at a plurality of points as each sheet travels through the plural-unit press.

Referring to FIG. 3*a*, it may be assumed that loss of sheet detector circuit LOS1 (FIG. 1) is coupled through an electromagnetic air gap to gripper finger set FG once per revolution of feed cylinder FC which is located ahead of press Unit 1. Detector circuit LOS2 is coupled to gripper finger sets TG1 and TG2 on alternate half revolutions of transfer cylinder TC which is located between press units 1 and 2 as hereinbefore described. And detector circuits LOS3 through LOS6 are coupled in the same manner as detector circuit LOS2, to the pairs of gripper finger sets on the respectively succeeding transfer cylinders between press units 2–3, 3–4, 4–5 and 5–6.

With the above connection arrangement in mind, it will become apparent by reference to the timing sequence diagram in FIG. 2 how the timing signal circuits supplied from connections 1 through 8 and 10 through 12 in FIG. 1 are in turn connected to the six loss of sheet circuits LOS1–LOS6 to supply trip, reset and preset timing signals thereto. As hereinbefore described in connection with FIGS. 5*a–c*, each loss of sheet circuit requires a trip signal to condition its trigger circuit for response to a loss of sheet signal, a reset signal to restore the gate signal flip-flop circuit to its original state and a preset signal to restore the output flip-flop circuit to its original state. Although output flip-flop circuit 22 need not be flopped to its original state by a preset signal unless it has theretofore been flipped by a loss of sheet signal, nevertheless it is simpler to apply preset signals regularly to insure that circuit 22 is always ready to respond to a loss of sheet signal in the event one should arrive.

In FIG. 2, reference characters have been employed which are indicative of the six loss of sheet circuits and their trip, reset and preset control signals. For example, 0–1 indicates circuit LOS1 which is ahead of the first press unit, that is, associated with feed cylinder FC. Similarly, 1–2, 2–3, 3–4, 4–5 and 5–6 indicate circuits LOS2 through LOS6, respectively, which are associated with the succeeding transfer cylinders between press units 1 and 2, 2 and 3, 3 and 4, 4 and 5, 5 and 6, respectively. LT, LR and LP indicate trip, reset and preset signals, respectively. Thus, 0–1LT indicates a trip signal to loss of sheet circuit LOS1 and its location at 95 degrees indicates that such trip signal is obtained from the timing signal circuit connected to conductor 4 in FIG. 5*c*, 0–1LR indicates a reset signal to loss of sheet circuit LOS1 and its location at 120 degrees on the timing diagram of FIG. 2 indicates that such reset signal is obtained from the timing signal circuit connected to conductor 5 in FIG. 5*c*. And 1–2LP indicates a preset signal to loss of sheet circuit LOS2 and its location at 335 degrees on the timing diagram of FIG. 2 indicates that such preset signal is obtained from the timing signal circuit connected to conductor 12 in FIG. 5*c*.

To avoid complicating FIG. 2 with excessive reference characters, only the signals involved with passage of one sheet through a six unit press have been shown therein. However, it will be understood that the signals indicated thereon are actually applied on each revolution of the

pulse generator. Also, although not indicated in FIG. 2, it will be apparent that whereas the output flip-flop circuit of circuit LOS1 is initially preset under manual control as hereinbefore described, following starting of the press a preset signal is applied thereto 180 degrees ahead of each trip signal thereof after the first trip signal, such trip signal being applied from the timing signal circuit connected to conductor **10** in FIG. 5*c*.

The spiral line in FIG. 2 starting from 0 degrees and going in the clockwise direction indicates press rotation. Each 360 degrees of such spiral line is equal to one revolution of a press unit which is also equal to one revolution of pulse generator 62. And for each revolution of the pulse generator, the transfer cylinder rotates one-half a revolution.

Starting from 0 degrees in FIG. 2 and following the spiral line clockwise, at 95 degrees feed cylinder FC in FIG. 3*a* has rotated to a position wherein gripper fingers FG thereof receive a sheet from feed table FT and grip the leading edge thereof to sense its registration. At the same time, the electromagnet mounted on the feed cylinder passes by its associated stationary electromagnet to null the bridge in loss of sheet circuit LOS1. At the same time, the timing signal circuit connected to conductor 4 in FIG. 5*c* applies trip signal **0–1LT** (FIG. 2) through the gate signal flip-flop and gate signal timer to the trigger circuit of loss of sheet circuit LOS1. If the sheet is properly registered so that it maintains the gripper fingers electrically insulated from their associated contacts, a loss of sheet output signal is not produced. If the sheet is not properly registered so that at least one gripper finger makes contact, loss of sheet circuit LOS1 provides an output signal.

Continuing along the spiral line in FIG. 2 at 120 degrees reset signal **0–1LR** is applied from the timing signal circuit connected to conductor **5** in FIG. 5*c* to reset the gate signal flip-flop circuit in loss of sheet circuit LOS1. During this time, feed cylinder FC moves the sheet counterclockwise to advance cylinder AC. Gripper fingers FG release the sheet and its leading edge is gripped by gripper fingers AG whereby the advance cylinder rotates the sheet clockwise to impression cylinder IG. Gripper fingers AG release the sheet and it is gripped by gripper fingers IG and drawn between the impression and blanket cylinders to be printed. During this movement of the sheet, at 335 degrees, preset signal **1–2LP** is applied from the timing signal circuit connected to conductor **12** in FIG. 5*c* to preset the output flip-flop circuit of loss of sheet circuit LOS2.

It takes 420 degrees of press rotation to move the sheet from feed cylinder FC through the first press unit to transfer cylinder TC. Thus, at 515 degrees (420 degrees from trip signal **0–1LT**) trip signal **1–2LT** is applied to loss of sheet circuit LOS2 which is associated with gripper fingers TG1 and TG2 on transfer cylinder TC. At the same time, gripper fingers TG1 close and electromagnet EM1 passes by electromagnet EM3 to null detector bridge **16**. Gripper fingers TG1 sense the sheet registration and circuit LOS2 produces an output signal if it is misplaced as hereinbefore described. At 540 degrees, reset signal **1–2LR** resets gate signal flip-flop circuit 24. At 995 degrees, preset signal **2–3LP** presets the output flip-flop circuit in loss of sheet circuit LOS3.

It takes 660 degrees to move the sheet from one press unit through the next press unit. Thus, a 1175 degrees (660 degrees from trip signal **1–2LT**) trip signal **2–3LT** is applied to loss of sheet circuit LOS3 when the gripper fingers on the next transfer cylinder close and the electromagnets associated with the latter pass one another.

In a similar manner, trip signals **3–4LT**, **4–5LT** and **5–6LT** are applied in 660 degree steps following trip signal **2–3LT** as shown in FIG. 2. Reset signals **3–4LR**, **4–5LR** and **5–6LR** are applied 25 degrees after the associated trip signals. And preset signals **3–4LP**, **4–5LP** and **5–6LP** are applied 180 degrees ahead of the associated trip signals. It will be apparent that no timing signals are shown in FIG. 2 at the 240 degree position. Thus, a timing signal circuit need not be connected to conductor **9** in FIG. 5*c* for a six unit press. However, if the press has seven or more units, such timing signal circuit will also be required.

We claim:

1. In article processing apparatus having means for moving precisely positioned, spaced apart articles through a plurality of stations in succession for treatment; means for detecting displaced articles and for providing output signals in response thereto for control of said apparatus comprising:

a plurality of detector means operating in synchronism with said moving means and being effective to detect unwanted displacements of the articles at points ahead of said stations and to prepare for transmission of detection signals;

a plurality of circuit means for the respective detector means responsive to input detection signals when conditioned therefor for providing output control signals to initiate control of said apparatus;

means operating in synchronism with said moving means for providing repetitive timing signals including trip signals and restoration signals for said circuit means, some of said timing signals being usable as trip signals or restoration signals for more than one circuit means depending upon the distance between said detection points;

means responsive to each said trip signal for conditioning for a timed interval the associated circuit means so that it can respond to a detection signal if applied thereto;

means operating in synchronism with said moving means for momentarily coupling each detector means to its associated circuit means during said timed interval to transmit a detection signal whereby to afford operation of said circuit means only when said displacement is initially detected thereby to prevent operation of said circuit means by extraneous signals;

and means responsive to said restoration signals for restoring each operated circuit means to its former condition a pretermined time after it has been operated thereby to terminate its output control signal and to prepare it for reoperation.

2. In article processing apparatus having means for moving precisely positioned and spaced apart articles through a plurality of work stations in succession for treatments and including gripper devices ahead of each station for gripping the articles as they are introduced into the stations whereby to maintain the articles in precise registration for said treatments; means for utilizing said gripper devices for sensing displaced articles and responding thereto to provide output signals for control of the respective stations comprising:

a plurality of detector means employing respective ones of said gripper devices for detecting undesired displacements of the articles from their correct positions and operating in synchronism with said moving means to prepare for transmission of detection signals when such displacements are detected;

a plurality of control circuits for the respective detector means responsive to detection signals if conditioned therefor for providing output control signals to initiate control of the respective work station apparatus;

means operating in synchronism with said moving means for providing repetitive timing signals for the respective control circuits to condition for a timed interval each control circuit at predetermined times so that it can respond to a detection signal if applied thereto;

and means operating in synchronism with said moving

means for momentarily coupling each detector means to the associated one of said control circuits during said timed interval to transmit a detection signal whereby to afford operation of such control circuit only when said displacement is initially detected thereby to prevent operation of said control circuits by extraneous signals.

3. The invention defined in claim 2, wherein said article is a flat member and said detector means comprises:

electrically conductive gripper elements movable with said moving means and being operable to grip an edge of said flat member to move the latter;

and means responsive to short circuiting of said gripper elements indicating that the edge of the sheet is not therebetween for closing a signal circuit.

4. The invention defined in claim 2, wherein said means for momentarily coupling each detector means to its associated control circuit comprises:

radiant energy control means comprising a stationary device connected to said control circuit and energized from said source to provide radiant energy;

and a movable device mounted on said moving means so as to pass through said radiant energy thereby to cause said stationary device to apply a detection signal to operate said control circuit.

5. The invention defined in claim 2, wherein said means for momentarily coupling each detector means to its associated control circuit comprises:

a stationary electromagnet connected to said control circuit and energized from said source to provide an electromagnetic field;

a movable electromagnet connected to said detector means and movable with said moving means in close air gap relation to said stationary electromagnet to alter the magnetic field of the latter in response to detection of a displaced article by an associated gripper device.

6. The invention defined in claim 5, wherein said control circuit comprises:

a bridge circuit balanced to provide no control signal when said movable electromagnet is passing by said stationary electromagnet and a displaced article is not being detected;

said bridge circuit providing an unwanted control signal when said electromagnets are displaced from one another;

and means to prevent said unwanted control signal from producing an output signal from said control circuit in the absence of a timing signal.

7. The invention defined in claim 6, wherein said preventing means comprises:

a static switching circuit normally biased to cutoff to prevent operation thereof;

and means for applying a timed pulse from said timing signal producing means to counteract said cutoff bias.

8. In a machine having a plurality of processing units arranged in consecutive relation and being operable in synchronism with one another to perform a plurality of successive work steps on articles passed successively therethrough, and an input device for feeding articles intermittently into the first unit, each said unit comprising a transfer device for transferring the articles from it to the next unit and away from the last unit, and each said unit also comprising article engaging means periodically operable to insure movement of successive articles in synchronism with machine operation; the improvement comprising:

loss of article detecting means for providing an electrical output signal whenever said article engaging means upon being operated fails to engage an out-of-position article, comprising:

an electrical power supply source;

a stationary electromagnetic device;

a movable electromagnetic device connected to said article engaging means and being arranged to move in close magnetic field proximity to said stationary electromagnetic device in synchronism with movement of the articles;

control signal developing means connecting said source to said stationary electromagnetic device and being adjusted to provide no control signal when said movable electromagnetic device is passing in close proximity to said stationary electromagnetic and said article engaging means engages an article, said control signal developing means being effective to provide a control signal when said movable electromagnetic device is passing in close proximity to said stationary electromagnetic device and said article engaging means fails to engage an out-of-position article, and said control signal developing means being also effective to provide an unwanted signal when said movable electromagnetic means is displaced from said stationary electromagnetic means;

and means for causing only said control signal to provide an output signal indicative of an out-of-position article and for preventing said unwanted signal from providing an output signal comprising:

output signal means connected to said control signal development means;

means normally maintaining said output signal means ineffective so that it will not respond either to said control signal or said unwanted signal;

a timing signal circuit supplied from said source and being adjusted normally to provide no timing signal;

a pulse generator operated in synchronism with said machine and being connected to cause said timing signal circuit to provide a timing signal at the same time as said movable electromagnetic device is passing in close proximity to said stationary electromagnetic device;

and means connecting said timing signal circuit to said output signal means whereby said timing signal renders the latter responsive to said control signal thereby to provide an output signal only when said movable electromagnetic device is passing in close proximity to said stationary electromagnetic device and said article engaging means fails to engage an out-of-position article.

9. In a plural-unit printing press of the type having sets of gripper fingers on the cylinders which feed the sheets into the first unit of the press and on the transfer cylinders between press units for gripping the sheets against the cylinders to maintain them in proper registration for printing, the improvement comprising:

a loss of sheet detector system utilizing at least one set of the gripper fingers ahead of each press unit for sensing an out-of-registration condition of the sheets comprising:

a loss of sheet circuit for each said set of sensing gripper fingers;

an alternating current source common to said loss of sheet circuits for energizing the same;

a plurality of timing signal circuits commonly supplied from said source;

and a pulse generator driven in synchronism with the press for operating said timing signal circuits in predetermined time relation for each revolution of a press unit thereby to provide spaced timing signals for controlling said loss of sheet circuits;

said predetermined time relation being such that a timing signal is applied as a trip signal to each loss of sheet circuit each time the associated set of gripper fingers closes;

each said loss of sheet circuit comprising:

electrical contacts on the cylinder for conductive engagement by one or more gripper fingers when a sheet is in an out-of-registration condition, the sheet insulating the contacts from the gripper fingers when in proper registration;

an electromagnetic coil rotating with the cylinder to

be short-circuited by a gripper finger engaging a contact to indicate a lost sheet condition;

a bridge circuit supplied from said source and having a stationary electromagnetic coil in a branch thereof to develop an electromagnetic field in the path of the rotating coil, said bridge circuit being balanced for minimum signal when said coils are nearest one another and all gripper fingers of the associated set are insulated from their contacts whereby said bridge circuit provides a lost sheet signal when at least one gripper finger makes contact and provides an unwanted signal when the coils are displaced from one another;

a static switching circuit connected to said bridge circuit and being inhibited to prevent said unwanted signal from operating the same;

and means for applying a control signal from one of said timing signal circuits to uninhibit said static switching circuit for a timed interval following closure of said gripper fingers thereby to allow said static switching circuit to respond to a lost sheet signal if at least one gripper finger makes contact and to prevent operation thereof by extraneous signals at other times;

and output means responsive to operation of said static switching circuit for providing an output signal from said loss of sheet circuit.

10. The invention defined in claim **9**, wherein said means for applying an uninhibiting signal comprises:

a flip-flop circuit responsive to the signal from said one timing signal circuit;

a one shot multi-vibrator circuit responsive to said flip-flop circuit for supplying said uninhibiting signal;

and means in said one shot multi-vibrator circuit for maintaining said uninhibiting signal for a timed interval.

11. The invention defined in claim **10**, wherein:

another one of said timing signal circuits is connected to apply a resetting signal to said flip-flop circuit after it has been operated as aforesaid to reset the same for response to another signal from said one timing signal circuit on the next revolution of the pulse generator.

12. The invention defined in claim **9**, wherein said output means comprises:

an output flip-flop circuit responsive to operation of said static switching circuit to provide an output signal;

said static switching circuit being of the self-restoring type;

and means connecting a third one of said timing signal circuits to apply a presetting signal to said output flip-flop circuit before it has been operated as aforesaid to preset the same for response to operation of said static switching circuit.

13. The invention defined in claim **9**, wherein said alternating current source comprises:

an oscillator having a frequency in the audio frequency range above commercial power frequency.

14. The invention defined in claim **9**, wherein said pulse generator comprises:

a drum driven in synchronism with press unit rotation;

an armature of magnetizable material secured to the periphery of said drum;

a plurality of electromagnetic pickup coils arranged at fixed points around said drum to be traversed by said armature in sequence on each revolution of the drum;

and said pickup coils being energized from said common source through the respective timing signal circuits.

15. The invention defined in claim **2**, wherein each said control circuit comprises:

an output flip-flop circuit operable to change its state in response to a detection signal applied thereto to provide said output control signal;

and means for utilizing one of said timing signals to restore said output flip-flop circuit to its former state after it has transmitted an output control signal.

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