

Dec. 23, 1969

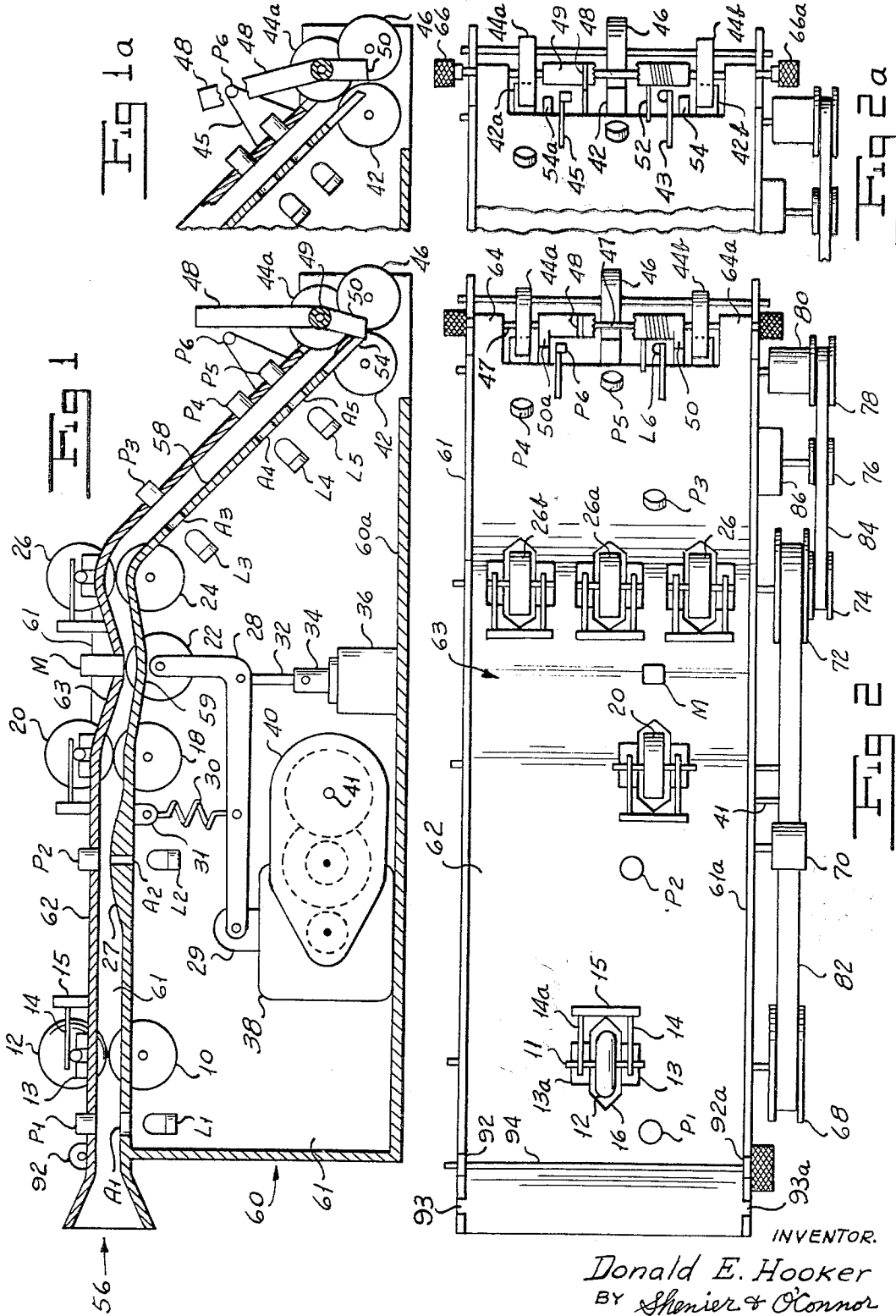
D. E. HOOKER

3,485,358

DOLLAR BILL COLLECTOR

Filed April 26, 1967

3 Sheets-Sheet 1



INVENTOR.

Donald E. Hooker

BY *Shenier & O'Connor*

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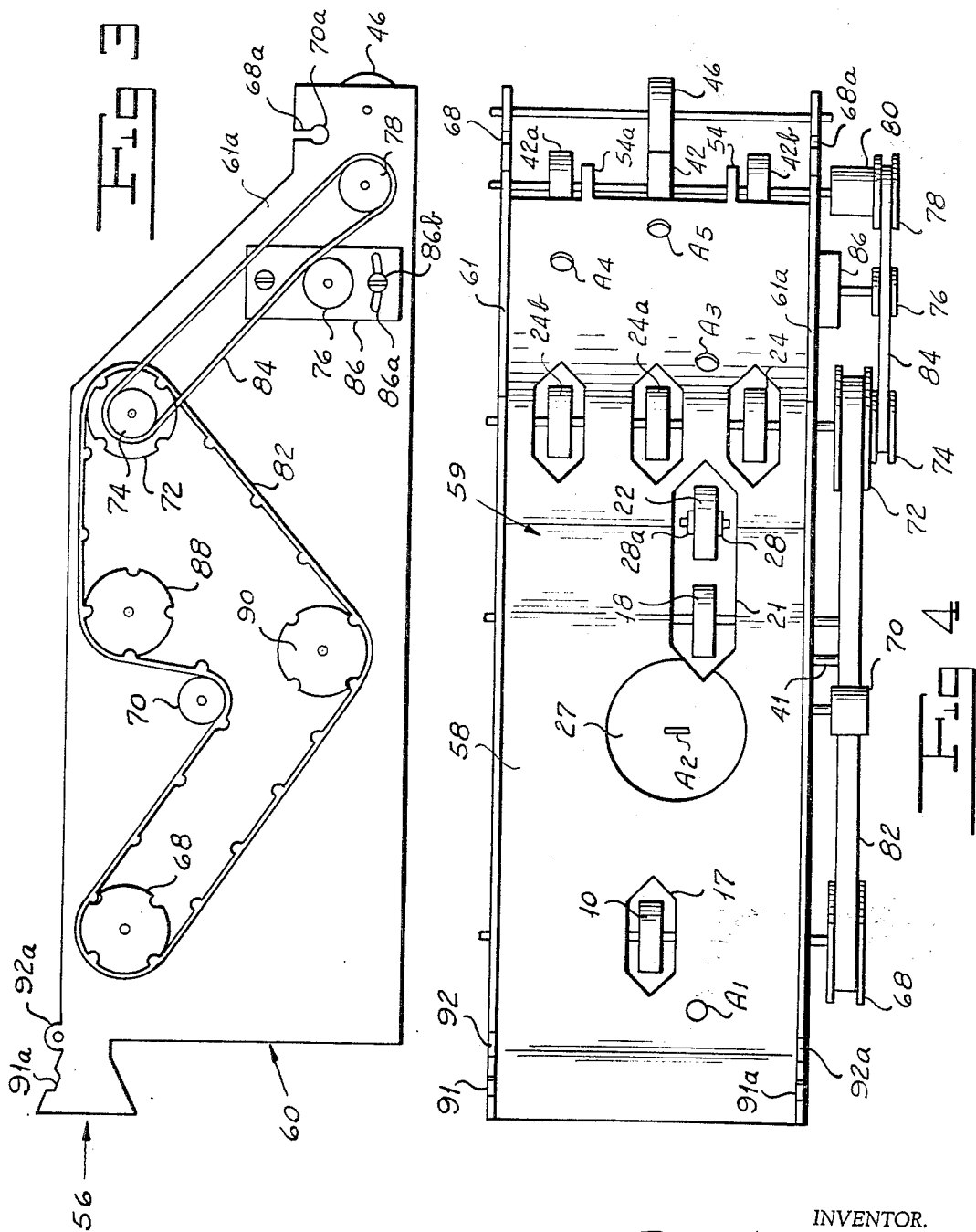
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3 Sheets-Sheet 2



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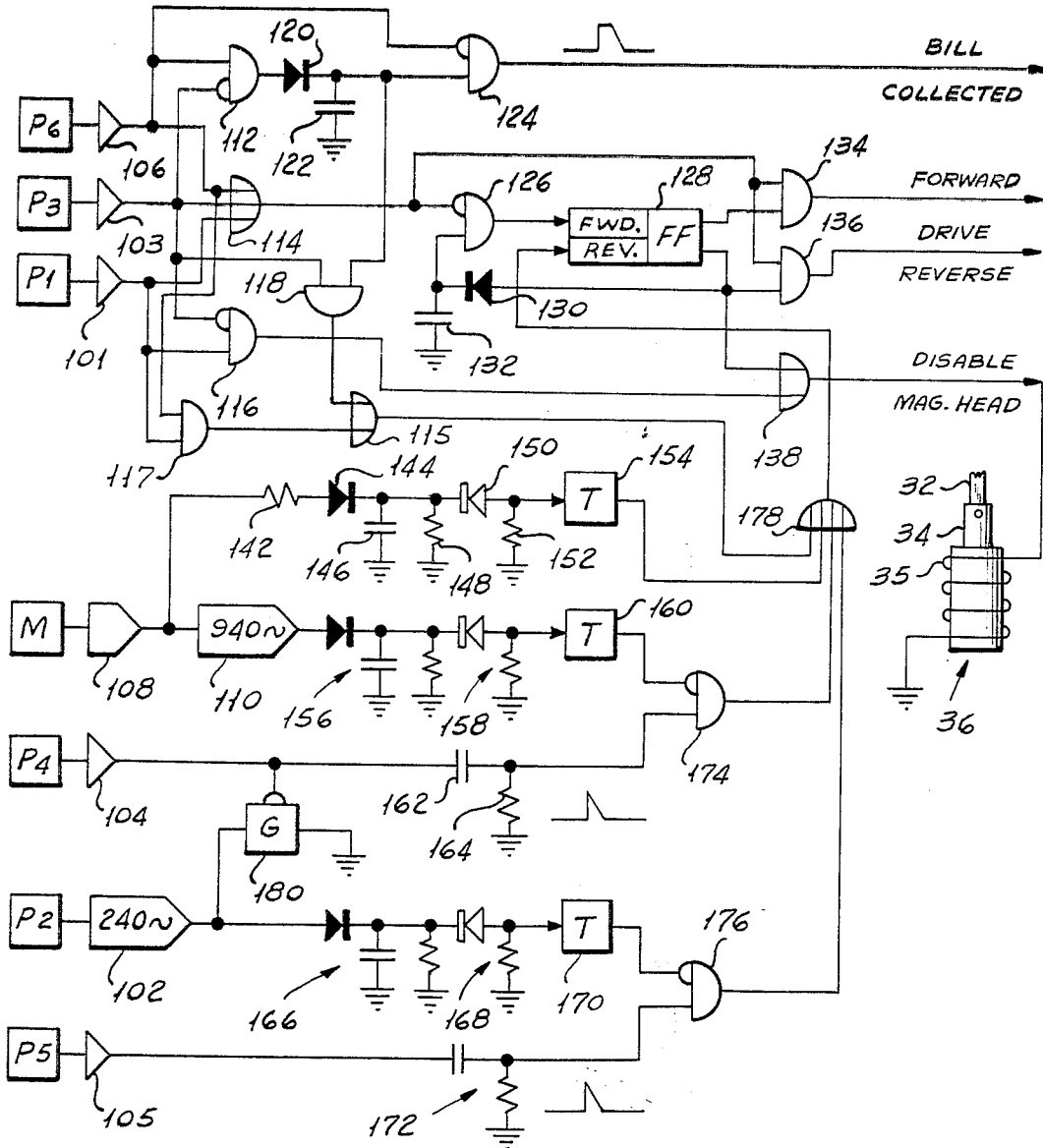
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3 Sheets-Sheet 3

Fig 5



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DOLLAR BILL COLLECTOR

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14 Claims

ABSTRACT OF THE DISCLOSURE

A dollar bill collector comprises a passageway along which a bill is normally driven in a forward direction. Magnetic and optical tests are serially performed; and a rejection signal is generated immediately upon the failing of any test. The magnetic test is performed by a normally enabled reading head which is selectively disabled to permit insertion of the leading edge of the bill. A tuned amplifier determines if the spacing of the vertical grid lines in the portrait background is correct. Excessive R.M.S. output from the reading head generates a rejection signal. The optical test is performed with a tuned amplifier to measure the spacing between the light and dark vertical bars forming the shield on the reverse or green side of the bill. A rejection signal is also provided if any attempt is made to withdraw the bill by a thread secured to its trailing edge. Any rejection signal reverses the drive mechanism and returns the bill to the patron. A unidirectional escapement mechanism at the passageway exit prevents withdrawal of collected bills.

BACKGROUND OF THE INVENTION

Some currency detectors of the prior art perform the magnetic and optical tests simultaneously rather than serially, and do not accept a bill unless both tests are passed.

Other currency detectors of the prior art provide anti-withdrawal devices for the dollar bill at the entrance of the passageway rather than at the exit of the passageway.

Still other currency detectors of the prior art employ tuned amplifiers for the magnetic test without any provision for discriminating against the white noise of a random but intense pattern of magnetic material.

Further currency detectors of the prior art perform optical tests measuring the space or time separation between two predetermined points on a bill. This requires the use either of a pair of accurately spaced optical detectors or the use of a single optical detector in conjunction with monostable flip-flops or other transient timing circuits, while in my invention the space or time separation in the optical test is for a recurrent pattern which is readily detected by a single tuned amplifier.

Still further currency detectors of the prior art employ a normally disabled magnetic head which is selectively enabled by the energization of a solenoid rather than using a normally enabled magnetic head which is selectively disabled by energizing a solenoid.

SUMMARY OF THE INVENTION

One object of my invention is to provide a dollar bill collector in which magnetic and optical tests are serially performed and the bill is rejected immediately upon the failing of any test.

Another object of my invention is to provide a dollar bill collector in which an escapement mechanism is provided at the exit of the bill passageway.

Still another object of my invention is to provide a dollar bill collector utilizing a normally enabled magnetic head which is selectively disabled by a solenoid.

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A further object of my invention is to provide a dollar bill collector which rejects any bill containing excessively intense magnetic material irrespective of its pattern.

A still further object of my invention is to provide a dollar bill collector employing a tuned amplifier responsive to light transmitted through the bill.

Other and further objects of my invention will appear from the following description.

DESCRIPTION OF THE DRAWINGS

In the accompanying drawings which form part of the instant specification and which are to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views:

FIGURE 1 is a sectional elevation of my dollar bill collector.

FIGURE 1a is a fragmentary sectional elevation showing the operation of the escapement or keeper mechanism at the exit of the passageway.

FIGURE 2 is a plan view of my dollar bill collector.

FIGURE 2a is a fragmentary plan view showing the operation of the escapement or keeper mechanism.

FIGURE 3 is a side elevation with the cover of the passageway removed.

FIGURE 4 is a plan view with the passageway cover removed.

FIGURE 5 is a schematic view showing the circuit connections of my dollar bill collector.

DESCRIPTION OF THE PREFERRED EMBODIMENT

More particularly, referring now to the drawings, a passageway 56 is defined by the upper surface 58 of a housing indicated generally by the reference numeral 60 and by a cover plate 62. The initial and major portion of the passageway extends horizontally; and the terminal portion of the passageway slopes downwardly toward the rear of the housing 60. The upper surface 58 is provided with spaced apertures, A1 through A5, through which light from corresponding lamps L1 through L5 passes to impinge upon corresponding photocells P1 through P5 which are mounted in the cover plate 62. The housing is provided with spaced rubber drive rollers 10, 18, and 24, 24a, and 24b, which extend into the passageway through slots cut in the upper surface 58 of the housing. Roller 10 extends through slot 17 and is mounted upon a shaft provided with a drive sprocket 68. Roller 18 extends through an elongated slot 21 and is mounted on a shaft provided with a drive sprocket 88. Rollers 24, 24a and 24b are laterally spaced across the passageway and are mounted on a shaft which is provided with a drive sprocket 72 and with a sheave 74.

Roller 10 engages a plastic wheel 12 which is mounted on the cover plate 62 and extends into the passageway through a slot 16. Wheel 12 is mounted on a stub shaft 11 which is provided with lateral and longitudinal restraint by open hangers 13 and 13a mounted on cover plate 62. From a support 15 mounted on cover plate 62 extend a pair of leaf springs 14 and 14a which bear upon shaft 11 to force wheel 12 downwardly into engagement with roller 10. Roller 18 is engaged by a magnetizing roller 20 formed of a permanent magnetic material which is mounted on cover plate 62 and extends into the passageway through a slot. Rollers 24, 24a, and 24b are engaged by corresponding plastic rollers 26, 26a, and 26b mounted on cover plate 62 and extending into the passageway through slots therein. Rollers 20 and 26 through 26b are provided with spring loading in the manner described for wheel 12. The cover plate 62 is provided with a laterally extending depression 63 where is positioned a magnetic reading head M. The upper surface 58 is provided with a co-acting depression 59 at which a rubber idler roller 22

extends into the passageway through the elongated slot 21 to bear against the reading head M. The depression 63 is greater than half the thickness of the passageway and is shown as being equal to the passageway thickness. Idler roller 22 is provided with a stub shaft which is supported by struts 28 and 28a which are journaled in a support 29 mounted on top of the drive motor 38. Roller 22 is resiliently urged against reading head M by a spring 30, one end of which is secured to parallel struts 28 and 28a, the other end of which is secured to a support 31 at the top of the housing. A link 32 connects the parallel struts 28 and 28a to the plunger 34 of a solenoid 36 which is secured to the bottom surface 60a of the housing. Motor 38 is also secured to the bottom surface 60a and is provided with a speed reduction gearbox 40 having an output shaft 41 upon which is mounted a master drive sprocket 90.

Passageway 58 is laterally defined by the side walls 61 and 61a of the housing. The upper surface 58 is provided with a circular mound centered upon aperture A2 to provide support for the bill in performing the optical test. The height of the mound 27 is substantially equal to half the thickness of the passageway. Aperture A2 comprises a transverse slit approximately $\frac{3}{16}$ inch wide and approximately .02 inch long.

At the exit of the passageway there are provided three laterally spaced rubber rollers 42, 42a and 42b, which extend into the passageway from within the housing 60. Rollers 42 through 42b are mounted on a shaft supported in side walls 61 and 61a, which is provided with a slip clutch 80 and a driving sheave 78. The outside rollers 42a and 42b are respectively engaged by plastic rollers 44a and 44b mounted on shaft 47. Shaft 47 is provided with spring loaded locating pins 66 and 66a which co-act with locating holes 70 (not shown) and 70a in respective side walls 61 and 61a. The locating holes 70a and 70 are positioned at the ends of slots 68a and 68 having widths slightly larger than the diameter of shaft 47. The cover plate 62 is pivotally supported on shaft 47 by extensions 64 and 64a. In FIGURE 2 the locating pins are shown engaging the locating holes; while in FIGURE 2a the locating pins 66 and 66a are shown withdrawn from the locating holes 70 and 70a for removal of cover plate 62. Cover plate 62 is provided with ears 93 and 93a which are received by respective slots 91 and 91a cut in side walls 61 and 61a at the passageway entrance. Cover plate 62 is held in position by a pin 94 which extends through holes in projections 92 and 92a of respective side walls 61 and 61a.

Upon shaft 47 is mounted a spool 49 which is provided with an upstanding vane 48 and with depending legs 50 and 50a. Spool 49 is resiliently biased clockwise in FIGURES 1 and 1a by a spring 52 so that depending legs 50 and 50a engage respective extensions 54 and 54a of the upper surface 58 of the housing. Cover plate 62 is provided with upstanding supports 43 and 45 at the ends of which are respectively mounted a lamp L6 and a photocell P6. The center roller 42 is engaged by plastic roller 46 mounted on a shaft journaled in side walls 61 and 61a.

Sprockets 68, 88, 72 and 90 are engaged by a cog belt 82. The cog belt is maintained in engagement with sprocket 88 for an appreciable portion of its periphery by an idler 70. Sheaves 74 and 78 are engaged by a drive belt 84. The tension on drive belt 84 is adjusted by an idler 76 which is mounted on a block 86 provided with a slide 86a and an adjusting screw 86b.

Referring now to FIGURE 5, the photocells P1, P3, P4, P5, and P6 provide outputs which are coupled to respective direct current amplifiers 101, 103, 104, 105, and 106. The outputs of amplifiers 101, 103, and 106 are coupled to an OR circuit 114 the output of which is impressed upon an inhibiting input of AND circuit 126 and one input of each of AND circuits 134 and

136. The output of AND circuit 126 sets a bi-stable flip-flop 128 for forward motor drive. One output of flip-flop 128 enables AND circuit 134; and the other output of flip-flop 128 is applied to AND circuit 136 and is coupled forwardly through a rectifier 130 to an enabling input of AND circuit 126. The cathode of rectifier 130 is connected to ground through a storage capacitor 132. Rectifier 130 in conjunction with capacitor 132 comprises a box car or holding circuit. The AND circuit 134 excites motor 38 for forward drive; and AND circuit 136 excites motor 38 for reverse drive. The outputs of amplifiers 101 and 103 are coupled to respective enabling and inhibiting inputs of AND circuit 116. The anode of rectifier 130 and the output of AND circuit 116 are coupled through an OR circuit 138 to energize the winding 35 of solenoid 36 and thus withdraw roller 22 from engagement with the magnetic reading head. The output of reading head M is coupled to a wide-band alternating current amplifier 108. The pass band of amplifier 108 may extend, for example, from 30 cycles to 30 kilocycles per second. The output of wideband alternating current amplifier 108 is coupled through a resistor 142 to the anode of a rectifier 144. The cathode of rectifier 144 is connected to ground through the parallel combination of a capacitor 146 and a resistor 148. Components 144, 146, and 148 comprise a detector. Resistor 142 is provided so that this detector responds more to average values of alternating current rather than to peak values. The cathode of rectifier 144 is coupled to the cathode of a Zener diode 150. The anode of Zener diode 150 is coupled to ground through a resistor 152 and is applied to a single input trigger circuit 154. Zener diode 150 and resistor 152 comprise a hysteresis or voltage delay circuit which requires a predetermined output from the detector to actuate trigger circuit 154. The output of wide-band amplifier 108 is coupled to a tuned amplifier 110 having a center frequency of 940 cycles per second. The output of tuned amplifier 110 is applied to a detector 156 the output of which is coupled through voltage delay circuit 158 to actuate a trigger circuit 160. The output of photocell P2 is applied to a tuned amplifier 102 having a center frequency of 240 cycles per second. The output of tuned amplifier 102 is coupled to a detector 166 the output of which is applied through a voltage delay circuit 168 to actuate a trigger circuit 170. The output of tuned amplifier 102 is normally grounded through a gate 180. The output of direct current amplifier 104 is applied to inhibit or disable the gate 180 and is further coupled through a high-pass filter or differentiating circuit, comprising a series capacitor 162 and a shunt resistor 164, to an enabling input of AND circuit 174. The direct current output of amplifier 105 is coupled through a high-pass filter or differentiating circuit 172 to an enabling input of AND circuit 176. The outputs of trigger circuits 160 and 170 are coupled to respective inhibiting inputs of AND circuits 174 and 176. The outputs of amplifiers 106 and 103 are applied to respective enabling and inhibiting inputs of AND circuit 112. The output of AND circuit 112 is applied to a box car or holding circuit comprising a forwardly polarized series rectifier 120 and a shunt storage capacitor 122. The cathode of rectifier 120 and the output of amplifier 103 are coupled to an AND circuit 118. The outputs of amplifiers 101 and 106 are coupled to an AND circuit 117. The outputs of AND circuits 117 and 118 are applied to an OR circuit 115. The outputs of OR circuit 115, trigger circuit 154, and AND circuits 174 and 176 are coupled to an OR circuit 178, the output of which triggers bi-stable flip-flop 128 for reverse motor drive. The cathode of rectifier 120 and the output of amplifier 106 are coupled to respective enabling and inhibiting inputs of AND circuit 124 which provides an output indicating that a dollar bill has been collected and change should be delivered.

In operation of my invention, a dollar bill is inserted at the passageway entrance with the portrait uppermost and

facing the direction of travel. When the leading edge of the bill masks aperture A1, thus reducing the light from lamp L1 which is received by photocell P1, the output of amplifier 101 rises from ground potential to provide a positive output which is coupled through OR circuit 114 to enable AND circuit 134. Flip-flop 128 is set for forward drive as will be explained hereinafter. Accordingly, AND circuit 134 provides an output energizing motor 38 in forward drive. The presence of an output from amplifier 101 also causes AND circuit 116 to provide an output which, through OR circuit 138, energizes winding 35 of solenoid 36, withdrawing roller 22 from engagement with the magnetic reading head in preparation for movement of the leading edge of the bill past the reading head. Upon further insertion of the bill, the leading edge is entrained by roller 10 and wheel 12, so that the bill may be released. The provision of wheel 12 permits alignment of the bill as it moves down the passageway by engagement with the side walls 61 and 61a. The leading edge of the bill is subsequently entrained by roller 18 and magnetizing roller 20 and thereafter by rollers 26-26b and 24-24b. The bill is now directed downwardly toward the rear of the housing where the leading edge masks aperture A3, reducing the light received by photocell P3 from lamp L3. This produces a positive output from amplifier 103 which is coupled through OR circuit 114 to maintain AND circuit 134 enabled. The spacing between apertures A1 and A3 is $5\frac{1}{16}$ inches, which is appreciably less than the $6\frac{1}{16}$ inch length of a dollar bill. Accordingly there is an overlap in the signals from amplifiers 101 and 103 in providing an output from OR circuit 114 to maintain the AND circuit 134 enabled. The output from amplifier 103 inhibits AND circuit 116, thus removing the disabling signal from winding 35 of solenoid 36. Roller 22 now moves upwardly and presses the bill against the magnetic reading head with a constant resilient force predetermined by spring 30. A dollar bill cannot support any appreciable compressional force; and the magnetic reading head is not enabled until rollers 26-26b and 24-24b have entrained the leading edge so that the bill can be pulled past the reading head, which does offer some retarding friction. The magnetic reading head and magnetizing roller scan along a band which is centered at about $1\frac{5}{16}$ inch from the bottom of the bill and passes through the neck of the portrait. As the bill continues down the passageway the magnetizing roller engages the leading portion of the portrait thus magnetizing the magnetic ink with which it is engraved. Motor 38 is preferably a synchronous motor but may be a low slip induction motor so that the speed of the bill is accurately regulated at approximately $8\frac{1}{2}$ inches per second. After approximately $\frac{1}{4}$ inch of further forward drive the trailing edge of the bill passes aperture A1; and the output of amplifier 101 drops to ground potential. However, the signal from amplifier 103 maintains a drive enabling signal from OR circuit 114. Upon further movement of the bill, the leading portion of the portrait background engages the magnetic head. If the horizontal spacing between the vertically extending grid lines of the portrait background is proper, amplifier 110 will build up an output at its tuned frequency of 940 cycles per second. Upon further movement the leading edge of the bill masks aperture A4. The spacing between the magnetic reading head and aperture A4 is $2\frac{3}{4}$ inches so that the magnetic reading head is approximately $\frac{1}{16}$ inch to the right of the neck of the portrait. Accordingly the magnetic reading head has scanned an $1\frac{1}{32}$ inch length, which constitutes most of the leading portion of the portrait background and contains approximately forty vertically extending grid lines in a normal bill, there are approximately 110 vertical grid lines per inch in the portrait background. The Q of amplifier 110 may range between 20 and 160, for example. For low Q's the output of tuned amplifier 110 approaches a steady state value by the time aperture A4 is masked. For high Q's the output of amplifier 110 is still building up exponentially toward a much

larger steady state value at the time aperture A4 is masked, so that the amplifier acts more as an integrator. Conveniently, the Q of amplifier 110 may be approximately 40 so that its output builds up to approximately 63% of its steady state value at the time aperture A4 is masked. This will yield an appreciable signal level in the output of amplifier 110 while affording a reasonable approximation to a time integral output. The peak amplitude of the alternating current output of tuned amplifier 110 is sensed by detector 156. If the horizontal spacing between grid lines is proper and the magnetic ink sufficiently intense, the output of detector 156 will appreciably exceed the voltage delay provided by hysteresis circuit 158, thus actuating trigger circuit 160 which inhibits AND circuit 174. The masking of aperture A4 causes the output of amplifier 104 to become positive, which produces a positive-going pulse from the differentiating circuit comprising capacitor 162 and resistor 164. However, this pulse is not coupled through AND circuit 174 when it is inhibited by trigger circuit 160.

If the horizontal spacing between the grid lines is improper or there are an insufficient number of grid lines or if the magnetic ink is excessively weak, the output of amplifier 110 will not build up to its proper value; and the output of detector 156 will not be sufficient to overcome the voltage delay of the Zener diode of hysteresis circuit 158. Trigger circuit 160 will not be actuated; AND circuit 174 will not be inhibited; and the differentiated pulse from amplifier 104 will be coupled through AND circuit 174 and OR circuit 178, triggering flip-flop 128 for reverse drive.

The triggering of flip-flop 128 inhibits AND circuit 134 and enables AND circuit 136. The master drive signal from OR circuit 114 is now coupled through AND circuit 136, actuating drive motor 38 in reverse to return the bill to the patron at the passageway entrance. Whenever flip-flop 128 is set for reverse drive, a signal is coupled through OR circuit 138 which energizes winding 35 of solenoid 36 to withdraw roller 22 from the magnetic reading head. The setting of flip-flop 128 for reverse drive also applies a positive signal through diode 130 to storage capacitor 132, which enables AND circuit 126. However, AND circuit 126 provides no output since it is inhibited by the presence of a master drive signal from OR circuit 114. Reverse drive may conveniently be at a linear speed of $8\frac{1}{2}$ inches per second so that the bill has sufficient momentum when being returned past roller 10 and wheel 12 to carry the leading edge of the bill beyond aperture A1, thus exposing photocell P1 to light and causing the output of amplifier 101 to drop to ground potential.

The OR circuit 114 no longer provides an output; and the inhibiting signal to AND circuit 126 is thus removed. The signal from the boxcar holding capacitor 132 is coupled through AND circuit 126 to trigger flip-flop 128 for forward drive. When flip-flop 128 is triggered for forward drive, no signal is impressed through rectifier 130 upon capacitor 132; and capacitor 132 discharges to ground with a time-constant of 1 millisecond, for example.

At the time the leading edge of the bill masks aperture A4, aperture A2 is approximately $\frac{1}{16}$ inch in front of the shield on the reverse side of the bill. The positive output of amplifier 104 inhibits gate 180, thus unclamping the output of amplifier 102 from ground potential. As the leading edge of the bill traverses the $\frac{3}{8}$ inch distance between apertures A4 and A5, aperture A2 and photocell P2 scan the $\frac{1}{4}$ inch length of the shield. At the time aperture A5 is masked by the leading edge of the bill, aperture A2 is approximately $\frac{1}{16}$ inch behind the shield. If the horizontal spacing between the grid lines of the shield is proper, amplifier 102 will build up an output at its tuned frequency of 240 cycles per second. The Q of amplifier 102 may range between 3 and 28, for example. For low Q's, the output of tuned amplifier 102

approaches a steady state value by the time aperture A5 is masked. For high Q's, the output of amplifier 102 is still building up exponentially towards a much larger steady states value at the time aperture A5 is masked, so that the amplifier acts more as an integrator. Conveniently, the Q of amplifier 102 may be approximately 6 or 7, so that its output builds up to approximately 63% of its steady state value at the time aperture A5 is masked. This will yield an appreciable signal level in the output of amplifier 102 while affording a reasonable approximation to a time integral output. It will be appreciated that a Q value of approximately 6 or 7 corresponds to the number of vertically extending lines in the shield. The peak amplitude of the alternating current output of tuned amplifier 102 is sensed by detector 166. If the horizontal spacing between the grid lines is proper and the grid lines are sufficiently intense, the output of detector 166 will appreciably exceed the voltage delay provided by hysteresis circuit 168, thus actuating trigger circuit 170 which applies an inhibiting signal to AND circuit 176. The masking of aperture A5 causes the output of amplifier 105 to become positive which produces a positive-going pulse from differentiating circuit 172. However, this pulse is not coupled through AND circuit 176, when it is inhibited by trigger circuit 170.

If the horizontal spacing between the grid lines of the shield is improper or there are an insufficient number of grid lines or if the lines are not sufficiently intense, the output of amplifier 102 will not build up to its proper value; and the output of detector 166 will not be sufficient to overcome the voltage delay of the Zener diode of hysteresis circuit 168. Trigger circuit 170 will not be actuated; AND circuit 176 will not be inhibited; and the differential pulse from amplifier 105 will be coupled through AND circuit 176 and OR circuit 178, triggering flip-flop 128 for reverse drive. Whenever flip-flop 128 is triggered for reverse drive, the previously outlined sequence of events occurs to return the bill to the patron, whereupon flip-flop 128 is triggered by boxcar holding capacitor 132 for forward drive.

If the bill fails neither the magnetic test which occurs at aperture A4 nor the optical test which occurs at aperture A5, then the bill continues down the passageway, where it is entrained by rollers 42a-42b and 44a-44b. The leading edge of the bill now engages depending legs 50 and 50a, rotating vane 48 from the position shown in FIGURE 1 to that shown in FIGURE 1a. With vane 48 in the position shown in FIGURE 1a, light from lamp L6 no longer impinges upon photocell P6; and the output of amplifier 106 becomes positive. The positive output of amplifier 106 is coupled through OR circuit 114 insuring the continued existence of a master drive signal. The positive output of amplifier 106 also applies an inhibiting input to AND circuit 124, an enabling input to AND circuit 112, and an enabling input to AND circuit 117.

If the patron has secured a long strip of paper to the trailing edge of the bill by pressure sensitive tape, for example, then the output of amplifier 101 will be positive at the time the output of amplifier 106 becomes positive. The AND circuit 117 will now provide an output which is coupled through OR circuits 115 and 178 to trigger flip-flop 128 for reverse drive. Thus the bill is returned to the patron at the passageway entrance.

I have found that the white noise of an irregular but intense pattern of magnetic material on a piece of ordinary paper may contain a sufficient R.M.S. component in the pass band of the tuned amplifier to improperly indicate the presence of a valid bill. Accordingly, the R.M.S. output of the magnetic head is measured; and an excessive value generates a rejection signal.

The leading edge of the bill is thereafter entrained by rollers 42 and 46 which direct the bill downwardly into a collection box (not shown). As the bill continues down

the passageway, the trailing edge thereof first passes aperture A2 and subsequently the magnetic reading head M. If the magnetic properties of the bill along the track scanned by the magnetic reading head are excessively intense, then the rectified output appearing across components 146 and 148 will exceed the hysteresis delay provided by Zener diode 150, thus actuating trigger circuit 154. The actuation of trigger circuit 154 at any time applies a signal through OR circuit 178 which triggers flip-flop 128 for reverse drive. It makes no difference whether the excessively intense magnetic pattern occurs in the area of the portrait or in the border adjacent the trailing edge of the bill. It will be seen that the bill is rejected if an excessively intense magnetic signal is received whether this occurs before or after the optical or magnetic tests which are accomplished by the tuned amplifiers 102 and 110. Resistor 142, as previously indicated, is provided so that the detector comprising components 144, 146, and 148 responds more to the average value of alternating current rather than to peak values. This insures that trigger circuit 154 will not be actuated by an extremely small deposit of excessively intense magnetic material. However, if desired, resistor 142 may be omitted so that the detector comprising components 144, 146, and 148 responds to peak values of alternating current; and trigger circuit 154 will be actuated if the bill contains even the smallest portion of excessively intense magnetic material.

The trailing edge of the bill subsequently passes rollers 24 through 24b and 26 through 26b. Thereafter the trailing edge of the bill passes aperture A3, causing the output of amplifier 103 to drop to ground potential. A master drive signal is still produced by OR circuit 114, because amplifier 106 provides a positive output. When the output of amplifier 103 drops to ground potential, the inhibiting signal is removed from AND circuit 112 which now provides an output. This output is coupled through rectifier 120 and stored by boxcar holding capacitor 122. The tension on slip clutch 80 is adjusted so that the bill may readily be withdrawn by any string or thread attached to the trailing edge of the bill without damaging the bill. If the patron begins withdrawing the bill backwardly through the passageway, the trailing edge will mask aperture A3 causing the output of amplifier 103 to become positive. The AND circuit 118 will now provide an output which is coupled through OR circuits 115 and 178 to trigger flip-flop 128 for reverse drive and thus return the bill to the patron. When the output of amplifier 103 becomes positive, an inhibiting signal is applied to AND circuit 112. Accordingly, AND circuit 118 provides but a brief positive output, since the boxcar holding capacitor 122 rapidly discharges with a time-constant of, for example, 1 millisecond. When the leading edge of the bill is withdrawn past the escapement mechanism at the passageway exit, the output of amplifier 106 drops to ground potential. However, AND circuit 124 provides no output erroneously indicating that a bill has been collected, since boxcar holding capacitor 122 has been previously discharged.

If the patron permits the bill to continue down the passageway until the trailing edge of the bill passes aperture A4 and then attempts to withdraw the bill backwardly past aperture A4 again, amplifier 104 will provide a positive output which is coupled through the differentiating circuit comprising components 162 and 164 to enable AND circuit 174. Since no portion of the bill is under the magnetic reading head, trigger circuit 160 will not provide an inhibiting output; and AND circuit 174 will provide a positive output which is coupled through OR circuit 178 to actuate flip-flop 128 for reverse drive.

If the patron permits the trailing edge of the bill to continue past aperture A5 before attempting to withdraw it, then amplifier 105 will provide a positive output which is coupled through differentiating circuit 172 to enable AND circuit 176. Since no portion of the bill is under the optical reading aperture A2, trigger circuit 170 will not

provide an output; and AND circuit 176 will provide an output which is coupled through OR circuit 178 to trigger flip-flop 128 for reverse drive.

It will be seen then that flip-flop 128 is triggered for reverse drive if the patron attempts to withdraw the bill backwardly past any of apertures A3, A4, or A5. If the patron permits the trailing edge of the bill to pass the escapement mechanism provided by depending legs 50 and 50a, then spool 49 will rotate to the position shown in FIGURE 1 where reverse movement of the bill through the passageway is blocked. The bill cannot be withdrawn; and the patron will succeed only in ripping the trailing portion of the bill to which the string or thread is attached.

When spool 49 returns to the position shown in FIGURE 1, the output of amplifier 106 drops to ground potential, since photocell P6 is exposed to the light from lamp L6. When the output of amplifier 106 drops to ground potential, the inhibiting signal from AND circuit 124 is removed; and boxcar holding capacitor 122 causes AND circuit 124 to provide an output pulse properly indicating that the bill has been collected. The duration of the output pulse from AND circuit 124 will be approximately 1 millisecond which corresponds to the time-constant of holding capacitor 122. When the output of amplifier 106 drops to ground potential, no drive signal is produced by OR circuit 114; and the motor stops with flip-flop 128 remaining in forward drive.

It will be seen that I have accomplished the objects of my invention. The magnetic and optical tests are serially performed; and the bill is rejected immediately upon the failing of any test without requiring that all tests be completed. As will be appreciated by those having ordinary skill in the art, it is not necessary that all tests be performed. For example, the optical test might be omitted entirely. My dollar bill collector rejects any bill containing an excessively intense pattern of magnetic material. My dollar bill collector utilizes a normally enabled magnetic head which is selectively disabled by a solenoid. Thus the force with which the bill is urged against the magnetic reading head may be accurately predetermined by the resilient bias of a spring. In my invention the bill is optically tested by a tuned amplifier in response to light transmitted through the bill. This obviates such problems as optical focusing and renders the test substantially independent of ageing of the bill. The use of a tuned amplifier for the optical test requires only one optical sensor and eliminates any requirement for auxiliary transient timing circuits. For both the magnetic and optical tests, the tuned amplifiers may have Q's which are approximately equal to the number of cycles sensed. This provides a reasonably large output, yet affords some approximation to a time integral output to discriminate against the effects of random noise or minor irregularities in the pattern. In my dollar bill collector, an escapement mechanism is provided only at the exit of the passageway. A bill may be readily withdrawn by the patron until the trailing edge of the bill passes the escapement mechanism. Indeed, if any reverse movement of the bill is detected while my collector is in forward drive, the drive is reversed in order to return the bill to the patron.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. It will be further obvious that various changes in detail may be made without departing from the spirit of my invention.

Having thus described my invention, what I claim is:

1. A dollar bill collector including in combination a passageway having an entrance and an exit, means extending into the passageway for longitudinally propelling a bill from the entrance toward the exit, the propelling means comprising a pair of opposed rollers abutting along a transverse line which is adjacent the passageway exit, the bill having a leading and a trailing edge, and escapement means operable at substantially the same instant that the trailing edge passes said transverse line of abutment for

preventing withdrawal of the bill, the escapement means comprising a lever extendable into the passageway and journaled for rotation about a transverse axis which is displaced appreciably toward the entrance from said transverse line of abutment, the lever having a trailing free end which is substantially coincident with said line of abutment, rotation of the lever moving the free end thereof into and out of the passageway, and resilient means rotationally biasing the lever such that the free end thereof normally extends into the passageway.

2. A dollar bill collector including in combination a passageway having an entrance and an exit, means extending into the passageway for driving a bill from the passageway entrance toward the passageway exit, means for serially performing a plurality of tests on the bill while it is traversing the passageway, and means immediately operable upon the failing of any test for reversing the drive means and returning the bill to the passageway entrance.

3. A dollar bill collector including in combination a passageway having an entrance and an exit, means extending into the passageway for propelling a bill from the passageway entrance toward the passageway exit, a magnetic reading head fixedly mounted on one side of the passageway, a co-acting roller extending into the passageway from the opposite side, resilient means biasing the roller against the magnetic reading head with a predetermined force, and means selectively operable to withdraw the roller from the magnetic reading head against the biasing force of the resilient means.

4. A dollar bill collector including in combination a passageway having an entrance and an exit, means extending into the passageway for driving a bill from the passageway entrance toward the passageway exit, means including a magnetic reading head for performing a magnetic test of the bill while it is traversing the passageway, means for sensing the amplitude of the output of the magnetic reading head, and means responsive to an output amplitude exceeding a predetermined limit for reversing the drive means and returning the bill to the passageway entrance.

5. A dollar bill collector including in combination a passageway having an entrance and an exit, means for driving a bill from the passageway entrance toward the passageway exit at a predetermined linear velocity, a photocell mounted on one side of the passageway, means including a lamp mounted on the opposite side of the passageway for transmitting light through the bill to the photocell, a tuned amplifier, and means coupling the photocell to the tuned amplifier.

6. A dollar bill collector as in claim 5 in which the tuned amplifier has a Q of the order of magnitude of 6 to 14.

7. A dollar bill collector as in claim 5 in which the means mounted on said opposite side of the passageway includes a transversely extending slit having a length of approximately .02 inch and a width of approximately 3/16 inch and positioned to transmit light through the bill in the region of the shield on the green side of the bill.

8. A dollar bill collector including in combination a passageway having an entrance and an exit, means extending into the passageway for driving a bill from the passageway entrance toward the passageway exit at a predetermined linear velocity, a magnetic reading head mounted on one side of the passageway, the bill being introduced at the passageway entrance with the portrait side thereof adjacent said one side of the passageway, a wide-band alternating current amplifier, a tuned amplifier, means coupling the magnetic reading head to the wide-band amplifier and to the tuned amplifier, a first detector, a second detector, means coupling the wide-band amplifier to the first detector, means coupling the tuned amplifier to the second detector, means responsive to the first detector for reversing the drive means and returning the bill to the passageway entrance, and means responsive to the second detector for inhibiting reversal of the drive means.

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9. A dollar bill collector as in claim 8 in which the tuned amplifier has a Q of the order of magnitude of 40 to 80.

10. A dollar bill collector as in claim 8 in which the magnetic reading head is positioned to scan the right-hand portion of the portrait background in the region of the neck of the portrait, said portion containing approximately forty vertically extending grid lines.

11. A dollar bill collector as in claim 8 in which the first detector responds to the R.M.S. output of the wide-band amplifier.

12. A dollar bill collector as in claim 8 in which the first detector responds to the R.M.S. output of the wide-band amplifier.

13. A dollar bill collector including in combination a passageway having an entrance and an exit, means extending into the passageway for driving a bill from the passageway entrance toward the passageway exit, means for sensing the actual direction of movement of the bill through the passageway, and means responsive to a reversed motion of the bill through the passageway for reversing the drive means and returning the bill to the passageway entrance.

14. A dollar bill collector including in combination a passageway having an entrance and an exit, means extending into the passageway for driving a dollar bill from the passageway entrance toward the passageway exit at a predetermined linear velocity, the bill having a leading edge and a trailing edge, means including an escapement mechanism mounted at the passageway exit for preventing withdrawal of a dollar bill after the trailing edge has passed the passageway exit, a magnetic reading head fixedly mounted on one side of the passageway, a co-acting roller extending into the passageway from the opposite side, resilient means biasing the roller against the

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magnetic reading head with a predetermined force, means selectively operable to withdraw the roller from the magnetic reading head against the biasing force of the resilient means, a photocell, means for transmitting light through the bill to impinge upon the photocell, a first tuned amplifier responsive to the photocell, a wide-band alternating current amplifier responsive to the magnetic reading head, a second tuned amplifier responsive to the magnetic reading head, means responsive to the first and second tuned amplifiers for serially performing a plurality of tests upon the bill, control means immediately operable upon the failure of any test for reversing the drive means and returning the bill to the passageway entrance, the control means comprising means responsive to the wide-band amplifier for reversing the drive means and means responsive to the first and second tuned amplifiers for inhibiting reversal of the drive means, means for sensing the actual direction of movement of the bill through the passageway, and means responsive to a reversed motion of the bill through the passageway for reversing the drive means.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3485358 Dated December 23, 1969

Inventor(s) D. E. Hooker

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 68, "pasageway" should be -- passageway --;

Column 10, line 22, "ito" should be -- into --;

Column 10, line 23, "passagewy" should be -- passageway --;

Column 11, line 13, "R.M.S." should be -- peak --.

SIGNED AND
SEALED
JUN 9 1970

(SEAL)

Attest:

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