

[54] MACHINE OPERATION DETECTION
APPARATUS

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[58] Field of Search **83/61, 165, 359, 522;
113/116; 192/125 A; 200/61.41**

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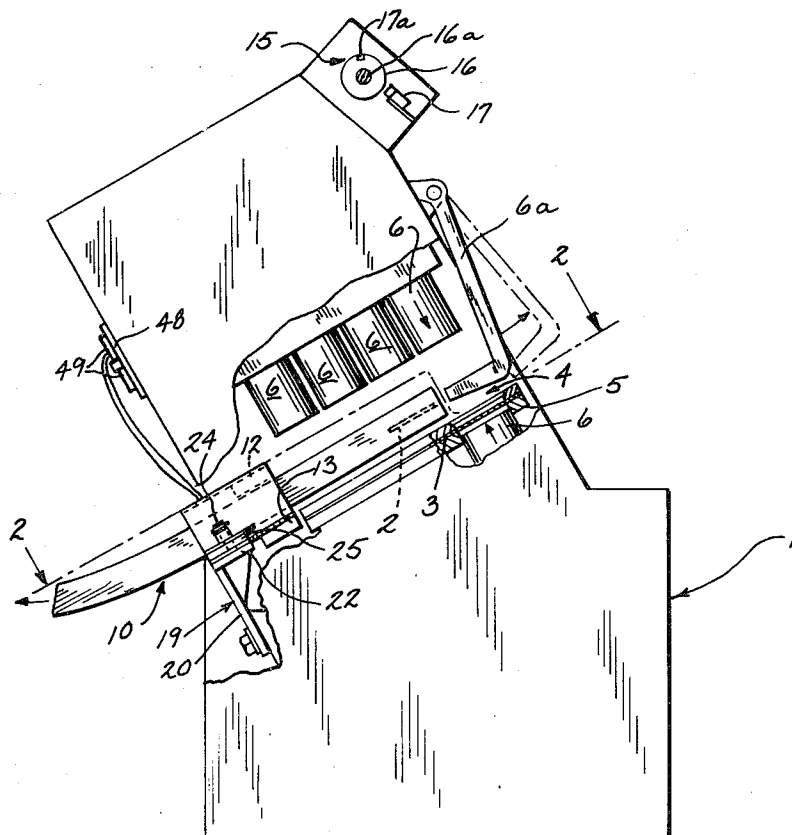
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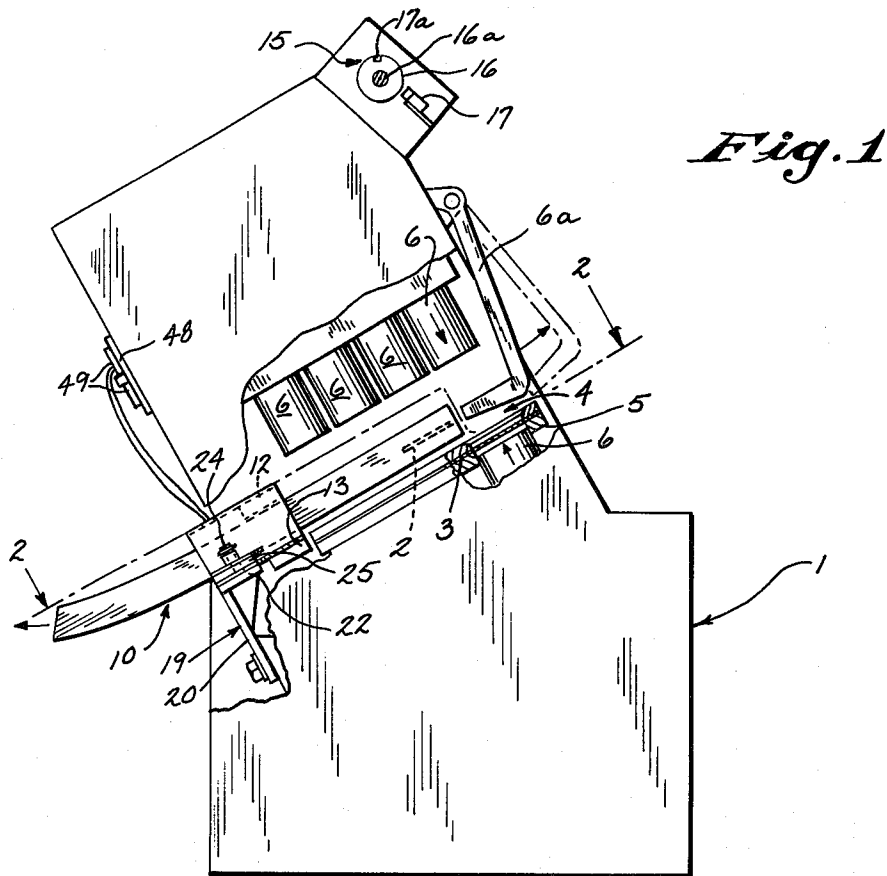
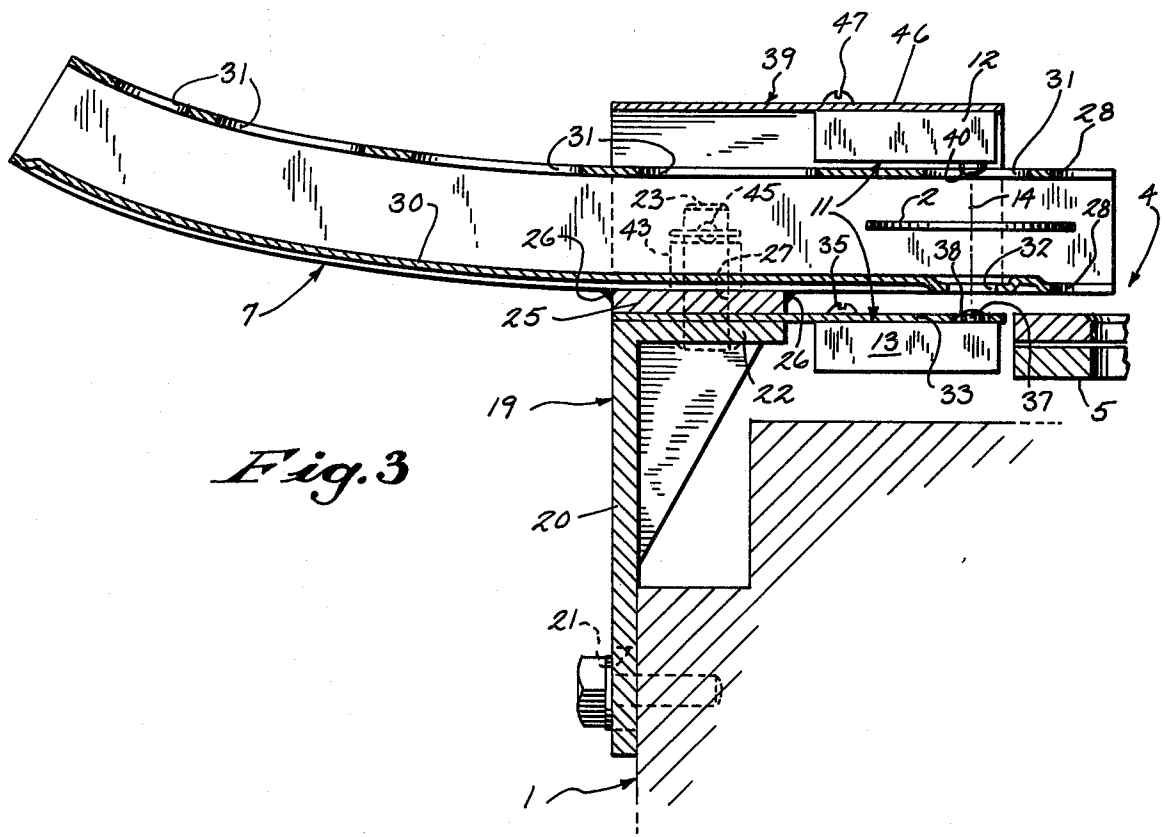
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ABSTRACT

A forming gang press includes a plurality of punch and die units to form flat blanks which discharge laterally through discharge chutes with means to monitor the failure of a die unit to discharge a blank. Each chute has a photocell establishing a beam perpendicular to the movement of the blank to form a signal per blank discharge. A cycle means is operated in synchronism with the dies to establish operational signals for each cycle of operation of the punch and die units. The detection signals and operational signals are connected to a logic circuit to disable the press if a detection signal and/or an operational signal is not generated for each cycle. The logic circuit uses a set-reset memory to monitor each cycle and a sealed logic gate to monitor the sequence of the signals and provide a sealed output to alarm circuitry to indicate the jammed die unit and to stop the press. The die chutes are supported by a common bracket between a bottom cover and a channel-shaped top cover. The covers carry the photocell source and receivers for alignment with the respective chutes. The covers and bracket are stacked upon a mounting plate on the press with aligned openings mating with mounting pins on the mounting plate and clamped in place by releasable clamping pins passing through openings in the outer ends of the mounting pins.

19 Claims, 5 Drawing Figures





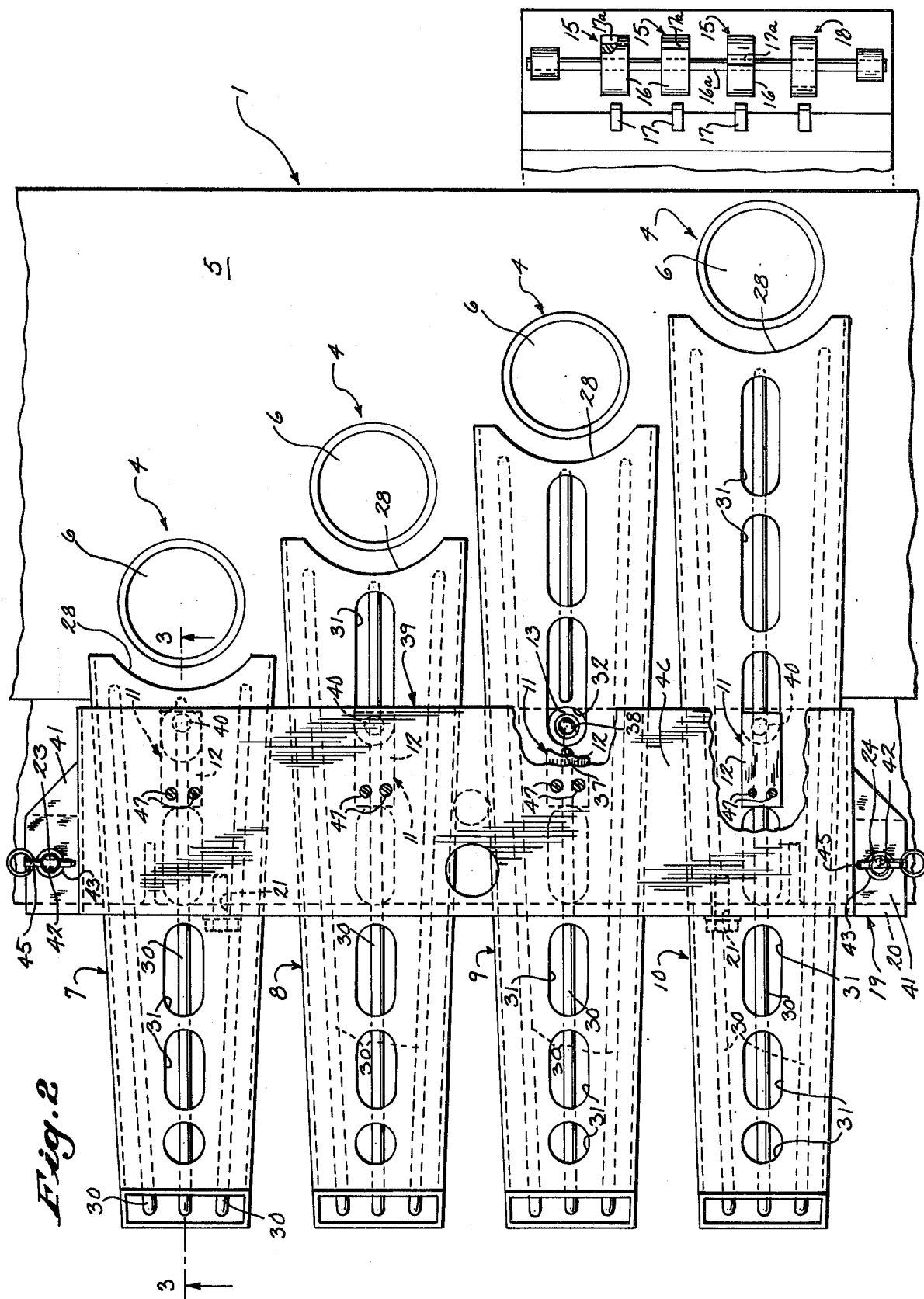


Fig. 4

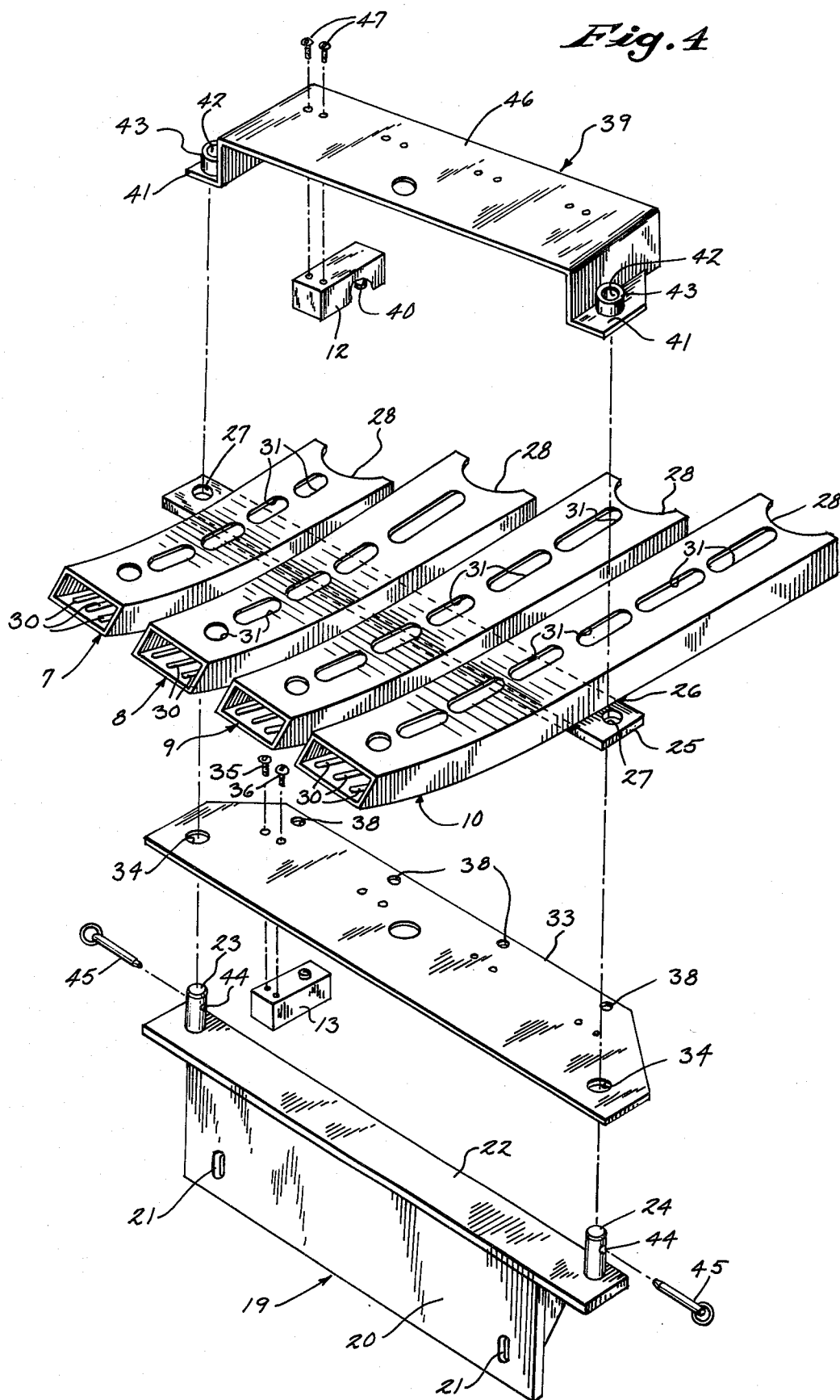
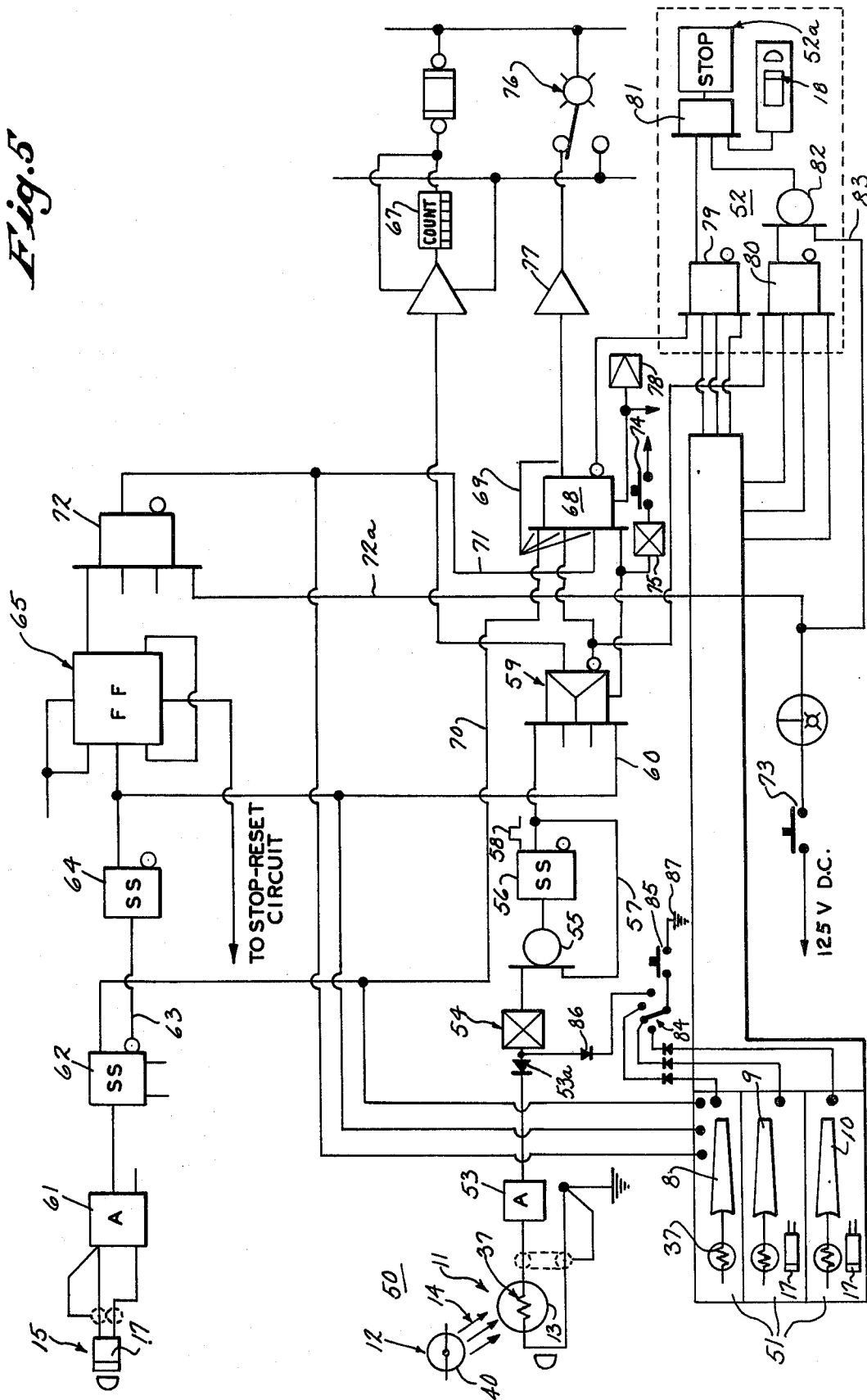


Fig. 5



MACHINE OPERATION DETECTION APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to a machine operation detection apparatus and particularly to a detection apparatus for continuously monitoring the operation of a forming machine such as a die press by sensing of the discharge of the formed work or elements.

In mass production of products, various elements may be formed by automatic cyclical operation of a machine with the formed element automatically discharged and a blank located for the next cycle. For example, in the manufacture of lids for metal cans, a plurality of lid blanks are conveniently formed in a multiple die or gage press, by punching or stamping from a metal sheet of lid stock. The forming press unit operates continuously, with automatic movement of the stock through the press unit in timed relation to the movement of the forming elements. The formed lid blanks are automatically discharged for subsequent processing.

In the operation of the machine, the continuous removal of the formed member is of course essential in order to prevent jamming of the stock in any given forming station of the press unit. Further, in the event of a jamming condition, it is important to rapidly shut down the press and thereby minimize the damage to the apparatus as well as to permit convenient and rapid maintenance. Various pressure responsive jam switches have been employed which respond to varying pressure condition in the event of the stock jamming in a die. Generally, such units have not been completely satisfactory.

SUMMARY OF THE PRESENT INVENTION

The present invention is particularly directed to a detection apparatus for an automatic forming machine by providing a continuous monitoring of the rejection of the formed parts, and in particular on a formed part per stroke timing system. Generally in accordance with the present invention, the part is discharged from the machine along a predetermined path and preferably through a special chute means. An energy beam means establishing an energy beam across or perpendicular to the part path such that a positive interruption of the beam is created by each formed part and results in a detectable signal in a receiver forming a part of the beam means. A sensing circuit is activated in timed relation to the working stroke of the forming machine and further interconnected to the beam receiver to provide an interlocking signal for each interruption of the beam. The positive signal generation in combination with the per stroke timing system has been found to provide a very reliable system for rapidly detecting jamming condition which permits shut down of the press, without excessive damage to the mechanism.

In accordance with a particularly novel feature of the present invention, the formed parts are discharged through a chute member extending from immediately adjacent to the forming mechanism. The element generally passes through the chute member and in the case of relative lightweight elements such as beverage can lids may be airborne and move in spaced relation to the base thereof. The energy beam means includes a light source and a photo-responsive element secured to opposite sides of the chute. Thus the light source and photo-responsive element may be mounted respec-

tively to the top and bottom walls of the chute structure such that the light beam projects downwardly through the chute generally, centrally thereof. As a lid moves down through the chute, it positively interrupts the light beam regardless of the location within the chute structure and thereby generates a positive pulse signal at the photo-responsive unit. The light beam thus provides a complete control over the full depth of the chute and is interrupted even though the lid is airborne.

A proximity sensor is located to sense the working stroke of the forming machine and generates a pulse signal per stroke. The two signals are interconnected through a signal logic processing network or circuit. If a pulse signal is not received from the photo-sensitive element for each pulse signal generated by the related proximity sensor, an output signal is generated to actuate an alarm and/or a stop control which will preferably automatically terminate the operation of the machine as well as provide the necessary alarm condition signal.

A particularly practical application of the present invention, has been in connection with a lid forming machine producing lids for the conventional can for beer, soft drinks and the like. The further description of the invention is therefore set forth in connection with lid blank forming machines having a plurality of die or punch elements mounted for synchronized and simultaneous movement to stamp lid blanks from a suitable sheet metal, which is normally thin aluminum stock.

Individual generally horizontal chutes are provided for removal of the lid blanks from each of the stations. Each of the chutes has a generally rectangular cross section with a width slightly greater than the lid diameter and a depth which is significantly greater than a lid thickness. The chute is provided with an individual photo-cell assembly secured with the beam projecting the depth of the chute for detecting the discharge of a formed lid blank on a per stroke basis. The beam extends across or through the complete depth of the path of the formed member and therefore is positively interrupted regardless of the location of a lid within the depth of such path. The individual photo-cell assemblies and the related forming units are each differently spaced such that the photo-cell signals are generated in a timed sequence. The electronic processing circuitry for combining of the stroke signals and the lid generated signals includes suitable memory means to properly process each pair of interrelated signals even though the forming units signals are simultaneously formed and the photo-sensitive signals are formed in sequence.

In a particularly practical application of the present invention, a ganged press unit is formed with the individual punches offset. The individual chutes terminate in a common discharge location and the chute length is varied in accordance with the position of the corresponding die punch unit. The individual chutes are interconnected to form a chute assembly having a common mounting plate-like member or bracket. A photo-cell and chute support is provided which is preferably releasably attached to the press unit. A bottom photo-cell cover plate is mounted on the common support in stacked relation with the die chute bracket and a top photo-cell cover. The total assembly includes corresponding connecting and locating means such that in the assembled relation the photo-cell lamps and the receivers are accurately located to the opposite sides of the top and bottom of the individual chutes. The locat-

ing means may be in the form of pin members which pass through aligned supporting openings in the several elements. The units are clamped over the pins with suitable quick release pins or the like to permit very rapid and convenient removal of the photo-cell and chute assemblies for maintenance, replacement and the like.

Applicant has found that this assembly provides a particularly practical construction for mass production operation.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings furnished herewith illustrate the best mode presently contemplated by the inventor for carrying out the subject invention in which the above advantages and features are clearly disclosed as well as others which will be readily understood from the description of such illustrated embodiment.

In the drawings:

FIG. 1 is a top elevational view of a lid forming gang press apparatus including a discharge detection means constructed in accordance with the present invention;

FIG. 2 is a side elevational view of the unit shown in FIG. 1;

FIG. 3 is an enlarged vertical section taken generally on line 3—3 of FIG. 1 and more clearly illustrating the detection means;

FIG. 4 is an exploded view illustrating the components of the chute and photo-cell assembly shown in FIGS. 1-3; and

FIG. 5 is a simplified schematic circuit diagram of the signal processing circuit for the press unit shown in FIGS. 1-4.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

Referring to the drawings and particularly to FIGS. 1 and 2, the present invention is illustrated applied to a roll feed gang press apparatus 1 for stamping of flat individual round lid blanks 2 from a sheet stock 3 of suitable material. For example, the individual lid blanks may be formed of a relatively thin gauge aluminum or the like and after formation further processed to form a cover for a beverage can by passing through a suitable curler and other necessary processing equipment. In the illustrated embodiment of the invention, the gang press apparatus 1 includes four forming stations 4, each of which is similarly constructed with an inclined die 5 through which the stock 3 passes. A reciprocating two piece cutter or punch elements 6 is moved perpendicularly of the stock 3 and into the die to cut the individual lid blanks 2 from stock 3, with the lower punch element raising the blank above the top level of the die 5. The several forming elements 6 are moved simultaneously and simultaneously form the individual lid blanks 2. A pivot discharge lever 6a positively wipes the lid blanks 2 from between the punch elements into individual chutes 7, 8, 9 and 10, respectively. Thus, in a practical application for forming beverage can lids each gauge press was operated at three hundred strokes per minute to form a total of twelve hundred lids per minute.

The individual lids 2 are directed by the several chutes 7, 8, 9 and 10 to subsequent processing apparatus. In the illustrated embodiment of the present invention, each of the individual chutes 7 and 10 is provided with a corresponding beam sensing means as photo-cell assembly 11 to detect the movement of a lid 2 through the corresponding chute. Each of the photo-cell assem-

blies 11 is similarly constructed, as more fully shown in FIGS. 2, 3 and 4, and that associated with chute 7 is particularly described. The photo-cell assembly 11 includes a light source 12 mounted to the top of the chute 7 and a photo-sensitive receiver 13 mounted to the bottom of the chute 7 in operative alignment with the source 12. The source 12 establishes a light beam 14 which is directed downwardly through the chute to the receiver 13. Movement of lid 2 through the chute 7 in any vertical position interrupts the light beam 14. The photo-sensitive receiver 13 correspondingly generates an appropriate electrical signal indicating the discharge and movement of the lid through the chute.

In the illustrated embodiment of the invention the movement of each lid blank 2 is detected on a per stroke basis. Three proximity sensor units 15 are provided for producing signals related to the movement of the punch elements 6 at each of the several stations 4. As more fully developed hereinafter, one sensor unit 15 is employed as a common generator for the first two stations. Individual sensor units 15 provide individual stroke signals for the other two stations. This is satisfactory as a result of the electricity circuitry as more fully developed as disclosed in FIG. 5 and described hereinafter.

The illustrated proximity sensor units 15 are similarly constructed and shown in accordance with the teaching of the copending application of Louis J. Handziak Ser. No. 311,763 entitled Rotary Field Switch Means For Machine Apparatus, which was filed on Dec. 4, 1972, and is assigned to the common assignee with this application. Generally, as disclosed more fully in that application, each of the individual sensor unit 15 include a collar member 16 secured to a common shaft 16a driven in synchronism with the die punches 6.

A metal proximity detector 17 is mounted adjacent the periphery of the collar member 16. The collar member 16 is formed of a metal and is provided with a peripheral recess 17a such that each rotation of the collar results in a change in the output of the proximity detector to thereby generate an electrical signal per working stroke of a station 4.

Generally, in accordance with the present invention the signals generated by a photo-cell assembly 11 from each of the chutes 7, 8, 9 and 10 is individually processed with one of the signals from the corresponding proximity sensor. Thus the proximity sensor signal activates the sensing circuitry for the corresponding photo-cell assembly 11. If a proper pulse signal is not generated by interruption of the corresponding beam 14, the output of the receiver 13 activates a circuit to indicate this failure. Applicant has found that this system rapidly responds to a jamming condition in a gang press unit operating at three hundred strokes per minute and permits detection of the condition and terminating of operation before serious damage is encountered.

The press unit 1 is preferably stopped, in the event a jam condition with the upper punch elements 6 at the top of the stroke or cycle. A top position proximity sensor unit 18 is provided as a part of the positive timing assembly. The sensor unit 18 is constructed as each unit 15 to produce a properly timed interlock signal as described in connection with FIG. 5.

In the illustrated embodiment of the invention, the several stations 4 are shown in staggered relation with respect to the several photo-cell assemblies 11 which are mounted in alignment. As a result, the lid blanks 2

must travel different distances through the several chutes 7 through 10 before engaging the photo-cell assemblies 11. This automatically generates timed spaced signals from the several photo-cell assemblies 11.

The several die chutes 7-10, inclusive, and associated photo-cell assemblies 11 are constructed in accordance with a further aspect of this invention as an inter-related die chute and photo-cell assembly in order to provide a convenient and simple means of establishing accurate alignment of the individual sources 12 and receivers 13 and also permitting the rapid and convenient servicing and maintenance of the photo-cell assemblies.

The die chute and photo-cell assembly is mounted with a quick disconnect unit to a die chute mounting unit 19 on the press 1, as follows. The mounting unit 19 is generally an L-shaped member having a front vertical mounting plate 20, for releasable attachment as by attachment bolts to a vertical wall of the press 1. Laterally spaced vertical slots 21 are provided for the mounting bolts and permit adjustment of the upper flat supporting wall plate 22. The support plate 22 of unit 19 extends laterally beyond the location of the individual chutes 7-10 and includes upstanding mounting pins 23 and 24 located one each at the opposite side of the die chutes.

The several chutes 7-10 are secured in laterally spaced relation to a chute bracket 25 as by welds 26 or the like to form an integrated sub-assembly unit. The bracket 25 is a rigid strip or plate which extends laterally beyond the interconnected chutes with end openings 27 spaced in accordance with the lateral spacing of the pins 23 and 24. The bracket 25 is mounted on the pins 23 and 24 and accurately locates the several chutes with respect to the corresponding stations 4.

Each of the chutes 7-10 has a corresponding rectangular cross section with an entrance opening 28 vertically aligned with the discharge position of the forming station 4. The entrance opening is somewhat larger than the maximum diameter of the lid blank 2 and the chute tapers downwardly to a discharge end which is essentially of the width of the lid blank. The depth of the chute is substantially greater than the lid thickness. The entrance end is provided with a curved or cut-out top and bottom wall to permit close spacing of the entrance opening 28 to the forming station 4. The bottom wall of the individual chutes is shown formed raised inwardly slightly as at 30. A plurality of longitudinally spaced top wall openings 31 and at least one bottom wall openings 32 are provided to prevent undesirable characteristics and to permit the free movement of the lid blanks 2 through the chutes, which are discharged from the station and may be airborne in passing through the chute to the discharge end.

The chutes 7-10 are thus similarly formed with the length varied to correspond to the staggering of the stations 4. The photo-cell assemblies 11, however, are mounted in lateral alignment, as follows.

A bottom photo-cell cover 33 rests on support plate 22 and extends beyond the chutes. The illustrated cover 33 is a plate-like member formed of a rigid self-supporting metal or other suitable material and is located immediately beneath the chute bracket 25. The opposite ends of cover 33 have end openings 34 mounted on the mounting and alignment pins 23 and 24. The cover 33 extends toward the die press bed beneath the chute sub-assembly, with the press end por-

tion aligned with the bottom chute wall opening 32. The receivers 13 of the photo-cell assemblies 11 are shown as rectangular block-like elements secured to the underside of the covers 33 by suitable mounting screws 35 and 36. The receiver includes a photo-sensitive cell 37 exposed in the upper wall of the receiver and in alignment with a small opening 38 in the cover 33. The cell 37 is thus exposed through the cover opening 38 and the bottom wall opening 32 to the interior of the chute 7.

The source 12 is shown as a similar block-like element mounted to the top side of the chutes by a top cover 39. The source 12 includes a light element or lamp 40 aligned with the photo-sensitive cell 37 to establish the beam 14, which projects downwardly through top and bottom chute wall openings 31 and 32 onto the photo-sensitive cell 37. The top cover 39 is mounted on pins 23 and 24 to provide automatic and accurate alignment of the source lamps 40 with the several photo-sensitive cells 37.

More particularly, the illustrated cover 39 is generally an inverted channel shaped member having end flanges 41 with openings 42 mating with the mounting pins 23 and 24. Tubular bosses 43 are provided on the flanges 42 with the upper edge of the bosses terminating beneath the upper end of the pins. The pins 23 and 24 are provided with laterally extended locking openings 44 immediately above the upper edges of bosses 43 for receiving a locking pin 45 which abuts against the upper edge of the bosses to firmly clamp the assembly onto the support plate 22 of mounting unit 18.

The top depth of the illustrated top cover 39 is significantly greater than that of the chute 7-10 to locate the top wall or base 46 in upwardly spaced relation from the corresponding chutes 7-10. The sources 12 are each similarly mounted by a pair of mounting screws 47 which pass through the unit and thread into the top wall to accurately locate the lamp 40 in alignment with a cell 37. Lamp sources 12 are particularly secured within the cover in alignment with the corresponding chutes 7-10 for producing the necessary individual beams 14.

The illustrated block-like source and receiver elements may include electronic amplification circuits and the like to produce an amplified signal suitable for driving a logic circuit as presently described.

Each beam 14 completely controls the full depth of each of the individual chutes 7-10. If it is necessary to replace or otherwise service any one of the units, the re-assembly maintains the desired accurate alignment. The quick disconnect bracket construction also provides a very convenient means for rapid maintenance and repair in the event of cell or lamp failure and substantially minimizes press down time.

The several individual sources 12 and receivers 13 are terminated to a common terminal box 48 with suitable quick disconnect receptacles 49 for connection into the signal processing circuit.

A particularly satisfactory signal processing circuitry for providing the desired per stroke monitoring is illustrated in FIG. 5. The illustrated circuit includes individual processing channels with the one channel 50 associated with chute 7 shown schematically in detail and the other channels are shown in block diagram as at 51 because they are essentially identical to channel 50. The output of the four channels 50 and 51 are connected to a signal combining or summing circuit 52, the output

of which is connected to a stop control means 52a for the press and in particular to terminate the press operation in the event of a jamming condition in any one or more of the stations 4.

Referring particularly to channel so for the chute 7, the photo-sensitive cell or element 37 is connected through a suitable shielded cable to an amplifier and signal processing unit 53, which may be a conventional printed circuit board for amplifying the output signal of the cell. The photo-sensitive element 37 is diagrammatically illustrated as a variable photo-resistive element, with the characteristic directly controlled by the illumination thereof. The amplified output signal of unit 53 is coupled by a diode 53a to a logic inverter 54 the output of which, in turn, provides one input to a two input OR gate 55. The output of the OR gate 55, in turn, is connected as the input to a one or single-shot unit 56, the output of which is connected via a feedback line 57 as the second input to the OR gate 55. The feedback allows adjustment of the width of the output pulse of the sensing channel to properly drive the subsequent circuitry. Thus each passage of a lid blank 2 through the beam 14 will interrupt the energization of the photo-resistive element 37 resulting in a change in the conductivity and an amplified output pulse signal which is coupled via the diode 53a and inverter 54 to apply to a positive pulse signal to the OR gate 55. The output of the OR gate 55 applies a related signal to the one shot unit 56 which generates an output pulse signal 58 of a predetermined length and width in response to the input signal.

The output of the signal shot unit 56 is connected as one input to a memory logic unit 59 which is shown as an off-return or set-reset type memory circuit. A reset or transfer input 60 of the unit 59 is controlled by the output of the proximity sensor unit 15 as follows.

The illustrated proximity detector is connected to an amplifier and processing circuit unit 61 to provide an amplified output signal in accordance with the location of the slot 17a in the rotating collar 16. An amplifier pulse signal is generated for each rotation of the slot 17a past the detector 17. The amplified signal is connected to an input of a single shot unit 62 having a "not" output 63 connected to a similar single shot unit 64. The output of the latter single shot unit 64 is connected to the transfer signal input 60 of the memory unit 59 and further to complement input of a complementing flip-flop circuit 65.

The output of the single shot unit 64 controls transfer of the signal established by photo-resistive cell 37 in the memory unit and reset memory unit 59 to provide a conjoint response to the lid discharge on a per stroke basis.

The memory unit 59 has its positive output connected to drive a counter 67 for recording the strokes of the press unit. The memory unit 59 of channel 50 is only connected to drive counter 67, as the other forming elements associated with channels 51 operate in synchronism with channel 50.

The NOT output of each memory unit 59 is connected as a separate input to a first input of an "AND SEALED" logic gate 68. The illustrated gate 68 is a four input unit having three SEALED inputs as shown by the feedback sealing symbol 69 and a single unsealed or reset input as well as a unit reset input. The second SEALED input of the gate 68 is connected by a line 70 to the positive output of the first single shot

unit 62 driven from the proximity detector. The third SEALED input of the gate 68 is driven via line 71 from the output of the flip-flop unit 65, as follows. The positive output of the flip-flop unit 65 is connected as an input to a two input AND gate 72, the positive output of which is connected by line 71 to the third SEALED input of the "SEALED AND" gate 68. The second input of the AND gate 72 is connected to a power sensing input line 72a interconnected to an override and idle control switch 73.

In accordance with conventional sealed AND logic, an output is produced when all of the inputs of gate 68 are energized. The output is further continued even though one or all of the SEALED input signals is removed. The fourth or reset input of gate 68 is connected by a lead to a stop reset switch 74 through an inverter 75 and is normally energized. When a malfunction occurs, with gate 68 sealed, the switch 74 must be actuated to remove the signal from line 73 and reset the AND gate 68. This resets all memory units 59 to an initial condition, also.

Once reset all must once again be energized to produce an output. Thus the first input responds to the output of the memory unit 59, the second input responds to the output of the related proximity sensor via lead 70 and the third SEALED input responds to the output of the corresponding delay flip-flop 65.

The output of the SEALED AND gate 68 has a positive output connected to energize a die jam station related alarm shown as a lamp. A suitable amplifier 71 connects the logic level output of the SEALED AND gate 68 to convert the logic signal to a suitable driving signal for the lamp 76. The NOT output of the SEALED AND gate 68 is connected to the combining network 52, to control activation of the stop means 52a. The circuit is shown with the usual unit reset means 78 to create a delayed on signal after application of power.

The combining circuit 52 generally includes first and second AND gates 79 and 80 driven from the several channels 50-51. The output of the two AND gates are combined in a further three input AND gate 81 having the third input connected to a top stop signal generated by the fourth sensor unit 18. The output of gate 81 is connected to actuate stop unit 52a and thereby terminate operation of the press and require resetting of the circuitry to condition the circuit for subsequent press operation.

Thus the first AND gate 79 of the combining circuit 52, is a four input AND having each of the individual inputs connected to the NOT output of the SEALED AND circuits 68 of the four channels 50 and 51. The second AND gate 80 is a similar four input gate having its individual inputs connected to the NOT output of the memory units 59 of the four channels 50 and 51. It thus combines the four signals and produces a signal whenever the NOT output is energized in all four channels. The positive output of gate 80 is connected as one input to an OR gate 82, the second input of which is connected by the line 83 to the idle-override signal line 70. The output of the OR gate 82 and the output of the AND gate 79 are connected as the individual inputs to the third AND gate 81, as previously described.

Thus in the operation of the system, the jamming of a lid blank 2 within any one of the forming stations 4 is detected by the failure of the lid blank to break the beam 14 and properly activate the SEALED AND gate

68 and the AND gate 80 in response to the stroke signal generated by unit 15. If the proper signals are not formed, the AND gate 81 generates a disable signal upon the punch unit reaching the top center position to terminate the press operation with the punch unit open. Further, the station or stations having a jammed condition are directly indicated by the illumination of the corresponding alarm lamp 76.

The system is preferably provided with a means to individually check the functions of each jam detector channel such as shown in FIG. 5. A selector switch 84 in series with a test switch 85 and a steering diode 86 selectively connects the input of the several gates 54 to ground 87. This applies a simulated die chute signal to the corresponding gate 54. If the channel is operating properly, the jam detection circuit should function to shut off the machine.

The channels 50 and 51 for the relatively short chutes 7 and 8 employ a common proximity sensing signal generated by the one unit 15. The total length of travel of the lid blanks 2 for these two chutes to the photocell detection means is sufficiently short so that the stroke signals and detection signals are properly timed. The channel for chute 8 thus has its sealed AND gate, not shown, connected to line 71 of the gate 72 and to the line 70 of the single shot unit 62 in the same manner as the illustrated connection of the sealed AND gate 68 for chute 7. The relatively long chutes 9 and 10, however, are provided with individual stroke sensing unit 16 to allow proper timed formation of the signals to properly activate the circuits. Thus, the channels 51 for chutes 9 and 10 include individual signal processing circuits corresponding to the illustrated units 61-65 and 72, similarly connected in the individual circuits for processing of the photoelectric detection signal processing circuits. As long as a lid blank 2 is discharged through each chute 7-10 forming operation or cycle, the sensing circuit is continuously reset such that the AND gates of the combining network 79 and 80 do not produce corresponding disconnect signals and AND gate 81 is off to enable operation of the press. If any one of the stations 4, however, jams the corresponding lamp 76 is illustrated and the AND gates 79 and 80 are activated to simultaneously provide disabling signals, which in combination with the top position signal, activates gates 81 to energize the stop means 52a.

Gate 82 is normally held on by the circuit of switch 73, in the run condition under idle, gate 82 must be held on from the gate 80. If stock is in the machine, however, the first lid discharge will activate memory 59 and turn off gate 80, thereby shutting down the press.

The signals from the detection elements 37 and the cycle and stroke units 15 are generated in proper timed relation to monitor the generation of each signal during each cycle. The output of the unit 15 generates a signal from unit 62 which is applied to the gate 68. The signal is not sealed, however, as there is not an input at both of the gates from the photo-cell channel and the flip-flop gate 65. The detection element 37 generates a signal which sets the memory unit 59. The unit 62 resets and pulses the single shot unit 64 to simultaneously reset the memory unit 59 and actuate the flip-flop unit 65 to thereby provide AND signals on the two corresponding inputs to gate 68. The output from the signal shot unit 62 has been removed, however, and gate 68 is not sealed. If the detection signal from element 37 or the cycle signal from unit 15 is not generated the above

sequence will not occur and all of the sealed inputs of gate 68 provide a similar logic signal simultaneously thereby sealing of the inputs of gate 68. This produces the simultaneous energization of the alarm lamp 76 for the corresponding stations and remove the NOT output from the related combining gate 79 to actuate the stop circuit. The press, therefore, stops with a visual indication of the jammed condition on the movement of the punch units to top dead center.

Further, if any one of the sensor units 15 or photocell assemblies should fail they will not, of course, provide the necessary input signal to the sensing circuitry which will function in the same manner as a failure to discharge a lid blank. The sensing circuit thus provides a fail-safe type operation to maintain continuous and reliable monitoring of the gang press 1.

The present invention has been found to provide a reliable means for monitoring of high speed forming apparatus and permits construction of conveniently constructed and serviced detection apparatus.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims, particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

We claim:

1. In a forming apparatus having a plurality of forming means for cyclically forming individual parts and automatically discharging of said parts along a predetermined path from the forming means, said forming means being simultaneously actuated, a plurality of similar chutes located adjacent to the corresponding forming means and extending therefrom to a common discharge location, a plurality of detection means mounted one each to each of said chutes and generating a beam across the corresponding chute to be positively interrupted by movement of a formed part through the chute, cycle means for each forming means and generating an operational signal per forming cycle of said apparatus, signal processing and combining means activated by said operational signal and responsive to said detection signal to continuously monitor the operation of each forming means on a per cycle basis, said detection means being spaced from the corresponding forming means by different lengths and generating time spaced detection signals as the result of the synchronous simultaneous operation of the plurality of forming means, and said cycle means producing corresponding signals in timed relation to said detection signals.

2. In a forming apparatus having means for cyclically forming individual parts and automatically discharging of said parts along a predetermined path from the forming apparatus, detection means for establishing an energy beam across said path and interrupted by movement of a formed part along said path to form a detection signal, cycle means generating an operational signal per forming cycle of said apparatus, signal processing and combining means activated by said operational signal and responsive to said detection signal to continuously monitor the operation of the machine on a per cycle basis, said cycle means generates a pair of timed spaced operational signal pulses for each cycle of said apparatus, said detection means generates a pulse for each interruption of the beam, and said processing and combining means includes logic circuit means to respond to the sequence of said pulses and providing a

sealed output signal in response to a failure to receive any one of said pulses.

3. In a forming apparatus having means for cyclically forming individual parts and automatically discharging of said parts along a predetermined path from the forming apparatus, detection means for establishing an energy beam across said path and interrupted by movement of a formed part along said path to form a detection signal, cycle means generating an operational signal per forming cycle of said apparatus, signal processing and combining means activated by said operational signal and responsive to said detection signal to continuously monitor the operation of the machine on a per cycle basis, said processing and combining means includes a memory unit having a set input and a reset input, said detection means and said cycle means being connected one each to the set input and reset input to cyclically set and reset the memory unit during each complete cycle, a first logic circuit means connected to the memory unit to produce a signal in accordance with the cycling of the memory unit, and a second logic circuit means having a plurality of inputs including first and second inputs connected respectively to the cycle means, and to the memory unit said second logic circuit having a third input, complementary logic circuit connected to said third input and having an input connected to said cycle means, and a jam fault responsive means connected to the output of the second logic circuit.

4. The forming apparatus of claim 3 wherein said detection means includes a pulse forming means for establishing a pulse signal for each beam interruption connected to set the memory unit, said cycle means including a pulse forming means having a first pulse output means connected to the second logic circuit, and having a second pulse output means producing a delayed pulse, said second pulse output means being connected to the memory unit and to the complementary logic circuit.

5. The forming apparatus of claim 3 wherein said second logic circuit is a "Sealed AND" gate wherein said first and second and third inputs are sealed, said gate having a positive output connected to the jam fault responsive means and a NOT input connected to a stop control.

6. The forming apparatus of claim 3 wherein said fault responsive means includes an indicating means and a stop control means, said second logic circuit is a "Sealed AND" logic gate wherein said first, second and third inputs are sealed, said gate having a positive output connected to the indicating means and the NOT output connected to the stop control means.

7. In a forming apparatus having a plurality of forming means for cyclically forming individual parts and automatically discharging of said parts along a predetermined path from the forming means, said forming means being simultaneously actuated, a plurality of similar chutes located adjacent to the corresponding forming means and extending therefrom to a common discharge location, a plurality of detection means mounted on each to each of said chutes and generating a beam across the corresponding chute to be positively interrupted by movement of a formed part through the chute, cycle means for each forming means and generating an operational signal per forming cycle of said apparatus, signal processing and combining means activated by said operational signal and responsive to said

detection signal to continuously monitor the operation of each forming means on a per cycle basis, a common support plate secured in spaced relation to said forming units, a chute mounting bracket secured to each of said chutes and forming a common mounting for all of said chutes, said plurality of detection means including a beam source and a separate beam receiver, a first cover including a plate member having one of said sources and receives of all of said detection means secured thereto and spaced in accordance with the spacing of said chutes on said common support bracket, a second channel shaped cover adapted to telescope over said chutes and having end mounting flanges, the second of each of said sources and receivers of all of said detection means being secured to said second cover and spaced in accordance with the detection means carried by the first cover, a mounting plate secured to said apparatus having attachment means, said chute mounting bracket and said first and second detection means covers having means releasably coupled to said attachment means to provide automatic interrelated alignment of the beam sources and receivers with each other and with a corresponding chute.

8. The apparatus of claim 7 wherein said chutes are each elongated tubular members having a generally rectangular cross section with the discharge ends located in a generally common plane, the length of said chutes varying, said detection means being located in alignment with each other laterally across the chutes, said forming means being laterally offset with respect to the corresponding detection means, said chutes being of a corresponding different length to locate the entrance end of the chute immediately adjacent the corresponding forming means, and said cycle means producing corresponding signals in timed relation to said detection signals.

9. The forming apparatus of claim 7 wherein said attachment means includes pins projecting from the mounting plate, said covers and chute mounting bracket having openings spaced in accordance with said pins, and releasable clamping means on the outer ends of the pins to fixedly clamp the covers and bracket to the mounting plate.

10. The forming apparatus of claim 9, wherein said mounting bracket is a plate-like strip, said first cover is a plate-like element having a width greater than that of said strip, and said second cover is a plate-like element having flat end flanges, said mounting pins having lateral openings adjacent said flanges and said releasable clamping means being pins extending through said mounting pins in abutting relation to said flanges.

11. In a forming apparatus having a plurality of forming means for cyclically forming individual parts and automatically discharging of said parts along a predetermined path from the forming means, said forming means being simultaneously actuated, a plurality of similar chutes located adjacent to the corresponding forming means and extending therefrom to a common discharge location, a plurality of detection means mounted one each to each of said chutes and generating a beam across the corresponding chute to be positively interrupted by movement of a formed part through the chute, cycle means for each forming means and generating an operational signal per forming cycle of said apparatus, signal processing and combining means activated by said operational signal and responsive to said detection signal to continuously monitor

tor the operation of each forming means on a per cycle basis, said processing and combining means includes a plurality of signal processing channels, one for each of said detection means, each of said channels including a memory unit connected to a corresponding detection means and a separate sequence logic gate, said cycle means and said detection means being connected to the memory units to cyclically set and reset each memory unit during each complete cycle, said sequence logic gate including first and second inputs connected to corresponding memory units and to the cycle means having a third input, a complementing logic circuit connected to the cycle means and to the third input to establish an interlocking sequence signal such that all inputs are in a common state if the detection means fails to generate a signal, and output signal combining means having a plurality of signal inputs connected one each to each of said channels.

12. The forming apparatus of claim 11 including discharge paths of varying length, and said cycle means includes a plurality of different sensors for establishing corresponding signals related to predetermined detection means, said signal processing channels for said predetermined detection means including separate reset and complementing logic circuits connected to the corresponding memory units and sequence logic gate.

13. The forming apparatus of claim 11 wherein the sequence logic gate is a "Sealed AND" logic gate, said memory unit having a standard output and a NOT output connected to the sequence logic gate, said cycle means including a pulse unit having a standard output connected to the sequence logic gate and a NOT output, a second pulse unit connected to the NOT output of the first named pulse unit and having an output connected to reset the memory unit and to the complementing logic circuit.

14. The forming apparatus of claim 13 having a first AND gate with individual inputs connected one each to each of the NOT outputs of the memory units of the channels, a second AND gate connected to the NOT outputs of the "Sealed AND" logic gates, and a stop control means forming a part of the fault responsive means connected to said first and second AND gates and controlled thereby.

15. A forming apparatus having a plurality of individual forming means operated to simultaneously shape members from a metal blank and for simultaneously laterally discharging of such members, a plurality of in-

dividual chutes one for each forming means, a chute mounting bracket secured to each of said chutes and forming a common mounting for all of said chutes, a plurality of detection means, one for each of said chutes, each of said detection means including a beam source element and a separate beam receiver element, a first cover having one of said elements of all of said assemblies secured thereto and spaced in accordance with the spacing of said chutes on said chute mounting bracket, a second channel shaped cover adapted to telescope over said chutes and having end mounting flanges, the second of each of said elements of all assemblies being secured to said second cover and spaced in accordance with said first elements carried by the first cover, a mounting plate secured to said forming means and having attachment means, said chute mounting bracket and said first and second covers mounted on said plate and having means releasably coupled to said attachment means to provide automatic interrelated alignment of the elements of the detection means with each other and with a corresponding chute.

16. The apparatus of claim 15 wherein each said chute is an elongated tubular member having a generally rectangular cross section with the discharge ends located in a generally common plane, said detection beam assemblies being located in alignment with each other laterally across the chutes.

17. The forming apparatus of claim 15 wherein said attachment means includes releasable connectors at each end of the mounting plate and clamping of the covers and the chute mounting bracket to the mounting plate.

18. The forming apparatus of claim 15 wherein said attachment means includes pins projecting from the mounting plates, said covers and support bracket having openings spaced in accordance with said pins, and releasable clamping means on the outer ends of the pins to fixedly clamp the covers and brackets to the mounting plate.

19. The forming apparatus of claim 18 wherein said mounting bracket is a plate-like strip, said first cover is a plate-like element having a width greater than that of said strip, and said top cover is a plate-like element having flat end flanges, said mounting pins having lateral openings adjacent said flanges and said releasable clamping means being pins extending through said mounting pins in abutting relation to said flanges.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,878,745

Page 1

DATED : April 22, 1975

INVENTOR(S) : LOUIS D. HANDZIAK ET AL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column	1,	Line	54,	before "jamming" insert --- a stock ---;
Column	2,	Line	3,	before "moves" cancel "lic" and insert --- lid ---;
Column	2,	Line	12,	after "two" insert --- pulse ---;
Column	3,	Line	58,	after "each" cancel "gauge" and insert --- gange ---;
Column	3,	Line	64,	before "10" cancel "and" and insert --- through ---;
Column	4,	Line	23,	before "circuitry" cancel "electri- city" and insert --- electronic ---;
Column	6,	Line	2,	before "13" cancel "receives" and insert --- receivers ---;
Column	6,	Line	34,	after "top" cancel "wal" and insert --- wall ---;
Column	7,	Line	5,	after "channel" cancel "so" and insert --- 50 ---;
Column	7,	Line	51,	after "memory unit" (first occurrence) insert --- 59 ---;
Column	8,	Line	22,	after "all" insert --- inputs ---;

UNITED STATES PATENT OFFICE Page 2
CERTIFICATE OF CORRECTION

PATENT NO. : 3,878,745
DATED : April 22, 1975
INVENTOR(S) : LOUIS D. HANDZIAK ET AL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column	9,	Line	30,	after "unit" cancel "16" and insert --- 15 ---;
Column	9,	Line	43,	after "is" cancel "illustrated" and insert --- illuminated ---;
Column CLAIM 3	11,	Line	24,	after "means" cancel the comma (,) and after "unit" insert a --- comma (,) ---;
Column	11,	Line	61,	after "mounted" cancel "on" and insert --- one ---.

Signed and Sealed this

twenty-fifth **Day of** *November* 1975

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks