Nov. 12, 1968 J. E. TRAVIOLI 3,410,384

PAPER CURRENCY ACCEPTOR

Filed Aug. 3, 1965 7 Sheets-Sheet 1

Fig. 1

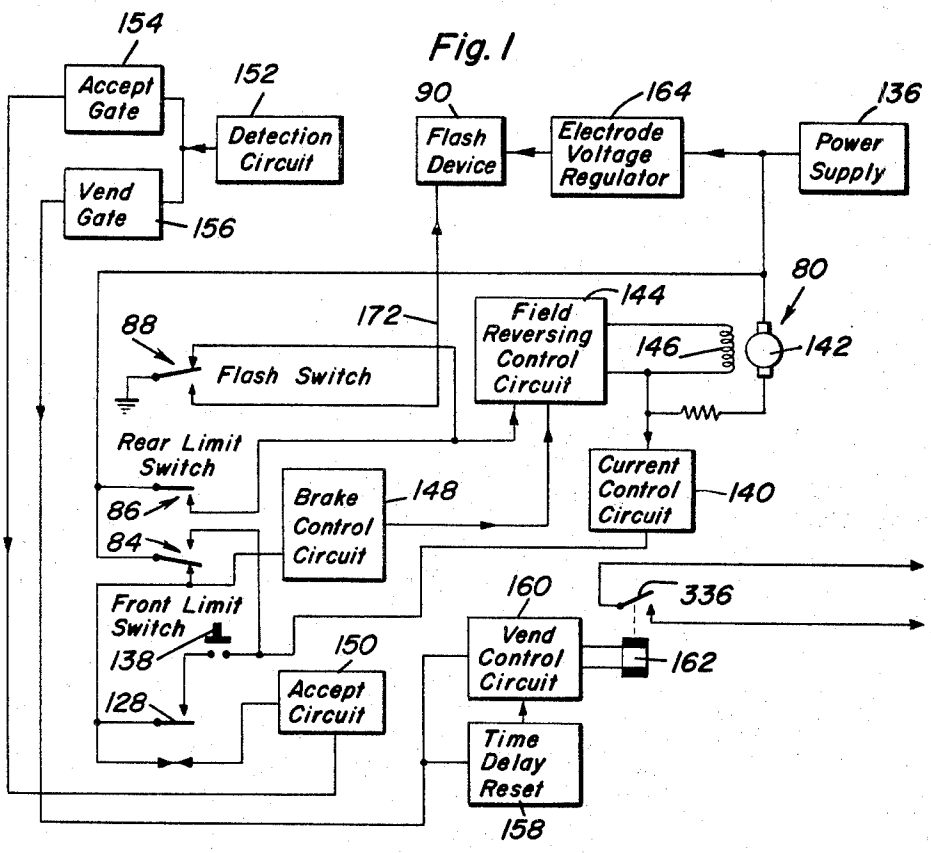


Fig. 4

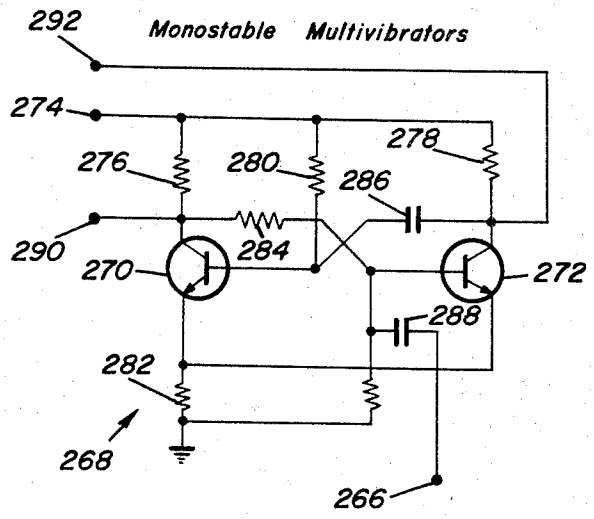
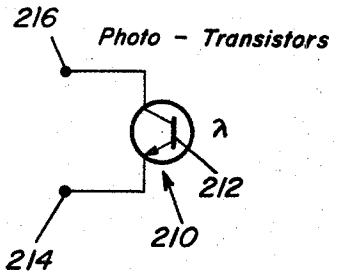


Fig. 3



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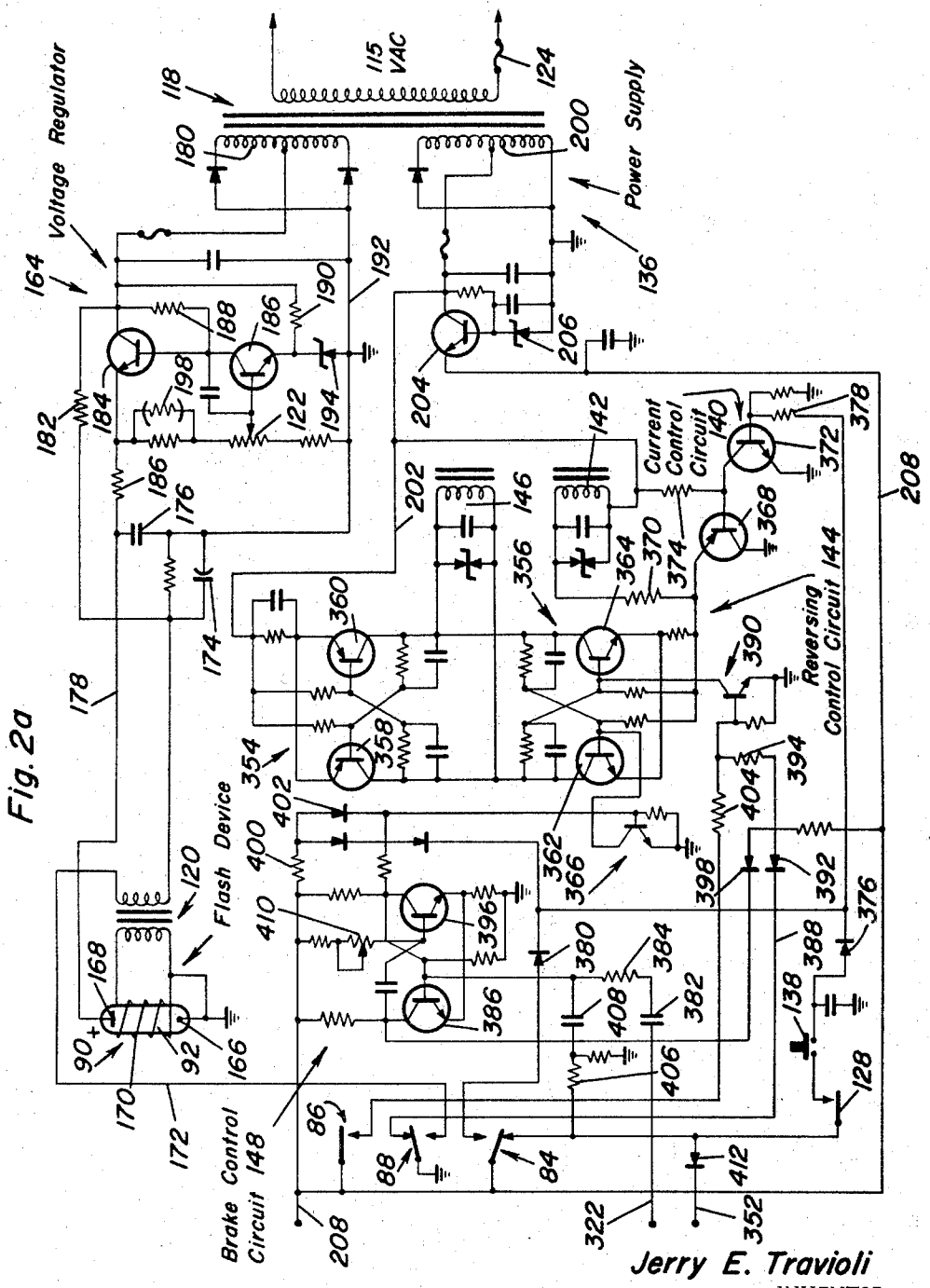

Fig. 2a

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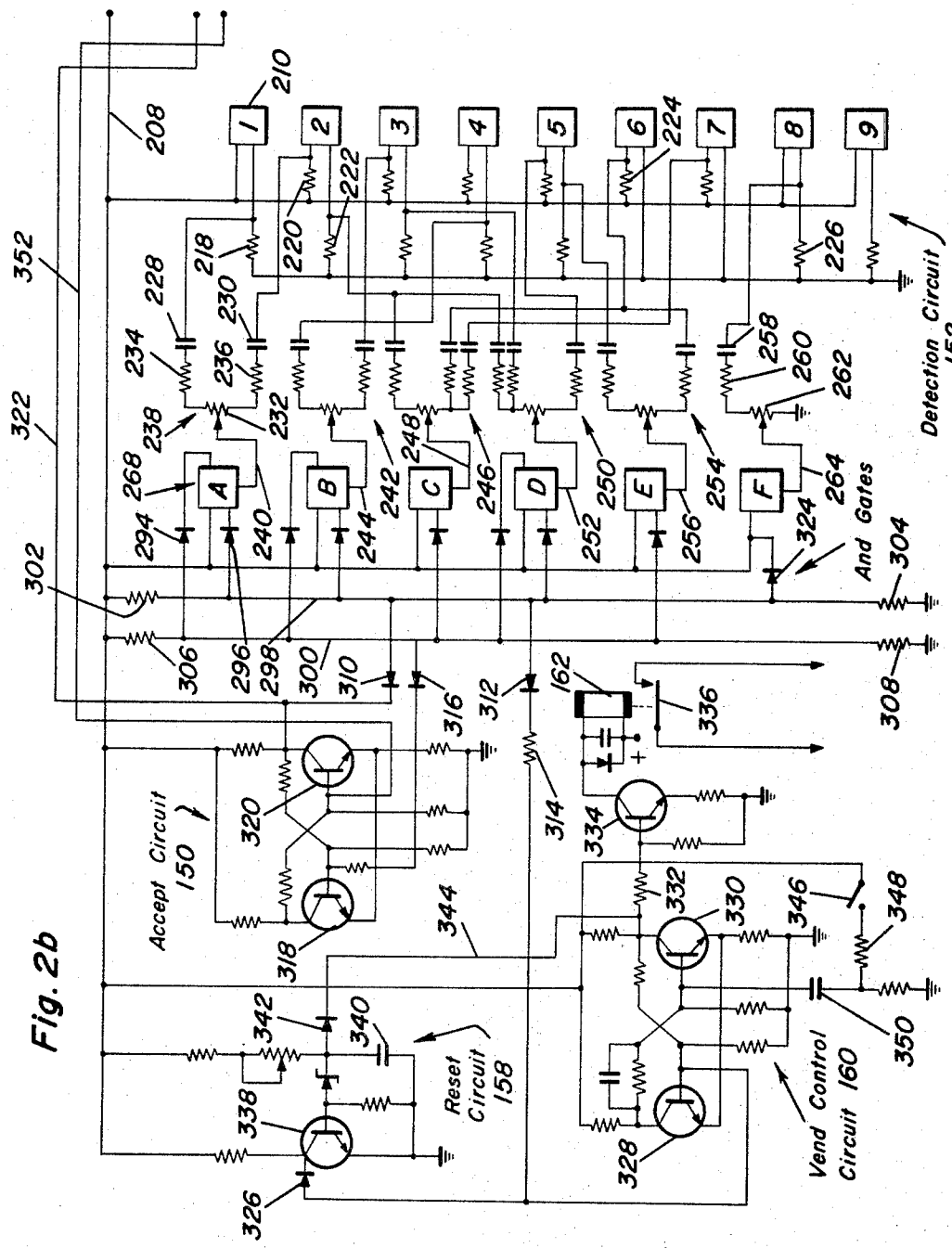

Fig. 2b

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Fig. 5

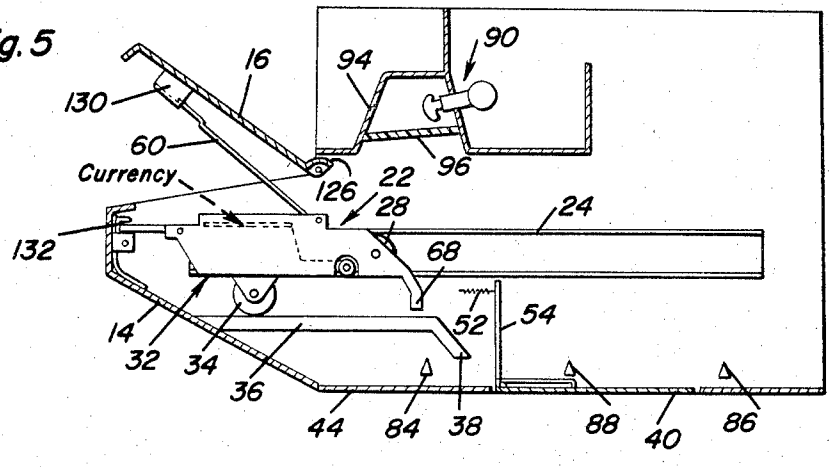


Fig. 6

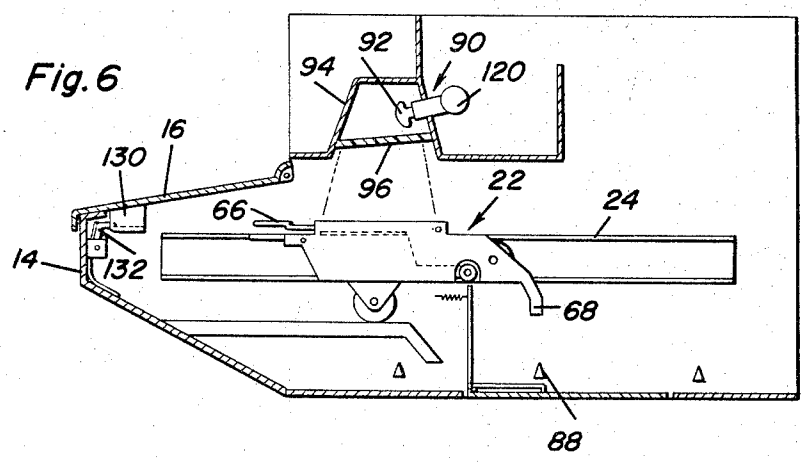
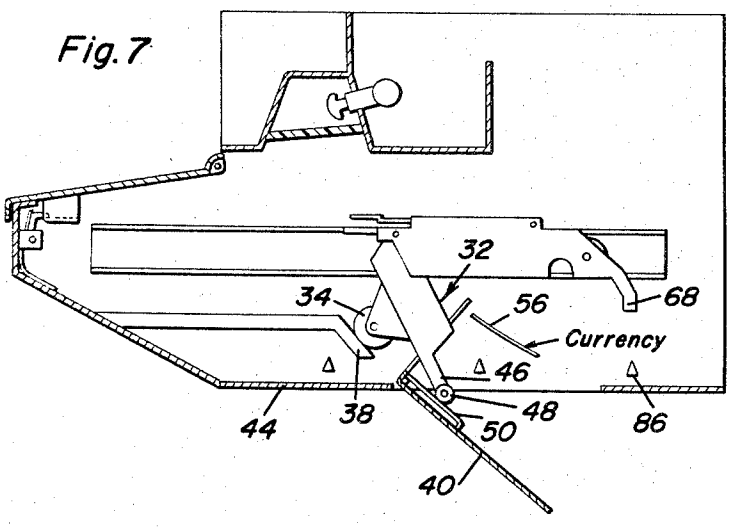


Fig. 7



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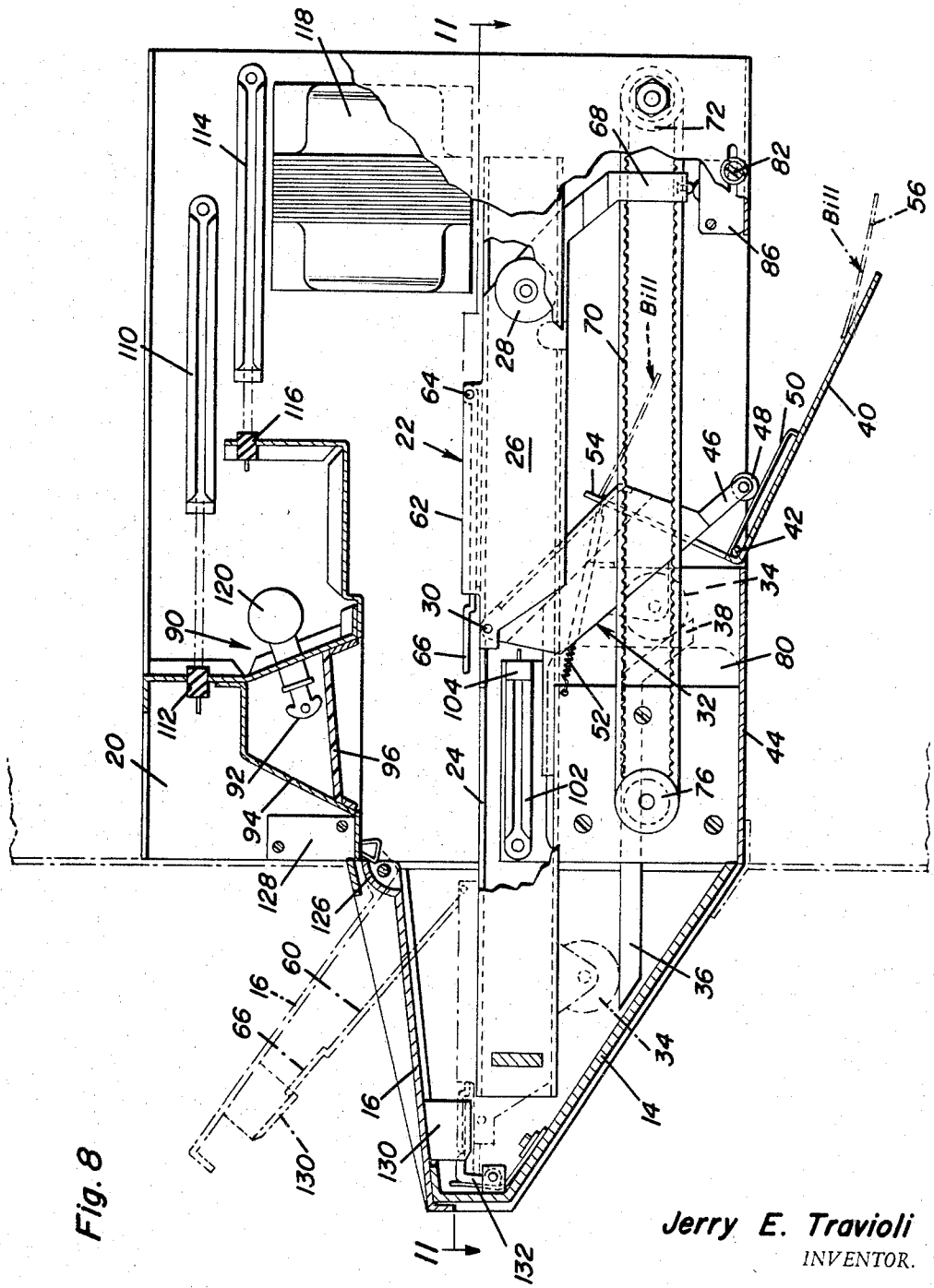

Fig. 8

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Fig. 9

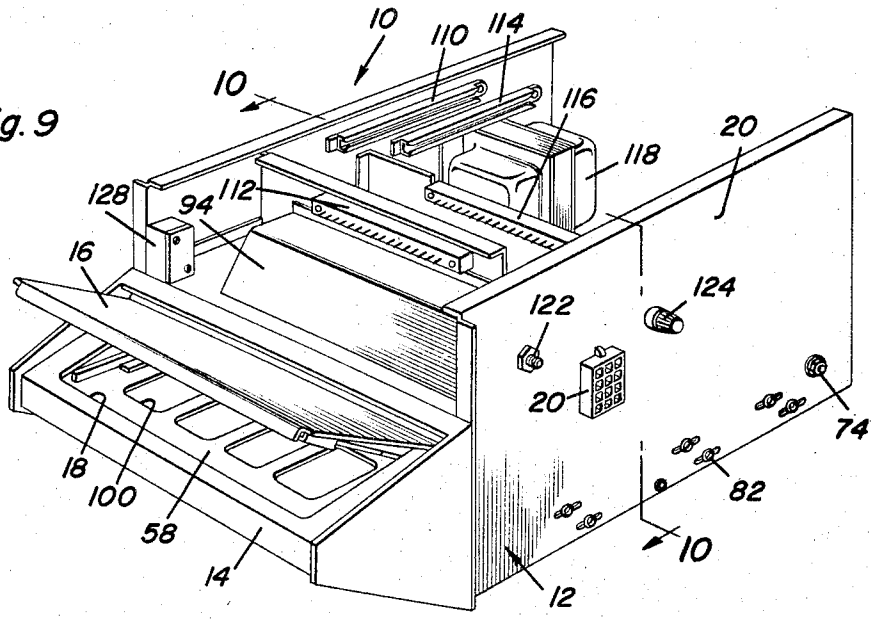
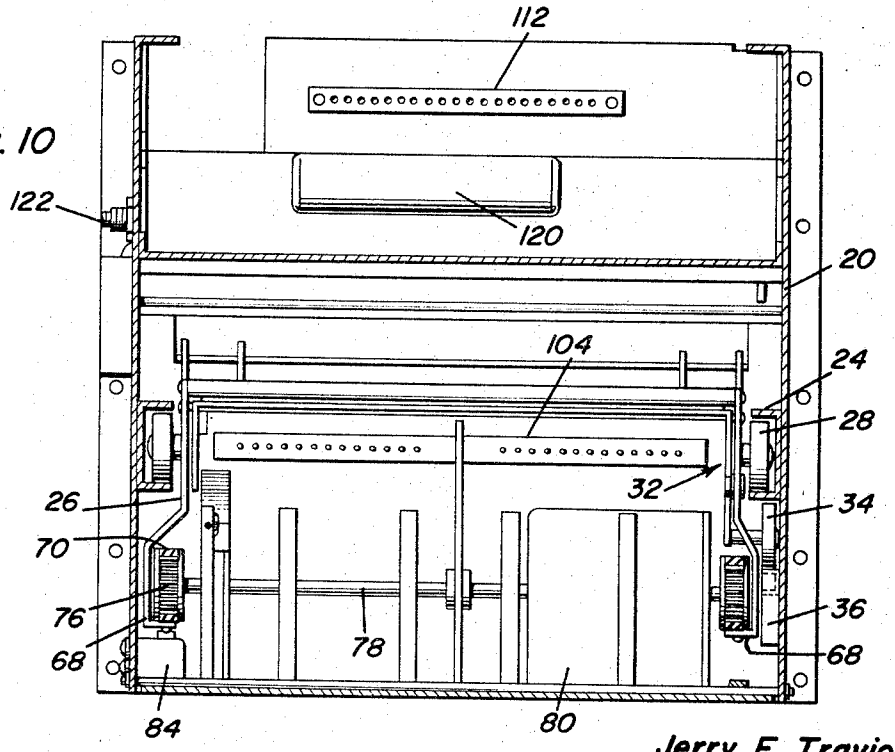


Fig. 10



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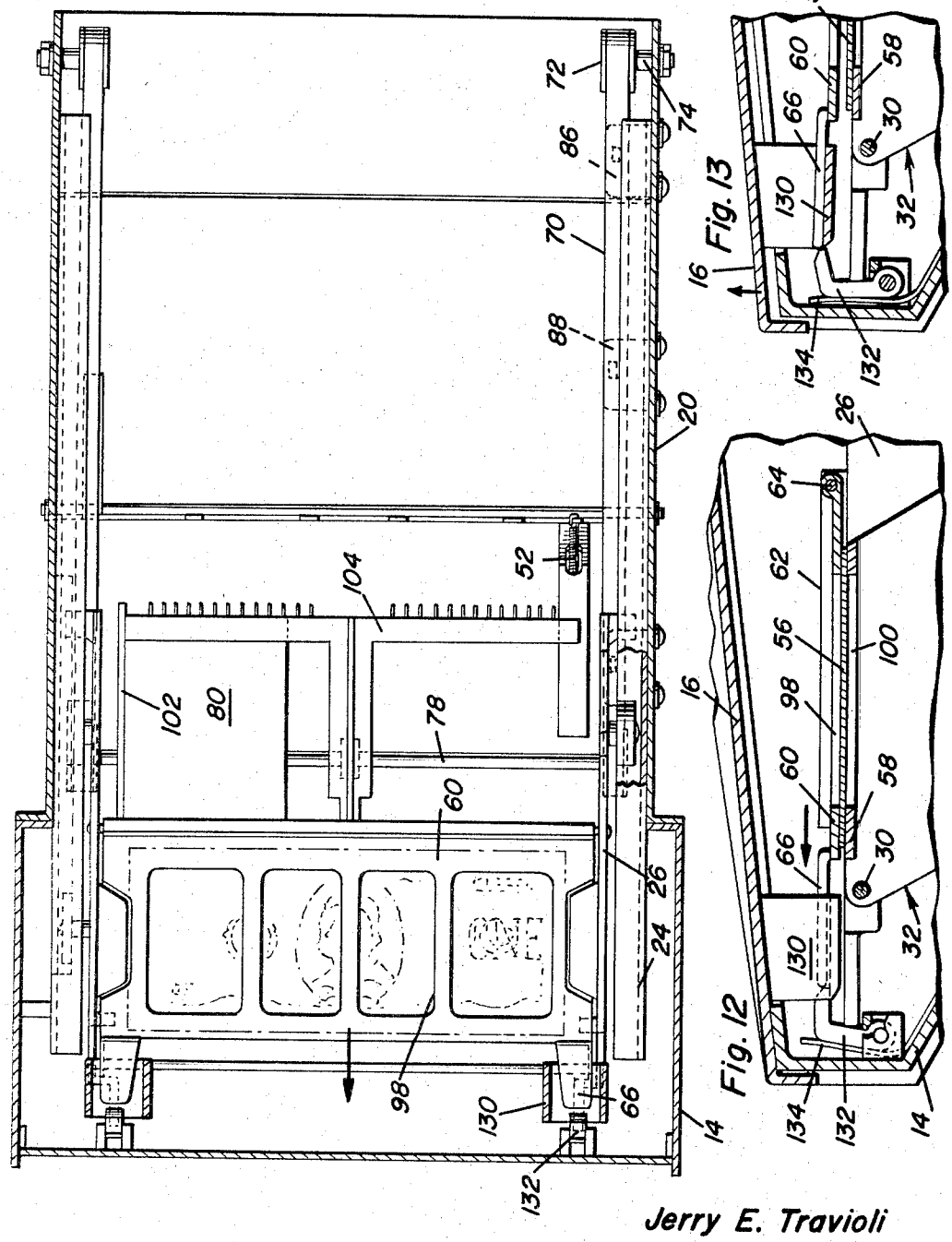

Fig. 11

Fig. 13

Fig. 12

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Patented Nov. 12, 1968

3,410,384

PAPER CURRENCY ACCEPTOR

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Visalia, Calif. 93277

Filed Aug. 3, 1965, Ser. No. 476,962
16 Claims. (Cl. 194—4)

ABSTRACT OF THE DISCLOSURE

A paper money accept-reject mechanism for use with a vending machine. A closure in the mechanism housing is opened to expose a paper money received tray pivotally mounted on a reciprocable carriage. Closing of the closure operates switch means controlling operation of a reversible motor for movement of the carriage away from the closure, such movement locking the closure. Movement of the carriage to a detection position initiates operation of infrared radiation detection means to authenticate the paper money. If acceptable, the carriage is advanced to a delivering position at which the tray is pivoted depositing the paper money. If not acceptable the carriage is returned to its initial position unlocking the closure.

This invention relates to a device adapted to receive paper currency of different denominations in order to set into operation a machine with which it is associated only when the paper currency is authenticated.

An important object of the present invention is to provide an electronically operated device which will detect authentic paper currency and accordingly control the acceptance and rejection of paper currency in a reliable and rapid manner.

In accordance with the foregoing object, an additional object of the present invention is to provide a paper currency accepting device which will prevent return of any authenticated paper currency to the depositor.

A further object of the present invention is to provide a paper currency acceptor which authenticates genuine bills by detecting the diffusion and distribution of infrared radiation passing through the paper. In accordance with the present invention, the level of radiation is automatically regulated so as to compensate for any variation in gain of the photo-detectors and loading of the associated circuitry, because of temperature changes.

A still further object of the present invention is to provide a paper currency accepting device featuring a novel carriage construction and arrangement which cooperates with a releasable lock device and closure lid to prevent opening of the closure lid once an operational cycle has begun.

Yet another object of the present invention is to provide a motor control circuit for controlling the movement of the carriage in accordance with the aforementioned objectives.

Another object of the present invention is to provide a logic circuit arrangement for the paper currency detector which is self-resetting whether or not a vend operation is completed.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is a simplified electrical block diagram showing the system associated with the present invention.

FIGURES 2*a* and 2*b* are electrical circuit diagrams corresponding to the system of the present invention.

FIGURE 3 is an electrical diagram of one of the photo detecting devices associated with the present invention.

FIGURE 4 is an electrical circuit diagram of one of the monostable multivibrators utilized in the system of the present invention.

FIGURES 5 through 7, are simplified longitudinal sectional views showing the structure of the present invention in various operational stages.

FIGURE 8 is an enlarged side elevational view of the paper currency acceptor with parts broken away and shown in section.

FIGURE 9 is a perspective view of the paper currency acceptor with the circuit boards removed.

FIGURE 10 is a transverse sectional view taken substantially through a plane indicated by section line **10—10** in FIGURE 9.

FIGURE 11 is a top sectional view taken substantially through a plane indicated by section line **11—11** in FIGURE 8.

FIGURES 12 and 13 are enlarged partial sectional views similar to the forward portion of the paper currency acceptor shown in FIGURE 8, in different operational conditions.

Referring initially to FIGURE 9, the paper currency acceptor generally denoted by reference numeral **10**, may form an assembled unit with all of the component parts thereof supported by a housing frame assembly generally referred to by reference numeral **12** so that it may be installed at any suitable location in connection with any other piece of equipment with which the paper currency acceptor is associated. The forward portion **14** of the housing frame assembly mounts a closure member or lid **16** adapted to be pivotally raised so as to uncover an access opening **18** through which paper currency is placed on a carriage. The forward portion **14** of the housing frame assembly is connected to a pair of rearwardly extending, parallel spaced side walls **20**. Thus, the side walls **20** form a chamber into which the paper currency is withdrawn by the carriage on which it is placed.

Referring now to FIGURES 8, 10 and 11, it will be observed that the carriage assembly generally referred to by reference numeral **22** is guidingly mounted for movement along a fixed linear path by means of a pair of channel track members **24** secured to the side walls **20** and extending into the forward portion **14** of the housing frame assembly. The carriage assembly includes a pair of parallel spaced side portions **26** on which a pair of guide rollers **28** are rotatably mounted adjacent a rear end of the carriage assembly. The rollers **28** are received within the channel track members **24** for guiding movement of the carriage assembly along the fixed path. The side portions **26** of the carriage assembly pivotally mount adjacent the forward ends thereof on a pivot pin **30**, a pivotal section **32** having a pair of lower rollers **34** extending laterally therefrom. The lower pair of rollers **34** are guidingly supported on a pair of lower track members **36** secured to the side walls **20** below the channel track members **24** and extending into the forward portion **14** of the housing frame assembly. Accordingly, the pivotal section **32** of the carriage assembly will be supported in an upper retracted position between the side wall portions **26** until the carriage assembly reaches its rearward position as illustrated by solid line in FIGURE 8. When reaching the rearwardmost position shown, the pivotal section **32** drops downwardly guided by its rollers **34** along the downwardly inclined terminal portion **38** of the lower track members. The pivotal section **32** is thereby operative to open an outlet gate member **40** pivotally mounted by the pivot pin **42** secured to the bottom wall **44** which interconnects the side walls **20**. The pivotal section **32** of the carriage assembly is therefore provided with a rearwardly extending portion **46** rotatably mounting a roller **48** which bears against a bearing portion **50**

secured to the gate member **40**. The gate member is thereby displaced to the open position shown in FIGURE 8 against the bias of the return spring **52** connected at one end to the housing frame assembly and at the other end to an upwardly extending portion **54** of the gate member. When the gate member is opened, an acceptable bill or paper currency **56** will drop off a bottom supporting tray member **58** secured to the top of the pivotal section **32** so that it may be deposited in some receptacle associated with a vending machine for example.

As more clearly seen in FIGURE 12, the bottom tray member **58** on which the paper currency **56** is supported, is aligned with a top cover member **60** when the pivotal section **32** is held retracted between the side portions **26** of the carriage assembly. The side portions include therefore a pair of upwardly extending sections **62** between which the cover member **60** is pivotally mounted by the pivot pin **64**. The forward lateral end portions of the top cover member **60** are provided with a pair of projections **66** for purposes to be hereinafter explained.

Connected to the side portions **26** of the carriage assembly and projecting downwardly and rearwardly therefrom, are switch actuating portions **68**. The switch actuating portions are secured to the lower runs of a pair of endless drive belts **70** entrained about idler wheels **72** rotatably mounted on spindle assemblies **74** secured to the side walls **20**. The forward ends of the drive belts **70** are entrained about drive wheels **76** which are secured to opposite ends of a motor shaft assembly **78** which extends from opposite sides of an electric drive motor **80**, mounted on the bottom wall **44** at the forward end between the side walls **20** as more clearly seen in FIGURE 10. The motor **80** is of the reversible type so that it will propel the carriage assembly in opposite directions by means of the drive belts **70** secured to the carriage assembly through the switch actuating extensions **68**. The switch actuating extension **68** on one side of the carriage assembly is operative to actuate a plurality of limit switch assemblies properly positioned along the side wall by pairs of slot mounted adjusting screws **82** as more clearly seen in FIGURE 9. In the forward position of the carriage assembly, the switch actuating extension **68** will actuate a front switch assembly **84** as shown in FIGURE 10 while in the rearmost position of the carriage assembly, a rear switch assembly **86** is actuated as shown in FIGURE 8. The carriage assembly will also assume an intermediate position in which the switch actuating extension **68** will actuate a flash switch assembly **88** as shown by dotted line in FIGURE 11. Thus, in the intermediate position, actuation of the flash switch assembly **88** is operative to trigger a flash device generally referred to by reference numeral **90** as shown in FIGURE 8. The flash device includes an electronic photoflash tube **92** which is enclosed within a flash housing **94** so that the illumination therefrom will be directed and reflected downwardly through an infrared filter **96** in order to expose paper currency to infrared radiation through the openings **98** formed in the top cover member **60** on the carriage assembly when it is in its intermediate position. Openings **100** are formed on the bottom supporting tray member **58** on which the paper currency **56** is supported. The openings **100** are aligned with the openings **98** in the top cover member **60** so that infrared radiation may pass through the paper currency and be detected by an electronic photo-detecting component mounted on a circuit board in proper position. The photo-detecting circuit board is mounted in proper position by circuit board tracks **102** associated with a circuit board connector **104** as shown in FIGURE 8. The side walls **20** also mount a pair of circuit board tracks **110** and an associated connector **112** for a logic circuit while a pair of circuit board tracks **114** and connector **116** accommodates a motor control and power supply circuit board. Also mounted on one of the side walls below the circuit board track **114** is a power transformer **118** to which a source of available AC current is connected through a connecting plug **120** adapted to be mounted on one of the side walls **20** as shown in FIGURE 9. Electrical energy for operating the flash device **90** is therefore derived from the power transformer **118** and supplied at a proper energy level to the flash tube **92** through the flash transformer **120** disposed outside of the flash housing **94** as shown in FIGURE 8. A flash level control **122** is also associated with the flash device and mounted on one of the side walls **20** as shown in FIGURES 9 and 10. Also mounted on this side wall, is a replaceable fuse **124**.

Referring now to FIGURES 8, 11, 12 and 13, it will be observed that the closure lid **16** has a hinge portion **126** by means of which it is pivotally mounted by the housing frame assembly. The hinge portion is also being operative to actuate a safety switch assembly **128** mounted on a side wall **20** at the forward end thereof. An operational cycle is thereby initiated only after the closure lid **16** is moved to its fully closed position, as shown by solid line in FIGURE 8. Once the operational cycle begins, the carriage assembly **22** is displaced rearwardly from its forward start position after which the closure lid **16** is locked in its fully closed position. Toward this end, the closure lid is provided with a pair of downwardly extending retainer elements **130** adapted to receive a pair of latch elements **132** pivotally mounted by the front portion **14** of the housing frame assembly. The latch elements are biased into engagement with the retaining elements by the springs **134** as more clearly shown in FIGURE 12. The retainer elements **130** also guidingly receive the extensions **66** of the top cover member **60**. Accordingly, when the carriage assembly moves to its forward position, it will displace the latch elements **132** against the bias of the springs **134** to the position illustrated in FIGURE 13 releasing the closure lid **16**. The closure lid may then be pivotally raised and will at the same time upwardly displace the cover member **60** in order to permit placement of paper currency on the bottom tray member **58**.

Operation of the paper currency acceptor as hereinbefore described, may be summarized with reference to FIGURES 5 through 7. In the forward start position of the carriage assembly **22** as shown in FIGURE 5, the closure lid **16** will be released so that it may be pivotally displaced upwardly to also raise the cover member **60**. Currency paper may then be placed on the bottom tray member carried by the pivotal section **32** of the carriage assembly held retracted within the carriage assembly by its guide rollers **34** riding on the horizontal portion of the lower guide tracks **36**. When the cover lid is fully closed, an operational cycle is initiated causing displacement of the carriage assembly from its start position to actuate the front switch assembly **84**. When the carriage assembly reaches the intermediate detection position illustrated in FIGURE 6, the flash switch assembly **88** is actuated in order to trigger the flash device **90** producing illumination from the flash tube **92** in order to expose the currency paper to infrared radiation. The degree to which the radiation is scattered or diffused after passing through the currency paper, depends of course upon the chemical and fiber structure of the paper. If the currency is authenticated as a result of the test performed thereon, the carriage proceeds from its intermediate position to a delivery position shown in FIGURE 7. As the carriage approaches the rear delivery position, the pivotal section **32** drops downwardly so that the currency paper carried on the bottom tray thereof will fall off and drop through the opening in the bottom wall **44** ordinarily closed by the drop gate **40**. The drop gate **40** is opened by the roller **48** on the rearward extension **46** of the pivotal section. Authentic paper currency is thereby ejected and deposited in some receptacle, not shown. When the carriage reaches its rearmost position, the rear switch **86** is actuated causing the carriage to return to its forwardmost position to cause

reset of logic circuit associated with the paper currency acceptor as well as to unlock the cover lid as aforementioned.

Referring now to FIGURE 1, operation of the paper currency acceptor may be explained with reference to the simplified circuit block diagram. With the carriage in the forward start position releasing the cover lid, the front limit switch **84** is in the position illustrated in FIGURE 1 so as to establish a current path from the power supply **136** to the push button start switch **138** through the safety switch **128** closed by closing of the cover lid **16**. The operational cycle is then begun upon closing of the start switch **138** to complete a start circuit switching on the current control circuit **140** in order to complete an energizing circuit through the armature **142** of the motor **80** and the reversing circuit **144** set for at the proper polarity of the field coil **146**. The motor **80** rotates in the proper direction to displace the carriage from the forward position causing the front limit switch **84** to move to its other operative position establishing a connection from the power supply to the current control circuit **140** by-passing the start switch **138** in order to maintain the motor energized. The carriage therefore continues to the intermediate detection position. The flash switch assembly **88** is thereby displaced from the position illustrated in FIGURE 1 to the other operative position removing ground from the field reversing circuit **144** to cause it to reverse the motor while at the same time placing ground on the flash device **90** to complete a trigger circuit. If the paper currency is authentic, an accept signal is supplied to the stop or brake control circuit **148** from the accept circuit **150** in order to send another reversing pulse to the field reversing circuit **144** before any physical reversal of the motor **80** occurs. The time that elapses from the actuation of the flash switch assembly **88** to the time that an accept signal is established, is approximately 40 micro seconds avoiding any physical reversal of the motor. Accordingly, if the paper currency is authentic, the carriage will continue from the intermediate position toward the rearmost delivery position because of the double reversal action aforementioned. On the other hand, if paper currency is not authentic, the second reversal does not occur because of the absence of any accept signal from the accept circuit **150**. Thus, the motor **80** will physically reverse and return the carriage to the forwardmost position retaining the paper carried thereon. If the carriage should reach the rearmost position, the rear limit switch **86** is actuated to the closed position so as to again reverse the field reversing circuit **144** and physically reverse the motor **80**. The carriage is thereby returned to the forward position, after the currency paper has been ejected. While returning, a double reversal again occurs at the detection position because of a vend signal transmitted from the vend gate to the brake control circuit **148**.

When the carriage is moved from the forward position to the intermediate position with the currency paper thereon, the radiation produced by the flash device **90** upon actuation of the flash switch **88**, will be sensed by the detection circuit **152** which conducts a signal directly proportional to the duration of radiation, and the amount thereof. If the paper currency is authentic, the detection circuit will supply an accept signal transmitted by the accept gate **154** to the accept circuit **150** aforementioned in order to supply a trigger signal pulse to the brake control circuit **148** for reversing the motor field. The carriage will then be displaced by the motor to the rearmost position as aforementioned. When the carriage is driven in the return direction by the motor toward the forward position it will again actuate the flash switch **88** in order to ignite the flash device **90** once again. However, since there will be no paper currency on the carriage, the infra red radiation sensed by the detection circuit **152** will satisfy the vend gate **156** only. A vend signal is thereby transmitted through the vend gate **156** to turn on a time delay reset **158** as well as to pulse a vend control circuit **160** in order to energize a control relay **162**. The control circuit **160** is then reset after elapse of a predetermined period of time by the time delay reset **158** or by an external vend complete signal which ever is first. It will also be appreciated, that if for some reason the paper currency was not dropped from the carriage in its rearmost position, no signal would be transmitted through the gate **156** and no vend pulse would be transmitted. When the carriage returns to the forward position, the front limit switch **84** is restored to the position illustrated in FIGURE 1 so that a connection is established from the power supply **136** to the accept circuit **150** in order to reset it. Also, the brake control circuit **148** is triggered to reverse the reversing control circuit **144**.

The detection circuit component **152** as hereinbefore indicated is operative to detect the difference between the diffusion pattern of infrared radiation respectively passed through authentic and counterfeit paper currency. Also, the detection circuit is operative to establish a comparison between areas with and without printing in order to determine the denomination of the paper currency. All of the information detected by the detection circuit is correlated by a digital logic circuit resulting in the passage of signals through the accept gate **154** and the vend gate **156** as hereinbefore explained. In order to assure however, proper operation of the circuit component **152**, the output radiation level of the flash device **90** must be regulated and toward this end, the voltage supplied thereto from the power supply **136** is controlled by a solid state voltage regulator **164** as diagrammatically shown in FIGURE 1. Automatic compensation is thereby provided for variation in gain within the detection circuit component **152** because of temperature variations. The paper currency acceptor unit may thereby operate over a relatively wide range of temperatures without requiring readjustment.

Referring now to FIGURE 2*a*, the flash tube **92** associated with the flash device **90** is a xenon filled tube having a grounded cathode **166** and an anode **168** supplied with voltage from the voltage regulator **164** so that the radiation output level of the flash tube may be regulated as aforementioned. The flash tube is ignited by the coil **170** connected to the secondary of the triggering transformer **120** the primary of which is connected by the conductor **172** to the flash switch assembly **88**. Thus, when the flash switch **88** is displaced from the position shown in FIGURE 2*a* to its other operative position, ground is applied to one terminal of the primary transformer **120** so as to complete an energizing circuit therethrough. When the transformer primary is grounded by the flash switch **88**, the trigger capacitor **174** is discharged through the primary so that the current induced in the secondary of the transformer **120** ignites the gas within the tube **92**. A conductive path is then established between the cathode **166** and the anode **168** in order to conduct the charge on the capacitor **176** to which the anode **168** is connected by the conductor **178**. The trigger capacitor **174** is charged by a rectified voltage supplied thereto from the secondary winding section **180** of the power transformer **118** through the charging resistor **182**. When the trigger capacitor **174** discharges, the NPN transistor **184** conducts in order to charge the capacitor **176** through resistor **186**. The emitter of the transistor **184** is connected through the resistor **186** to the capacitor **176** so as to maintain the anode voltage on the anode **168** while the tube is conducting. The charge on the capacitor **176** is therefore varied in accordance with the signal applied to the base of the transistor **184** from the collector of the transistor **186**. The center tap of the secondary winding section **180** is therefore connected through the bias resistor **188** to the base of the transistor

184 and through the resistor 190 to the emitter of the transistor 186. A reference bias level is maintained on the emitter of the transistor 186 above the reference voltage line 192 (to which the capacitors 174 and 176 are connected) by the Zener diode 194. The bias on the base of the transistor 186 on the other hand is established through the fixed resistor 196 in parallel with thermistor 198 and the control potentiometer 122. It will therefore be apparent that the anode voltage established on the anode 168 will change in accordance with temperature so that the radiation output from the flash tube will be inversely proportional to the temperature because of the presence of the thermistor 198.

Also associated with the power supply 136, is a secondary winding section 200 supplying a rectified voltage from its center tap to the reversing control circuit 144 through the conductor 202. A regulated voltage is also conducted through the transistor 204 at a level determined by the Zener diode 206 to the voltage line 208 in order to supply operating current for the detection and logic circuits shown in FIGURE 2*b*.

The detection circuit component 152 is properly positioned on a circuit board below the paper supporting tray of the carriage in its intermediate position as aforementioned, and includes a plurality of photo-transistors 210 arranged in proper positions to detect infrared radiation passing through the paper. As shown in FIGURE 3, each transistor 210 includes an emitter connected to a bias regulating terminal 214, a base 212 responsive to infrared radiation and a collector connected to an output terminal 216. With continued reference to FIGURE 2*b*, the base of the first photo-transistor is directly connected to the voltage line 208 while its emitter is connected through the resistor 218 to ground, in order to establish the level of radiation at which this transistor will be rendered conductive. The collectors of the second, third, fourth, and fifth photo-transistors are connected to the voltage lines 208 through resistors 220 while the emitters thereof are respectively connected to ground through resistors 222. Resistors 224 respectively connect the collectors of the sixth and seventh photo-transistors to the voltage line 208 while the emitters thereof are respectively connected directly to ground. Resistors 226 respectively connect the emitters of the eighth and ninth photo-transistors to ground while the collectors thereof are directly connected to the voltage line 208. The values of the collector and emitter resistors 218, 220, 222, 224 and 226 are selected so that the respective photo-transistors will conduct in response to a predetermined distribution and level of infrared radiation corresponding to an acceptable paper currency. When conducting, the output signals from the emitter and collector of the first and second photo-transistors respectively, are fed through coupling capacitors 228 and 230 to the potentiometer 232 through coupling resistors 234 and 236 to form a signal adding network 238 between the first and second photo transistors in order to supply a trigger signal to line 240 dependent upon the amplitude and polarity of the resultant signal. A similar adding network 242 combines the outputs of the third and fourth photo-transistors to supply a triggering signal to line 244. Network 246 combines the output of the second, sixth and seventh photo-transistors in order to develop a trigger signal in line 248. Network 250 combines the output signals from the second, third and fifth photo-transistors to develop a trigger signal in line 252. The fifth and sixth photo-transistors are interconnected by the signal adding network 254 in order to supply a trigger signal to line 256 while the output signal from the emitter of the eighth photo transistor is fed through coupling capacitor 258 and resistor 260 to the grounded potentiometer 262 in order to supply a triggering signal to the line 264. Each of the trigger signal lines 240, 244, 248, 252, 256 and 264 is therefore connected to the trigger terminal 266 of a plurality of monostable multi-vibrators 268, six of which are shown in FIGURE 2*b*. Each monostable multivibrator 268 as shown in FIGURE 4, includes a pair of transistors 270 and 272, the collectors of which are connected to the voltage line 208 by the terminal 274 and the bias resistors 276 and 278. Bias voltage is also applied to the base of transistor 270 through the resistor 280 while the emitters of the transistors are connected to ground through the resistor 282. Resistor 284 couples the collector of transistor 270 to the base of the transistor 272 while capacitor 286 couples the base of transistor 270 to the collector of transistor 272. The trigger signal supplied to terminal 266 is fed through the signal coupling capacitor 288 to the base of transistor 272 in order to trigger the multivibrator into its unstable state. The collectors of the transistor 270 and 272 are also connected to the output terminals 290 and 292, current being conducted through one of the terminals dependent upon the state of the vibrator. The output terminals of the multivibrators A, B and D are respectively connected to the input diodes 294 and 206 of two And gates respectively including the lines 296 and 300. The diodes 296 that are connected to the line 298 form part of the vend gate maintained at a proper level between ground and the voltage line 208 by the resistors 302 and 304. The line 300 to which the diodes 294 are connected from part of the accept gate maintained at the proper potential level between the ground and the voltage line 208 by the resistors 306 and 308. With regard to the monostable multivibrators C and E, only the output of transistor 272 is connected by a diode to the accept gate line 300 while the output of transistor 270 in the monostable multivibrator F is connected by a diode only to the vend gate line 298. The vend line 298 is connected by an output diode 310 to the bistable multivibrator of the accept circuit 150. The diode 312 and resistor 314 also connects line 298 to the bistable multivibrator of the control circuit 160. The accept gate line 300 on the other hand is connected by the diode 316 to the bistable multivibrator 150 so as to transmit a trigger pulse thereto constituting an accept signal. Accordingly, if monostable multivibrators C and E are triggered to their unstable states while monostable multivibrators A, B and D remain in their stable states, an accept voltage is established in line 300 transmitting an accept signal through the diode 316 switching transistor 318 to a non-conductive state and transistor 320 to a conductive state. The voltage line 208 is connected by bias resistors to the transistors 318 and 320 arranged in a conventional bistable multivibrator circuit so that when the transistor 320 is switched to its conductive state, an output pulse will be fed through accept signal line 322 connected to the collector of the transistor 320.

When the vend gate transmits a signal through diode 312 following ejection of an authentic bill from the acceptor 10, the transistor 328 is switched to its non-conductive state while the transistor 330 is switched to its conductive state in order to feed a signal through transistor 332 to the base of transistor 334. The transistor 334 then conducts energizing current to the vend relay 162 in order to perform some vending function by closing of the relay switch 336. At the same time, the transistor 338 of the time delay circuit 158 is switched on so that after a predetermined interval, the capacitor 340 will discharge through diode 342 to supply a reset pulse to the collector of the transistor 330 by a line 344. The control bistable 160 will then be switched to its original state. The control bistable could also be reset manually by means of the switch 346 connecting the voltage line 208 to the resistor 348 so that a trigger pulse may be fed through the capacitor 350 to the base of transistor 330. When the carriage reaches the forward position, a reset pulse is dispatched through line 352 to the base of the transistor 320 in the accept bistable 150 so as to switch it back to its original state. The circuit will then be in condition for a new cycle of operation.

The reversing control circuit 144 includes two bistable

multivibrators **354** and **356** as shown in FIGURE 2*a*. The bistable multivibrator **354** includes two transistors **358** and **360** of the PNP type the output collectors of which are respectively connected to the opposite terminals of the field coil **146** of the motor **80**. Also connected to the opposite terminals of the field coil are the output collectors of the NPN type transistors **362** and **364** in the bistable multivibrator **356**. Assuming that the transistor **358** of the bistable **354** is conductive at the same time that the transistor **364** of the bistable **356** is conductive, current will flow from the regulated voltage line **202** through the transistor **358** to one terminal of the field coil **146** and from the other terminal through the conductive transistor **364** in order to establish a magnetic field of one polarity. A reversing signal applied to the base of transistor **362** through transistor **366** will switch the bistable **356** from one state to the other. The output of the bistable **356** will then supply collector triggering voltage to the bistable **354** to cause it to switch from one state to the other in order to complete a reversal in polarity of the motor field established by the field coil **146**. The field circuit established by the transistors of the bistables **354** and **356** is however completed through the transistor **368** which is switched on and off in order to control the flow of current through the field coil **146** in a direction determined by the bistables **354** and **356** as aforementioned. The switching transistor **368** also controls the flow of current through the armature coil **142** which is connected by the resistor **370** to the emitter of the transistor **368**. The transistor **368** is switched on by a start signal supplied thereto from the collector of transistor **372**. Accordingly, the base of transistor **368** is biased to the proper voltage level through the resistor **374** connecting it to the regulated voltage line **202**. Closing of the series connected safety switch **128** and push button start switch **138** when the carriage is in the forward position as aforementioned, will therefore supply voltage from the voltage line **208** through diode **376** and resistors **378** to the base of the transistor **372** switching it on in order to start a cycle. When the cycle has begun and the carriage moves away from its forward position, the front limit switch **84** then connects the voltage line **208** to the resistor **378** through diode **380** by-passing the switches **128** and **138** and the diode **376**. The field and armature circuits of the motor are thereby maintained complete until the carriage returns to the forward position displacing the front limit switch **84** to the position illustrated in FIGURE 2*a*.

As herebefore indicated, when the photo-transistors **210** sense an acceptable paper, an accept signal is dispatched from the collector of transistor **320** in the accept circuit bistable **150** through accept signal line **322** connected by signal coupling capacitor **382** and resistor **384** to the base of transistor **386** in the monostable multivibrator forming the brake control circuit **148**. The trigger signal supplied to the monostable **148** follows displacement of the flash switch **88** from the position illustrated in FIGURE 2*a* grounding the line **388**. When ground is removed from line **388**, the shunt path through diode **392** is opened so that current is supplied from the voltage line **208** through resistor **394** to the base of transistor **390** to switch it on and conduct base current from the base of transistor **364** in the reversing control circuit. Therefore, the polarity of the motor field is reversed before the accept signal is operative to switch the brake control monostable **148** to its unstable state. When the monostable **148** is switched to its unstable state, the transistor **386** is rendered conductive so as to switch off the transistor **390** by establishing a shunt path through the diode **398** to cut off the transistor **364** of the bistable **356**. At the same time, the transistor **396** in the monostable **148** is rendered non-conductive so that base current from the voltage line **208** may be conducted through the resistor **400** and diode **402** to the base of transistor **366** to switch it on and conduct a trigger pulse from the base of transistor **362** in the bistable **356**. The reversing control circuit **144** is thereby reversed once again so as to immediately restore the polarity of the motor field necessary to continue movement of the carriage toward the rearmost position.

When the carriage reaches the rearmost position, the rear limit switch **86** is closed so as to connect the voltage line **208** to the base of transistor **390** through resistor **404** in order to once again switch the bistable **356** to reverse the field. When the carriage returns to the forward position, actuation of the front switch **84** triggers the monostable of the brake control circuit **148** by supply of voltage from the voltage line **208** through the resistor **406** and capacitor **408** to the base of transistor **386** in order to temporarily switch the monostable to its unstable state so that a reversing pulse is passed through diodes **402** and transistor **366** to the bistable **356** of the reversing control circuit. The motor is stopped at the exact start position by regulating the pulse time of the monostable **148** through the potentiometer **410**.

Also when the switch **84** is actuated to the position shown in FIGURE 2*a* by the carriage returning to the start position, voltage from line **208** is supplied through diode **412** to the reset line **352** in order to reset the bistable multivibrator of accept circuit **150** as aforementioned. During return movement of the carriage, a double reversal of the reversing control circuit occurs once again because a vend signal is transmitted by the vend gate through its output diode **310** to the signal line **322** to switch the monostable multivibrator of the brake control circuit **148** to its unstable state for the second reversal of the reversing control circuit. Accordingly, the carriage will proceed to the forward position.

From the foregoing description, the construction, operation and utility of the paper currency acceptor will be apparent. The device of the present invention may therefore be associated with vending machines for example so as to render them operative in response to the acceptance of authentic paper currency. Inasmuch as the paper currency is authenticated by the passage of infrared radiation therethrough, automatic regulation of the radiation level by the voltage regulator **164** represents an important feature of the invention. Further, in view of the regulated level of radiation, it is essential that the housing enclosure be closed during the paper detecting operation. The releasable lock for the closure lid therefore serves an important function in preventing opening of the lid after the operational cycle has begun. Also, when the releasable lock mechanism is released, opening of the lid will be effective to lift the cover member **60** pivotally mounted on the carriage so that a bill may be paced on the supporting tray mounted on the pivotal section **32** of the carriage. The pivotal section will drop downwardly away from the cover member in the rearmost position of the carriage in order to eject the bill if it is found to be acceptable by the logic circuitry. The logic circuit may be conveniently mounted on a circuit board received by the circuit board track members **110** while the photo detecting circuit will be properly positioned by the circuit board mounting track members **102**. The other circuit component including the reversing and brake control circuits may also be mounted on a circuit board supported by the track members **114**. Thus, the operating component of the device may be readily assembled and disassembled for repair purposes.

Proper operation of the device is also assured because of the manner in which movement of the carriage is controlled. Thus, the drive motor **80** is aways reversed when the carriage reaches the intermediate detecting position so that if an accept signal is not established within the short interval during which the detection operation occurs, the carriage is returned to the forward start position with the counterfeit bill. Establishment of the accept signal on the other hand, reverses the motor once again before there is any physical return movement of the carriage resulting in the continued rearward movement of the

carriage to the delivery position at which the paper currency is ejected. If for some reason the paper currency is not removed from the carriage in the delivery position, no vend signal will be estabished as the carriage reaches the detecting position in a return direction so that no double reversal will occur and the carriage will instead go back to the delivery position in an attempt to again eject the paper currency. The carriage returns finally to the forward start position only when the vend gate is satisfied by saturation of the photo detectors in the absence of any bill on the carriage. Thus, there is no danger of the device returning an authentic bill to the customer, should the bill be taped or otherwise caused to adhere to the carriage in an attempt to prevent it from being deposited.

By replacing the circuit board mounting the detection circuit, the device may be conditioned for different denominations of paper currency as well as for foreign currency.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. In a paper currency acceptor, a housing having an access opening, a closure element mounted on said housing for closing said access opening, a carriage mounted within said housing for movement from a start position exposed through said access opening to a detecting position, a source of infrared radiation mounted within said housing aligned with the carriage in the detecting position thereof, motive means operatively connected to the carriage for displacement thereof to the detection position only after closing of the closure element, photo-detecting means operatively connected to said source of radiation for measuring the opacity of paper currency on the carriage in the detecting position thereof, logic means operatively connected to the photo-detecting means for establishing an accept signal in response to detection of a predetermined opacity and distribution of diffused radiation passing through the paper currency, lock means operatively engageable with the closure element for holding thereof in a position closing the access opening except when the carriage is in the start position, resetting means operatively connected to the logic means and the motive means for returning the carriage to said start position to release the lock means, and means responsive to establishment of said accept signal for removing said paper currency from the carriage before the resetting means is rendered operative.

2. The combination of claim **1** wherein said carriage compises a track mounted assembly having a driven portion movable along a fixed path and a displaceable portion pivotally connected thereto. a supporting tray mounted on the displaceable portion for carrying paper currency thereon, a cover member movably mounted by the driven portion in alignment with the supporting tray, means connected to cover member and engageable with the lock means for release thereof including means for displacing the cover member from the tray in response to opening of the closure element.

3. The combination of claim **2** including an outlet gate mounted on the housing through which acceptable paper currency is ejected, means responsive to movement of the carriage to a delivery position beyond the detecting position for displacing the displaceable portion from said fixed path to eject the paper currency and means responsive to said displacement of the displaceable portion of the carriage from the fixed path for opening the outlet gate.

4. The combination of claim **3** wherein said motive means comprises, a reversible electric motor having a field circuit and an armature circuit, polarity control means connected to the field circuit for reversal of the motor at the detection position of the carriage, stop control means connected to the polarity control means and rendered operative for reversal of the motor at the detection position and the start position of the carriage, means responsive to establishment of said accept signal for rendering the stop control means operative to reverse the the motor at the detection position, limit switch means connected to the stop control means and the polarity control means for rendering the stop control means operative at the start position to reverse the motor, and starting means connected to the limit switch means for selectively completing the field and armature circuits when the carriage is in the start position.

5. The combination of claim **4** wherein said logic means comprises a first And gate for transmitting said accept signal in response to detection of acceptable paper currency by the photo-detecting means, an accept circuit connected to the first And gate for rendering the stop control means operative to reverse the motor, and a second And gate connected to the photo-detecting means for transmitting a return signal in response to return movement of the carriage to the detection position without any paper currency thereon to reverse the motor.

6. The combination of claim **5** wherein said limit switch means includes a trigger switch actuated by the carriage at the detection position, ignition means connected to the source of radiation for igniting thereof and means connecting the trigger switch to the ignition means and the polarity control means for simultaneously igniting the source of radiation and reversing the motive means.

7. The combination of claim **1** wherein said motive means comprises, a reversible electric motor having a field circuit and an armature circuit, polarity control means connected to the field circuit for reversal of the motor at the detection position of the carriage, stop control means connected to the polarity control means and rendered operative for reversal of the motor at the detection position and the start position of the carriage, means responsive to establishment of said accept signal for rendering the stop control means operative at the detection position, limit switch means connected to the stop control means and the polarity control means for rendering the stop control means operative at the start position to reverse the motor, and starting means connected to the limit switch means for selectively completing the field and armature circuit when the carriage is in the start position.

8. The combination of claim **7** wherein said logic means comprises a first And gate for transmitting said accept signal in response to detection of acceptable paper currency by the photo-detecting means, an accept circuit connected to the first And gate for rendering the stop control means operative to reverse the motor, and a second And gate connected to the photo-detecting means for transmitting a return signal in response to return movement of the carriage to the detection position without any paper currency thereon to reverse the motor.

9. The combination of claim **8** wherein said limit switch means includes a trigger switch actuated by the carriage at the detection position, ignition means connected to the source of radiation for igniting thereof and means connecting the trigger switch to the ignition means and the polarity control means for simultaneously igniting the source of radiation and reversing the motive means.

10. In a paper currency acceptor, a housing having an access opening, a closure element mounted on said housing for closing said access opening, a carriage mounted within said housing for movement from a start position exposed through said access opening to a detecting position, a source of infrared radiation mounted within said housing aligned with the carriage in the detecting position thereof, motive means operatively connected to the carriage for displacement thereof to the detection position in response to closing of the closure element, photo-

detecting means operatively connected to said source of radiation for measuring the opacity of paper currency on the carriage in the detecting position thereof, logic means operatively connected to the photo-detecting means for establishing an accept signal in response to detection of a predetermined opacity and distribution of diffused radiation passing through the paper currency, lock means operatively engageable with the closure element for holding thereof in a position closing the access opening except when the carriage is in the start position, resetting means operatively connected to the logic means and the motive means for returning the carriage to said start position to release the lock means, and means responsive to establishment of said accept signal for removing said paper currency from the carriage before the resetting means is rendered operative, an outlet gate mounted on the housing through which acceptable paper currency is ejected, means responsive to movement of the carriage to a delivery position beyond the detecting position for displacing the carriage from a fixed path to eject the paper currency and means responsive to said displacement of the displaceable portion of the carriage from the fixed path for opening the outlet gate.

11. In a paper currency acceptor, the combination of a housing having an access opening and an outlet opening, a closure element closing said access opening, an outlet gate closing said outlet opening, track means mounted in said housing and a carriage mounted for movement by said track means including, a driven portion movable along a fixed path from a start position to a delivery position and a displaceable portion for carrying paper currency thereon, a cover member movably mounted by the driven portion, means connected to cover member and engageable with the lock means for release thereof including means for displacing the cover member from the driven portion in response to opening of the closure element, means responsive to movement of the carriage to said delivery position for displacing the displaceable portion from said fixed path to eject the paper currency and means responsive to said displacement of the displaceable portion of the carriage from the fixed path for opening the outlet gate.

12. In a paper currency acceptor having a carriage movable to and from a start position, a detection position and a delivery position and logic means for establishing an accept signal, motive means for displacing said carriage between said positions comprising a reversible electric motor having a field circuit aand an armature circuit, polarity control means connected to the field circuit for reversal of the motor at the detection position of the carriage, stop control means connected to the polarity control means and rendered operative for reversal of the motor at the detection position and the start position of the carriage, means responsive to establishment of said accept signal for rendering the stop control means operative at the detection position, limit switch means connected to the stop control means and the polarity control means for rendering the stop control means operative at the start position to reverse the motor, and starting means connected to the limit switch means for selectively completing the field and armature circuits when the carriage is in the start position.

13. The combination of claim **12** wherein said logic means comprises a first And gate for transmitting said accept signal in response to detection of acceptable paper currency, an accept circuit connected to the first And gate for rendering the stop control means operative to reverse the motor, and a second And gate for transmitting a return signal in response to return movement of the carriage to the detection position without any paper currency thereon to reverse the motor.

14. In a paper currency acceptor having a flash device and a photo-detection circuit for detecting radiation emitted from the flash device, motor means for moving paper currency to and from a start position, a detection position and a delivery position and a control circuit for controlling movement of the motor means comprising, a plurality of limit switches respectively actuated by the motor means in said positions thereof, a bistable accept device connected to one of said limit switches for resetting thereof in the start position of the motor means, a first And gate connecting the photo-detection circuit to the accept device for switching thereof in response to an accept signal from the photo detection circuit, a monostable control device connected to said one of the limit switches and the accept device for switching thereof to an unstable state, a second And gate connected to the photo-detection circuit for transmitting a vend signal in the absence of any paper currency, names connecting the second And gate to the monostable control device for switching thereof to said unstable state, a field reversing switch device connected to the motor means, means connecting two other of the limit switches to the field reversing switch device for reversal of the motor means at the detection and the delivery positions, means connecting one of said two limit switches to the flash device for ignition thereof simultaneously wtih said reversal of the motor means at the detection position, and means connecting said monostable control device to the field reversing switch device for reversal of the motor means in response to said switching to the unstable state.

15. The combination of claim **14** wherein said field reversing switch device includes a pair of interconnected bistable multivibrators conducting field current in opposite directions, a circuit completing switch device connected to said bistable multivibrators and selectively controlled start means connecting said one of the limit switches to the circuit completing switch device for energizing the motor means at the start position.

16. In a paper currency acceptor, an enclosure having an access opening, carriage means displaceable from a start position exposed through said opening to a detection position, radiation means triggered by the carriage means in the detection position, a reversible motor operatively connected to the carriage means for displacement thereof to the detection position, control means connected to the motor for reversing the motor at the detection position and at the start position, and photo-responsive means connected to the control means for reversing the motor twice at the detection position of the carriage means.

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