United States Patent

Conant et al.

[15] **3,699,981**

[45] **Oct. 24, 1972**

[54] **COIN VALUE DETERMINING APPARATUS AND SYSTEM**

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[73] Assignee: **Abbott Coin Counter Co., Inc.**, Greenwich, Conn. ; by said Conant

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[21] Appl. No.: **21,726**

[52] **U.S. Cl.**.....**133/8**, 209/111.7, 235/92 CN

[51] **Int. Cl.**.....**G07d 9/04**

[58] **Field of Search**.....133/8; 194/1 M, 1 N; 209/80, 209/111.7; 235/92 CN, 92 V, 92 DN

[56] **References Cited**

UNITED STATES PATENTS

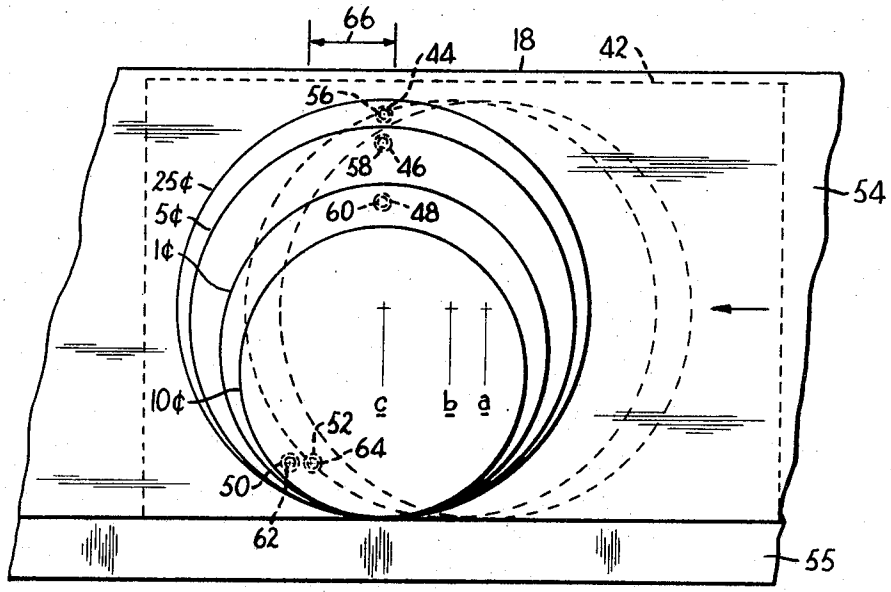
3,086,536	4/1963	Klopp	133/8
3,323,626	6/1967	Akira Abe	194/10
3,344,898	10/1967	Klinikowski	194/9
3,513,321	5/1970	Sherman	209/111.7
3,480,141	11/1969	Rock	209/111.7
3,089,594	5/1963	Early	209/111.7

Primary Examiner—Robert B. Reeves
Assistant Examiner—Thomas E. Kocovsky
Attorney—Watson, Leavenworth & Kelton

[57] **ABSTRACT**

Apparatus for high speed, high volume coin processing comprises sensor elements adapted for indicating both sizes and positions of coins in continuous non-selective transit. Systems incorporating such apparatus and providing denominational value indication are also disclosed.

16 Claims, 9 Drawing Figures



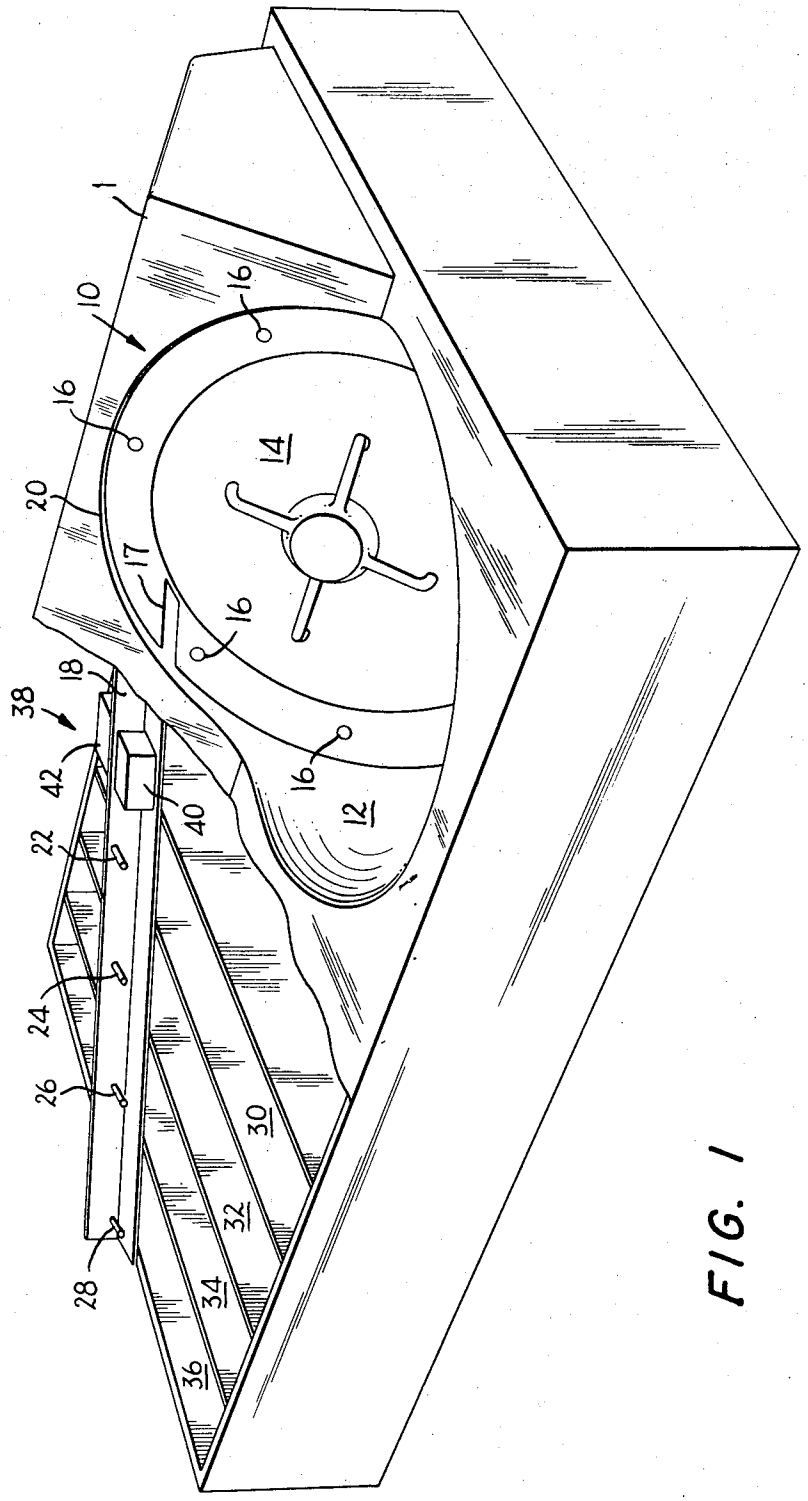


FIG. 1

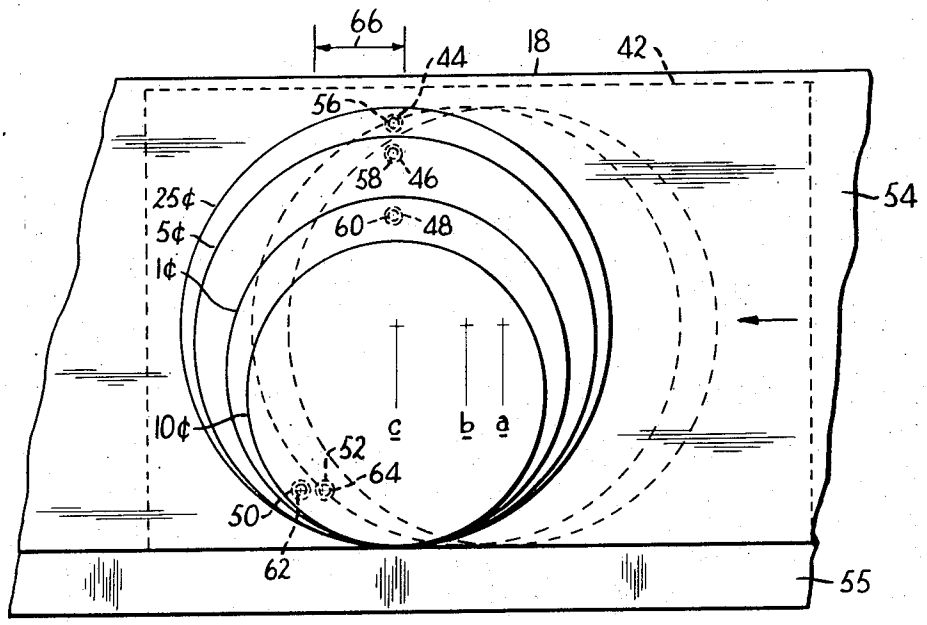

66
44
18
42
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46
25¢
5¢
1¢
60
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10¢
c
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FIG. 2

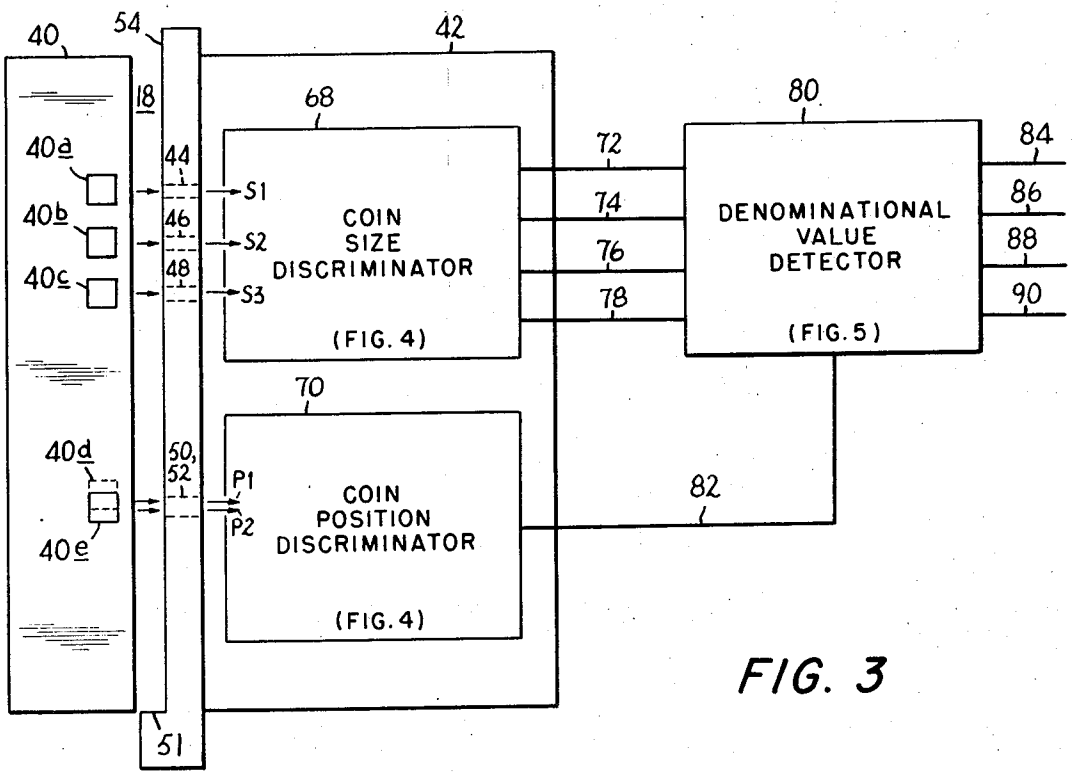

40
54
42
18
68
80
40a
44
S1
72
84
40b
46
S2
COIN SIZE DISCRIMINATOR
74
DENOMINATIONAL VALUE DETECTOR
86
40c
48
S3
76
88
78
90
(FIG. 4)
(FIG. 5)
70
40d
50, 52
P1
82
COIN POSITION DISCRIMINATOR
P2
40e
(FIG. 4)
51

FIG. 3

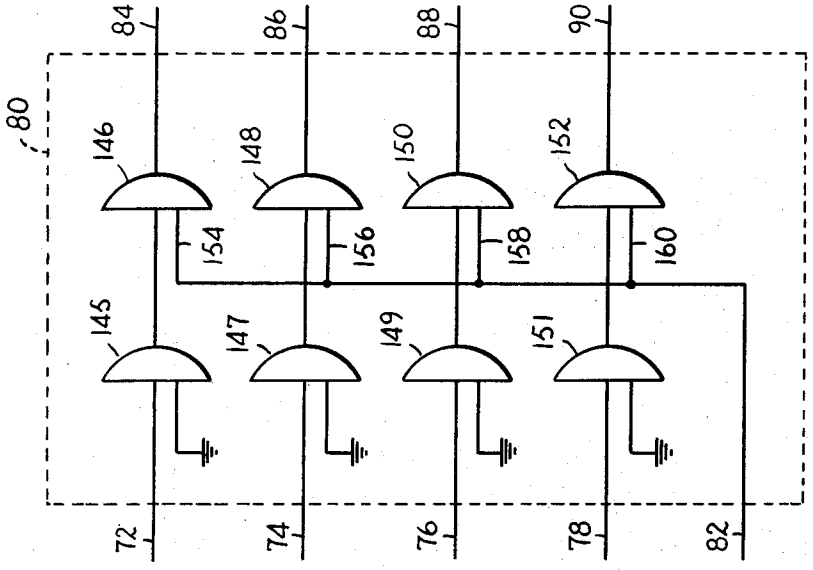
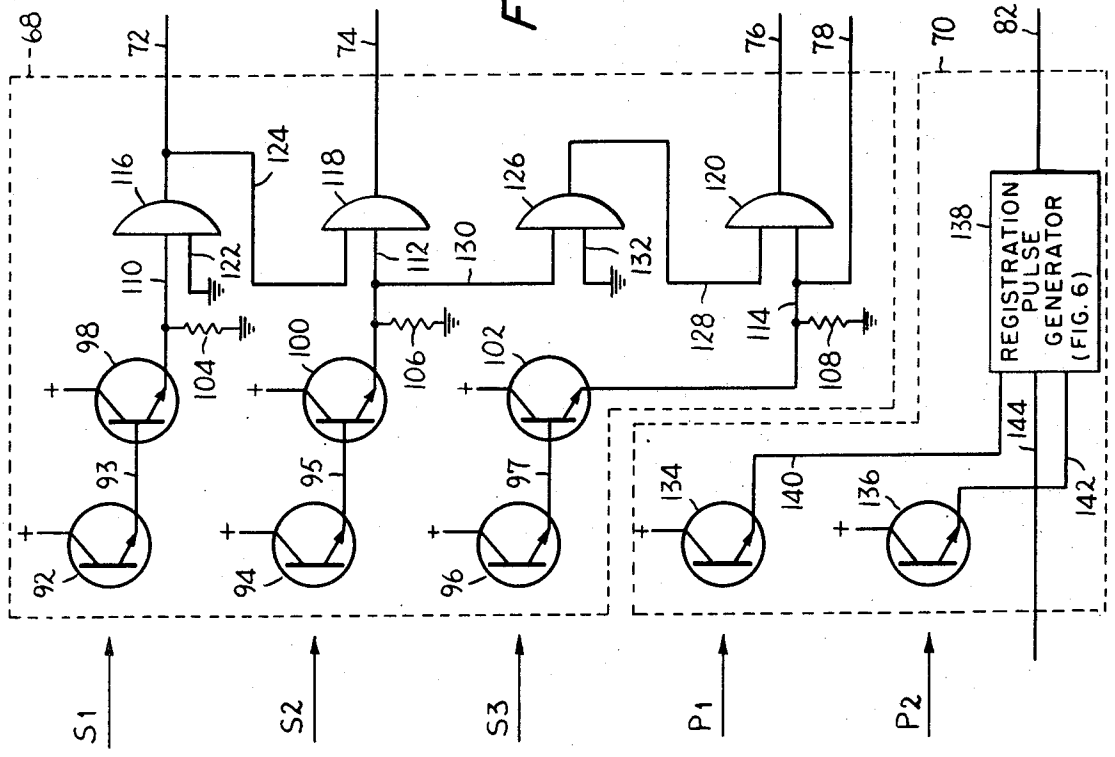

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FIG. 5

FIG. 4


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REGISTRATION PULSE GENERATOR (FIG. 6)
S1
S2
S3
P1
P2

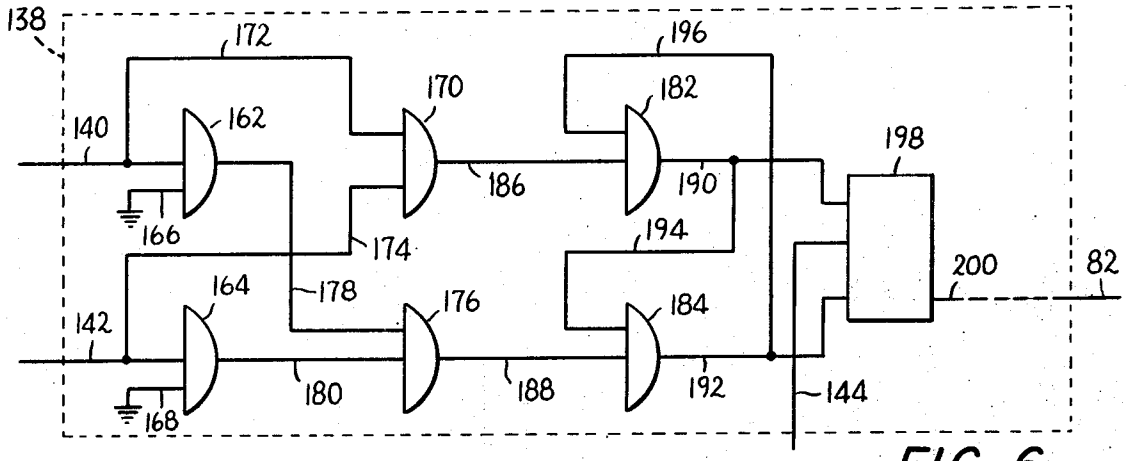


FIG. 6

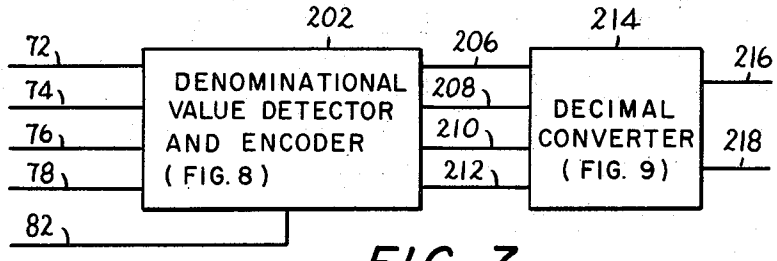


FIG. 7

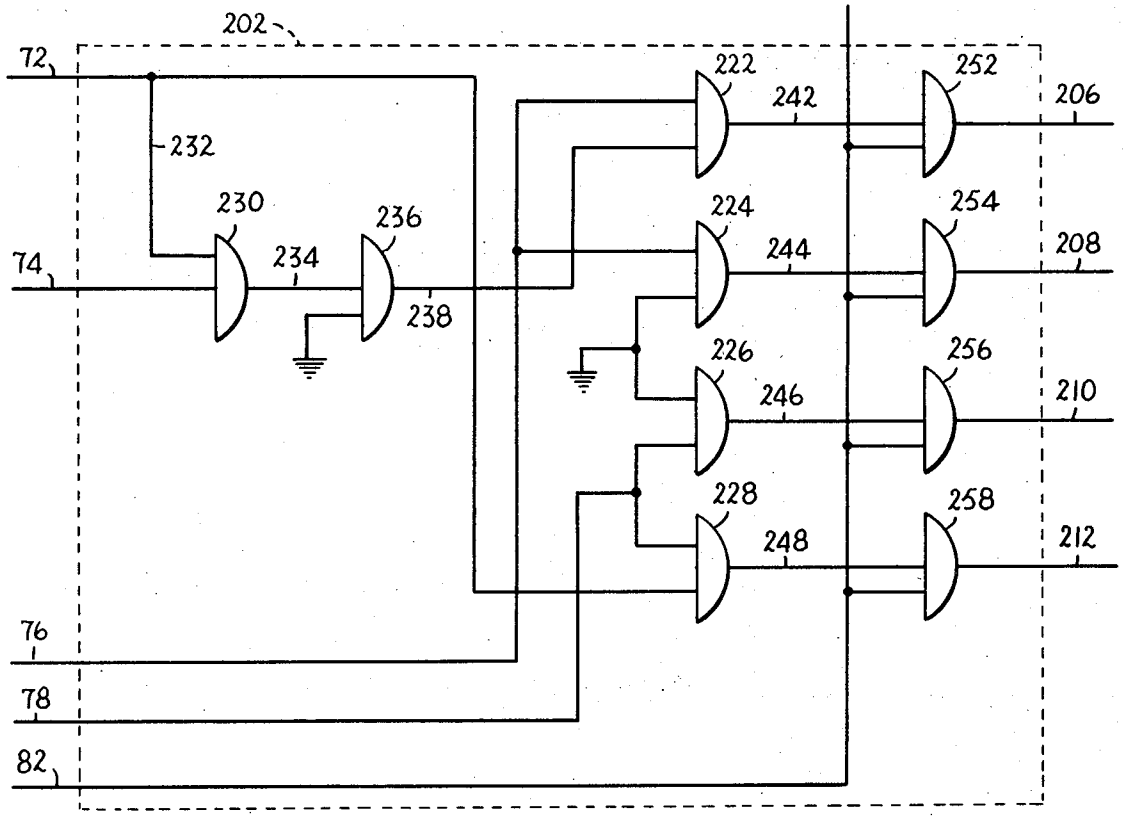


FIG. 8

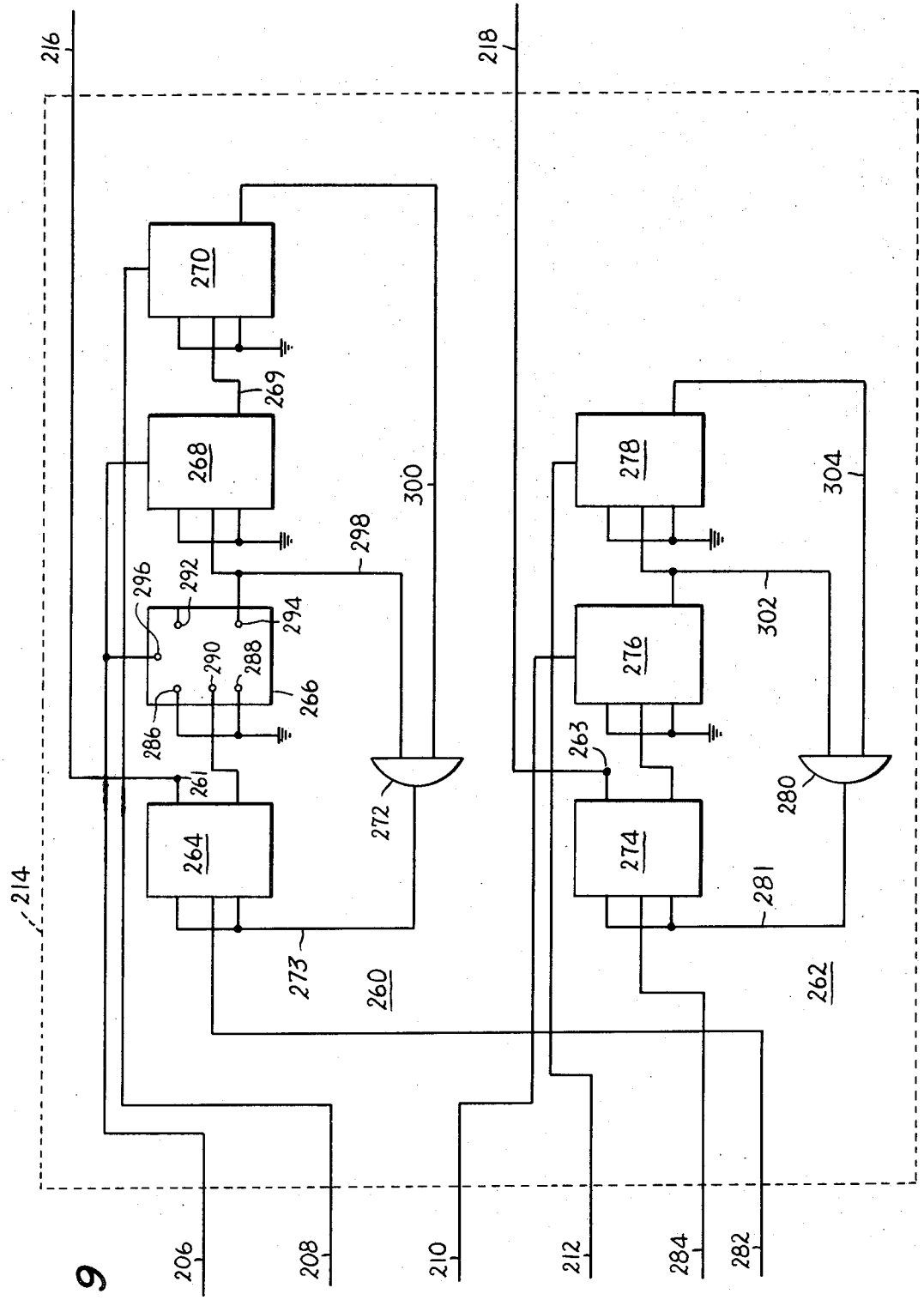

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FIG. 9

COIN VALUE DETERMINING APPARATUS AND SYSTEM

FIELD OF THE INVENTION

This invention relates to devices for processing diverse coins in transit and more particularly to apparatus and system employable therein for determining the denominational values of such coins while same are in continuous transit.

BACKGROUND OF THE INVENTION

Present day coin processing devices for determination of the number or denominational value of diverse coins have as their point of origin the detection of different size characteristics of the coins, such characteristics providing the only consistent basis of difference in the case of, for example, the U. S. coins comprising the half-dollar, quarter, nickel, penny and dime, which exhibit decreasing diameter in the stated succession.

Various mechanical, photoelectric and electromechanical apparatus presently known for such detection fall into one of two basic categories, a first type adapted for use where coin transit is momentarily interrupted and a second type adapted for use where coin transit is continuous and unaffected by the size detection. In the first type of apparatus, typified by that illustrated in U. S. Pat. No. 2,594,422, coins in transit are individually received prior to size segregation by an indexable rotor which controllably positions each received coin in precise relation to a sensor which generates an output signal having an amplitude characteristic related to coin size. The evident shortcomings of such apparatus are the severe limitation on coin processing speed and the need for the rotor and associated mechanism.

With respect to the second type of apparatus, two versions are known. In one version, coins in continuous transit are first segregated in accordance with size by selective deflection thereof into collection bins. Thereupon, as shown in U. S. Pat. Nos. 3,048,251 and 3,016,191, sensors not having size-discriminating capacity and disposed in the respective collection bins are actuated by the segregated coins to provide count signals. While processing speed is unlimited by the nature of coin size detection in such apparatus, the required multiple sensors are independent of one another and are randomly energized or deenergized by the segregated coins, simultaneous coin sensing by more than one sensor being probable. To avoid count confusion, it is necessary in such apparatus to provide independent counting means in association with each sensor. The dependency of such apparatus on coin segregating means is a further shortcoming thereof.

In the other version of the second type of known size-detection apparatus, typified by the showings of U. S. Pat. Nos. 2,237,132 and 3,086,536, observation is made of the selective interruption of multiple light beams disposed in succession along a chute adapted to continuously transfer the coins to segregating means. In order that such observation have meaning, it is essential in this version of the second type of apparatus that a single coin selectively completes its traverse of the succession of light beams before a second coin begins its traverse thereof. Thus, high speed processing of coins in non-selective transit is prohibited by the nature of these devices.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide coin size determination apparatus for use in high speed coin processing devices.

It is a particular object of this invention to provide apparatus for determination of the sizes of coins while same are in continuous non-selective transit.

It is a further object of the invention to provide coin size determining apparatus operative without need for prior coin sorting.

It is an additional object of the invention to provide a system for indication of denominational values of coins in continuous non-selective transit.

It is a more particular object of the invention to provide such denominational value indication systems adapted for use in conjunction with independent totalizers adapted to receive diverse indications of all denominational values of processed coins or in conjunction with cooperating totalizers adapted to receive indications of units and tens denominational values of processes coins.

In the efficient attainment of these and other objects, apparatus is provided in the present invention comprising a first sensor group adapted to provide first signals exhibiting changing characteristics in accordance with the varying sizes exhibited by each coin in transit, and second sensor means so positioned with respect to said first sensor group as to provide a second output signal exhibiting changing characteristics at such a time at which said first output signals provide size indication definitive of the denominational value of the coin in transit past the sensors. The sensor group and sensor means define a registration zone successively occupyable by each of successive coins in continuous, non-selective transit thereby. Coin processing speed and volume is substantially increased by such apparatus and same is readily adapted by signal processing circuitry to provide individual denominational value indication for each coin in transit or alternatively, to provide said units and tens denominational value indications. Systems employing the apparatus of the invention in combination with different signal processing circuitry comprise further aspects of the invention provided herein.

The manner in which the foregoing and other objects of the invention are attained will be evident from the detailed discussion of preferred embodiments of the invention hereinafter and from the drawings wherein like numerals are used to identify like parts throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a coin counter and sorter partly broken away to show apparatus of the invention.

FIG. **2** is a frontal elevational view of a section of transfer chute **18** of FIG. **1** illustrating coins in transit therethrough.

FIG. **3** is a pictorial side elevational view of transfer chute **18** with block diagrammatic illustration of circuit elements associated therewith.

FIG. **4** is a schematic diagram of discriminators **68** and **70** of FIG. **3**.

FIG. **5** is a schematic diagram of denominational value detector **80** of FIG. **3**.

FIG. **6** is a schematic diagram of registration pulse generator **138** of FIG. **4**.

FIG. 7 is a block diagrammatic illustration of alternate circuit elements usable in the arrangement of FIG. 3.

FIG. 8 is a schematic diagram of detector and encoder 202 of FIG. 7.

FIG. 9 is a schematic diagram of decimal converter 214 of FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, collector and transfer unit 10 of coin sorter-counter 1 includes a coin depository scoop 12 and a continuously rotating turntable 14. Coins, the denominational values of which are to be totalized, are gravity-fed onto the turntable and are individually displaced by turntable pins 16 from the vicinity of plate 12 and are carried by the turntable to acceptor 17 of chute 18, the coins being maintained about the periphery of the turntable during such transfer by centripetal forces provided by retaining guard 20 or by gravitational forces depending upon turntable rotational speed. Chute 18 is inclined downwardly such that coins transferred thereto roll edgewise through the chute under the influence of either the force attending their issuance from turntable 14 to acceptor 17 or gravitational force. Coin deflector elements 22, 24, 26 and 28 are secured in chute 18 at different elevations corresponding with the different sizes of coins traversing the chute for purposes of selectively deflecting coins into sorting bins 30, 32, 34 and 36. In the arrangement of FIG. 1 sorting-counting apparatus 1 accommodates four differently sized coins, e.g. dime, penny, nickel and quarter. In all discussion to follow, this specific exemplary arrangement will be considered, modification of the system and apparatus herein to accommodate coins of further different sizes requiring only evident modifications. Disposed along chute 18 between collector and transfer unit 10 and the first deflector element 22 is a coin size and position discriminator 38. This unit preferably includes photoelectric means for coin size and position indication and to this extent embraces an exciting unit 40 and a unit 42 containing sensing devices and signal processing circuitry.

Referring to the side elevational view of chute 18 illustrated in FIG. 2 and to the FIG. 3 showing, apertures 44, 46, 48, 50 and 52 are provided in wall 54 of the chute and unit 42 sensors 56, 58, 60, 62 and 64 are mounted on wall 54 in respective registration with the apertures such that the apertures define the fields of view of the sensors. In the absence of coins in chute 18 all of the sensors will be continually excited by illuminators 40*a* through 40*e* of exciting unit 40 of FIG. 1. In the preferred arrangement, sensors 56, 58 and 60, constituting a first sensor group, are aligned in a plane transverse to the longitudinal axis of chute 18 and are positioned at respectively increasing heights above longitudinal guide rail 55 to be selectively deenergized and to thereby provide size indication of diverse coins in transit through the chute. Sensors 62 and 64, constituting second sensor means, are preferably aligned in a plane parallel to longitudinal guide rail 55. As will be clarified hereinafter in detail, the second sensor means is positioned with respect to the first sensor group such that, upon deenergization of the second sensor means by a coin in transit, the states of energization or deenergization of the individual sensors of the first sensor group will provide size indication definitive of the proper denominational value of the coin. In this respect, the first sensor group output signals will be identified hereinafter as size-indicating signals and the second sensor group signals will be referred to as position-indicating or coin registration signals. Such distinction will be clarified by discussion of events accompanying the transit of a particular coin through chute 18.

The four diverse coins discussed above are illustrated in solid lines in FIG. 2 in such position in chute 18 that each coin covers apertures 50 and 52 of wall 54 thereby deenergizing the second sensor means. In this connection only one coin can pass a given position in the chute at a given instant by reason of the cross-sectional dimensions of the chute (FIG. 3) and the indication in FIG. 2 of all four coins in common position is thus descriptive only. With its direction of travel indicated by the arrow, the 25¢ piece is illustrated in successive transit positions *a*, *b* and *c* wherein its vertical diameter coincides with the vertical lines defining such positions. In position *a*, the coin occupies the fields of sensitivity of certain of the sensors of the first sensor group, namely sensors 58 and 60. If the output signals of the first sensor group with the coin in this position were to be accepted as having size indication definitive of the size of the coin then traversing the chute, confusion would ensue since these output signals would be identical respecting the 25¢ piece at position *a* and the 5¢ piece at position *c*. Such confusion would similarly result if position *b*, wherein the coin is further advanced in transit through chute 18, were employed as the denominational value sensing position in the chute, sensor 56 remaining partially excited at such position. To avoid such confusion the system herein has as a 25¢ piece-defining condition that all of the first group sensors be unenergized. At chute position *c*, the size indication provided by the output signals of the first sensor group meets this condition and the signals are clearly definitive of size distinctly indicating the proper denominational value of the coin traversing the chute. Note that at position *c*, the second sensor means is unenergized by reason of the presence of each of the coins at said position.

The following other denominational value-defining conditions are applicable. If all sensors of the first sensor group are energized and the second sensor means is unenergized, a dime is in transit. With only the second sensor means and sensor 60 unenergized, a penny is in transit. Deenergization of sensors 50, 52, 58 and 60 occurs where a nickel is in transit. As previously stated, where all sensors are unenergized a quarter is in transit. Evidently the single position *c* is not the only position at which the above conditions occur. Rather a registration zone generally indicated at 66 may be readily defined wherein the conditions apply.

Such zone commences for each coin in transit upon the initial interruption of second sensor means excitation thereby and extends thereafter through and beyond position *c* above. Whereas any position within such zone may be employed in practicing the invention, said commencement of such zone is preferably employed. Reference hereinafter to such registration zone is intended to indicate such preferred portion of such registration zone.

A fourth sensor may be included in the first sensor group at a position below sensor **60** such that light beam excitation of said fourth sensor will be interrupted upon transit of a dime to provide specific first sensor group output signal change indicative of a dime in transit upon occurrence of second sensor means deenergization. On the other hand, such fourth sensor is unnecessary since *n* different denominational value-defining conditions can be derived from *n*–1 sensors as described above.

Whereas the particular sensor arrangement of FIG. **2** is preferred, it is not requisite that the sensors of the first sensor group be aligned in the specified plane. Also, as mentioned, positioning of the second sensor means is dependent upon the choice of location of the first sensor group such that the respective output signals thereof are meaningful of true coin denominational values.

From the foregoing it will be evident that the first group of sensors generates first output signals exhibiting changing characteristics (e.g. HI to LO) upon deenergization thereof, which signals are indicative of varying sizes exhibited by individual coins traversing the chute as same are in transit. Such signals initially take on size definition according with the denominational value of the coin in transit when the coin is within said registration zone, i.e. when the second sensor group becomes deenergized and generates output signals exhibiting changing characteristics (e.g. HI to LO) indicative of such occurrence.

The first group of sensors and the circuitry processing the output signals thereof comprise coin size discriminator **68** of FIG. **3**. The second sensor means and circuitry processing the output signals thereof comprise coin position discriminator **70** of FIG. **3**. Discriminator **68** provides its output signals on lines **72**, **74**, **76** and **78** to a denominational value detector **80** to which is also applied over line **82** the output signals of discriminator **70**. A selective one of output lines **84**, **86**, **88** and **90** of detector **80** is energized to thereby provide a denominational value indicating signal. In such selective energization, detector **80** is operatively responsive to the line **82** signal change characteristic to selectively gate the signals then provided on lines **72**, **74**, **76** and **78**.

Circuitry employable in discriminators **68** and **70** is illustrated in FIG. **4**. Light beams S1, S2 and S3 impinge upon and excite phototransistors **92**, **94** and **96**, the collectors of which are connected to a voltage source providing a positive potential and the emitters of which are directly-connected respectively to transistors **98**, **100** and **102**. The transistor collectors are also tied to said positive potential and the emitters thereof are connected through resistors **104**, **106** and **108** to ground. Said positive potential constitutes a first voltage level (HI) for the logic circuits to be discussed hereinafter. A second voltage level for the logic circuits is ground (LO). The outputs of the transistors are coupled over lines **110**, **112** and **114** to first inputs of AND gates **116**, **118** and **120**. These gates have their outputs coupled directly to discriminator **68** output lines **72**, **74** and **76**. The fourth output of the discriminator is provided on line **78** by direct interconnection thereof with line **114**.

Gate **116** has the second input thereof connected to ground by line **122** and the second input to gate **118** is provided by line **72** through connecting line **124**. Gate **120** receives its second input from a further AND gate **126**, the output of which is applied to line **128**. Gate **126** receives a first input from line **112** over connecting line **130** and the second input thereto is grounded by line **132**.

The foregoing AND gates and all AND gates in subsequent discussion are adapted to provide a HI output only upon coincident LO state of both inputs thereto. Under all other input conditions the gates provide LO output signals. All gates to be discussed hereinafter are AND gates and follow this operating characteristic. Fairchild 9914 Medium Power Dual Two Input Gate includes gates providing the foregoing logic and may be used throughout.

The operation of discriminator **68** will be evident by consideration of the functions therein attendant upon consideration of a penny entering the aforementioned registration zone of chute **18**. In the absence of a coin in transit, all of the phototransistors **92–96** are energized, in turn energizing transistors **98–102**. As a result, all of lines **110**, **112** and **114** are HI. Light beam S3 is interrupted by said penny with resulting deenergization of phototransistor **96** and transistor **102** whereupon line **114** is LO as is output line **78**. Since lines **110** and **112** remain HI, output lines **72** and **74** are LO, since both inputs to gates **116** and **118** are not LO. In contrast to output lines **72**, **74** and **78** output line **76** is HI indicating the interruption of light beam S3. Same occurs since both inputs to gate **120** are LO. As mentioned, line **114** is upon UPON deenergization of transistor **102**. Line **128** is also LO since the line **130** input to gate **126** is HI.

The following other conditions apply as respects the condition of the output lines of discriminator **68** and selective blocking of input light beams S1–S3. Where S2 and S3 are interrupted, only line **74** is HI. Where S1, S2 and S3 are interrupted, only line **72** is HI. Where none of S1, S2 and S3 is interrupted, line **78** is HI. The logic operations involved in such selective generation of signals indicative of size characteristics of other coins in transit are provided by the remaining identified circuitry of the discriminator.

In order that the output signals of discriminator **68** be processed at such time that they contain pertinent size information definitive of denominational values of coins in transit, discriminator **70** provides a signal on line **82** at the instant a coin first enters the registration zone. To this effect the light beams P1 and P2 impinge upon and excite phototransistors **134** and **136**, the collectors of which are coupled to the positive supply and emitters of which are connected to registration pulse generator **138** over lines **140** and **142**. The registration pulse generator, which is discussed in detail in connection with FIG. **6** below, receives a further input in the form of continuous clock pulses provided on line **144**. Suffice it to say for the present that pulse generator **138** provides on line **82** a LO signal only upon coincident deenergization of phototransistors **134** and **136** upon interruption of both light beams P1 and P2.

One embodiment of coin denominational value detector **80** of FIG. **3** is shown in detail in FIG. **5**. The detector includes AND gates **145**, **147**, **149** and **151** each

of which has one grounded input and one input connected individually to lines **72** through **78**. Each of further AND gates **146, 148, 150** and **152** receives a first input from one of gates **145, 147, 149** and **151**. The coin registration signals provided on line **82** are applied in common to all of the gates over lines **154, 156, 158** and **160** as the second gate inputs.

In operation detector **80** will provide a LO signal on a selective one of its output lines **84, 86, 88** and **90** upon the occurrence of the line **82** registration signal thereby providing indication of one of denominational values 25¢, 5¢, 1¢ and 10¢, respectively. Such output line will be associated with that one of gates **145, 147, 149** and **151** which derives a HI input signal from lines **72–78**. By way of example, if input line **76** is HI and lines **72, 74** and **78** are LO, as occurs when a 1¢ piece enters said registration zone, gate **149** will provide a LO output and gates **145, 147** and **151** will provide a HI output. With one input HI, gates **146, 148** and **152** will yield low outputs irrespective of the occurrence of the LO signal on line **82** indicative of coin registration. On the other hand, gate **150** will have both inputs thereto LO upon occurrence of the registration signal on line **82** and will thereupon yield a HI output signal on line **88**, the 1¢ denominational value line.

The respective characteristics of the size-indication signals of the sensors and discriminator **68**, the position-indication signals of discriminator **70**, and the denomination value indication signals of detector **80** are set forth in Table I below for the cases of each diverse coin entering said registration zone and the 25¢ piece also in the non-registration zone position *b* of FIG. **2**.

TABLE I

Function	Line	Coin in Transit				
		25	5	1	10	*
	93	LO	HI	HI	HI	HI
	95	LO	LO	HI	HI	LO
Size	97	LO	LO	LO	HI	LO
Defini-	72	HI	LO	LO	LO	LO
tion	74	LO	HI	LO	LO	HI
	76	LO	LO	HI	LO	LO
	78	LO	LO	LO	HI	LO
Registra-	140	LO	LO	LO	LO	HI
tion De-	142	LO	LO	LO	LO	HI
finition	82	LO	LO	LO	LO	HI
Denomina-	84	HI	LO	LO	LO	LO
tional	86	LO	HI	LO	LO	LO
Value De-	88	LO	LO	HI	LO	LO
finition	90	LO	LO	LO	HI	LO

*25 piece at position *b* of FIG. 2.

A preferred circuit arrangement for registration pulse generator **138** is illustrated in FIG. **6** wherein lines **140** and **142** of FIG. **1** provide first inputs for AND gates **162** and **164**, the second inputs to which are connected to ground by lines **166** and **168**. Lines **140** and **142** provide first and second inputs to gate **170** over lines **172** and **174**. Outputs of gates **162** and **164** are applied to gate **176** over lines **178** and **180**. The outputs of gates **170** and **176** provide first inputs for gates **182** and **184** through lines **186** and **188**. These gates provide their outputs on lines **190** and **192** which are respectively coupled to the alternate gate inputs over lines **194** and **196**.

Lines **190** and **192** provide gating signals for flip-flop **198** to which clock pulses are applied over line **144**. The logic for this flip-flop is that output line **200** thereof will be set HI upon the occurrence of a HI gating signal on line **190** and is set LO upon the occurrence of a HI gating signal on line **192**. Line **200** is coupled through appropriate pulse-shaping circuitry as indicated by the dotted line, to pulse generator output line **82**. Since such pulse-shaping circuitry may take various forms depending upon the pulse width desired to be produced by the generator, same is not indicated in detail.

In light of the foregoing detailed logic operations discussed in connection with FIGS. **4** and **5** the logic operations of the circuitry of FIG. **6** will be clear from Table II below, which indicates the states of circuit lines during transit of a coin through chute **18** of FIG. **1**.

TABLE II

Lines					
140	HI	LO	LO	HI	HI
142	HI	HI	LO	LO	HI
178	LO	HI	HI	LO	LO
180	LO	LO	HI	HI	LO
186	LO	LO	HI	LO	LO
188	HI	LO	LO	LO	HI
190	HI	HI	LO	LO L	HI
192	LO	LO	HI	HI	LO
200	HI	HI	LO	LO	HI

From Table II it will be seen that line **200** is HI as the coin in transit enters the chute since both of input lines **140** and **142** are HI. This state of line **200** continues as one of light beams **P1** and **P2** exciting phototransistors **134** and **136** (FIG. **4**) is interrupted. Line **200** goes LO as both light beams **P1** and **P2** are interrupted and both input lines **140** and **142** are LO, and line **200** returns to its HI state as the coin leaves the registration zone and both input lines **140** and **142** are returned to the HI state. Thus, in terms of coin transit line **200** is HI at all times other than when the coin in transit interrupts both light beams **P1** and **P2**, i.e. when the coin first enters and resides in the registration zone.

Whereas the foregoing system of FIG. **4** is adapted to provide coin size indicating signals discretely indicative of the denominational values of coins in transit and may be associated with various counting devices known in the art for totalization of such values, the foregoing sensing apparatus of the invention is preferably employed in the system embodiment disclosed in FIG. **7** wherein a coin denominational value detector and encoder **202** is employed in place of detector **80** of FIG. **4**. This detector and encoder receives signals from lines **72–78** and **82**, as in the case of detector **80**, and generates output signals on lines **206, 208, 210** and **212** which have characteristics both indicative of coin denominational value and adapted for automatic zeroing of decimal converter **214** to which they are applied. In response to the states of lines **206–212**, converter **214** provides output pulses on line **216** indicative of the denominational value of certain coins in units count and provides on line **218** pulses indicative of the denominational value of other coins in tens count. For example, in the case of a processing of a quarter, five

pulses are provided on line **216** and two pulses on line **218**. The denominational value information is thus in the form adapted for direct use in connection with known decimal input totalizing display devices, such as Nixie-tube units and the like. An understanding of the FIG. **7** system will follow from detailed discussion of the circuit arrangements of FIGS. **8** and **9** respectively indicating the structure and operation of detector and encoder **202** and decimal converter **214**.

In FIG. **8** a plurality of AND gates **222, 224, 226** and **228** is provided for selective combination of the input signals provided on lines **72** through **78**. For this purpose, lines **72, 76** and **78** are connected directly to certain inputs of the gates whereas line **74** is applied directly to one input of gate **230**, the second input to which is derived over line **232** from line **72**. Gate **230** provides its output over line **234** to gate **236**, the output of which is provided over line **238** to certain of the aforementioned four selective combination gates. Gate **236** provides on line **238** a signal which is HI only when line **234** is LO which is the case when either line **72** or line **74** is HI. Thus AND gates **230** and **236** combine to provide an OR function such that whenever the coin in transit is a 5¢ piece or a 25¢ piece, i.e. when either line **72** or line **74** is HI, line **238** will be HI. Since it is desired to perform only two types of counting in the FIG. **7** system, i.e. multiples of one and multiples of ten, gates **230** and **236** act to indicate the 5¢ content of the quarter piece and line **72** may thereafter be considered as indicating a denominational value of 20¢ or twice the desired multiplicand of ten. Line **78** provides denominational value indicative of 10¢ or one times this multiplicand. Lines **238** and **76**, respectively indicative of denominational values of 5¢ and 1¢ , involve the units multiplicand. The particular manner of interconnection of these denominational value lines and the selective combination AND gates is illustrated in FIG. **8**. Output lines **242, 244, 246** and **248** have the states indicated in Table III below in accordance with the states of input lines **72** through **78** relating denominational values.

TABLE III

	25	5	1	10
Line 72	HI	LO	LO	LO
Line 74	LO	HI	LO	LO
Line 76	LO	LO	HI	LO
Line 78	LO	LO	LO	HI
Line 238	HI	HI	LO	LO
Line 242	LO	LO	LO	HI
Line 244	HI	HI	LO	HI
Line 246	HI	HI	HI	LO
Line 248	LO	HI	HI	LO

Output lines **242–248** are applied to a further set of four AND gates **252, 254, 256** and **258** along with the registration signal provided on line **82**. The respective states of output lines **206** through **212** is indicated in Table IV below, again in relation to the denominational value signals on lines **72** through **78**.

TABLE IV

	25	5	1	10
Line 72	HI	LO	LO	LO
Line 74	LO	HI	LO	LO
Line 76	LO	LO	HI	LO
Line 78	LO	LO	LO	HI
Line 206	HI	HI	HI	LO
Line 208	LO	LO	HI	LO
Line 210	LO	LO	LO	HI
Line 212	HI	LO	LO	HI

Output lines **206** and **208** are indicative of units values of certain coins in transit, i.e. of nickels and pennies, and of a five-cent value of each quarter. Output lines **210** and **212** are indicative of tens values of coins in transit, i.e. dimes and a twenty-cent value of each quarter. The circuitry of unit **202** is effective also to provide such units and tens values signals with encoding which effectuates an automatic zeroing of decimal converter **214** shown in detail in FIG. **9**.

In FIG. **9** the converter comprises an upper channel pulse generator **260** having an output terminal **261** and a lower channel pulse generator **262** having an output terminal **263**. The upper channel provides units readout on line **216** and includes flip-flops **264, 266, 268** and **270** and an AND gate **272**. The lower channel provides tens readout on line **218** and includes flip-flops **274, 276** and **278** and an AND gate **280**. The inputs to the converter are derived from lines **206** and **208** for channel **260** from lines **210** and **212** for channel **262**. Clock pulses are provided over lines **282** and **284**.

The various flip-flops other than **264** and **274** of FIG. **9** exhibit like state-changing characteristics and detailed discussion will be given for flip-flop (F/F) **266** in explanation of flip-flop logic. The F/F has input gating terminals **286** (set) and **288** (clear), an input trigger (clock pulse) terminal **290**, first and second output terminals **292** (output) and **294** (complementary output) and a further input terminal (preset) **296**. When gating terminals **286** and **288** are LO, any change in state at terminal **290** from a HI to a LO will alter the state of the F/F. When the gating terminals are HI, no change in state will occur other than that which may be provided by application of either a LO or HI signal to preset terminal **296**, which is effective to respectively provide a LO or HI signal at complementary output terminal **294**. Output terminals **292** and **294** provide opposite phase signals at all times, one terminal yielding a HI or LO signal and the other respectively yielding LO or HI. In the case of F/F **266** the gating terminals **286** and **288** are constantly enabled by connection thereof directly to ground (LO) such that any change in state of F/F **264** from HI to LO will change the state of F/F **266**. In the case of F/F **266** only output terminal **294** is used. Fairchild **9923** Medium Power JK Flip Flop provides the foregoing logic and may be used in channels **260** and **262**.

As a typical example of flip-flop operation, let it be assumed that a HI signal is applied from line **206** to terminal **296** thereby setting terminal **294** HI. If F/F **264** now changes state from HI to LO at the complementary output terminal thereof, F/F **266** will be triggered and terminal **294** will go LO. No further change will occur at line **294** until F/F **264** reverts to its original state and thereafter changes state from HI to LO again, thereby directing terminal **294** to HI.

Flip-flops **268, 270, 276** and **278** are each connected in like manner to F/F **266**, and presetting signals are applied to these flip-flops from input lines **206** through **212**. F/F **264** and F/F **274** are connected similarly with the exceptions that the trigger (clock pulse) terminals thereof are connected directly to clock pulse lines **282** and **284**, that the preset terminals thereof are not used and that the gating terminals thereof are connected to gates **272** and **280**. Thus, these flip-flops change state

only when the outputs of the gates **272** and **280** are LO, i.e. when at least one of the gate inputs is HI. As illustrated gate **272** derives its input signals from lines **298** and **300** which are respectively connected to the complementary output terminals of F/F **266** and F/F **270**. AND gate **280** derives its input from lines **302** and **304** which are respectively connected to the complementary output terminals of F/F **276** and F/F **278**.

As a particular example of operation of channel **260** let it be assumed that input line **206** is HI and input line **208** is LO. Note from Table IV that this condition occurs for the 5¢ and 25¢ pieces. F/F **266** and F/F **268** provide HI signals at their output terminals and F/F **270** provides a LO signal at its output terminal. The signals appearing on lines **298**, **300** being HI, LO, gate **272** provides a LO output on line **273** and upon the occurrence of the next clock pulse (CP1) on line **282**, F/F **264** is triggered. This F/F, as is the case of F/F **274**, is monostable in operation, since no signals are applied to its preset terminal. Output terminal **261** of the F/F exhibits a pulse (LO to HI to LO) upon triggering in accordance with the monostable character thereof and input terminal **290** of F/F **266** receives a triggering signal (HI to LO). F/F **266** is thereupon set LO, providing a LO signal on line **298**. F/F **268** is similarly changed in state since the trigger terminal thereof receives a HI to LO signal. The same result occurs in the case of F/F **270** whereby line **300** goes HI. AND gate **272** continues to provide a LO signal on line **273** and F/F **264** is again triggered upon the occurrence of the next succeeding clock pulse (CP2). A second pulse is generated at terminal **261** and F/F **266** is again changed in state to exhibit a HI output signal on line **298**. F/F **268** does not change state at this time, the triggering signal applied thereto changing from a LO to a HI in contrast to the required triggering signal characteristic. With no change in state of F/F **268**, F/F **270** remains unchanged. This sequence of events will continue until both inputs to AND gate **272** are LO whereupon line **273** will go HI disabling the gating terminals of F/F **264**. These events are compiled in Table V below.

TABLE V

	Before CP1	Upon CP1	Upon CP2	Upon CP3	Upon CP4	Upon CP5	Upon CP6
Line **298**	HI	LO	HI	LO	HI	LO	LO
Line **269**	HI	LO	LO	HI	HI	LO	LO
Line **300**	LO	HI	HI	HI	HI	LO	LO
Line **273**	LO	LO	LO	LO	LO	HI	HI
Terminal **261**		pulse	pulse	pulse	pulse	pulse	no pulse

As a result of the states of input lines **206** and **208**, five pulses only are generated at terminal **261**, indicative of the units denominational value of the 5¢ piece of five cents of a 25¢ piece.

With this example the circuit may be inspected in like manner upon the occurrence of 1¢ and 10¢ pieces in transit and it will be found that the number of pulses provided at terminal **261** will accord in number with the units denominational value of the penny, i.e. one pulse only, and no pulses will appear thereat for the dime. Furthermore, by reason of the particular encoding of the signals on lines **206** and **208**, it will be noted that the counting flip-flops **266–268–270**, and **276–278**, each comprising a serial chain of bistable elements, are all returned to a LO state upon the completion of generation of such precise number of pulses. The counter is thus automatically reset to zero upon the completion of pulse generation. The pulses generated at terminal **262** may be counted as units input by any appropriate totalizing device.

In the case of lower channel **262** operation therein is similar to the foregoing exemplary operation of the units channel and there will be selectively generated at output terminal **263** a single pulse in the case of a 10¢ piece in transit and two pulses in the case of a 25¢ piece in transit. Table VI indicates circuit occurrences in the case of a quarter.

TABLE VI

	Before CP'1	Upon CP'1	Upon CP'2	Upon CP'3
Line **302**	LO	HI	LO	LO
Line **304**	HI	HI	LO	LO
Line **281**	LO	LO	HI	HI
Terminal **263**		pulse	pulse	no pulse

In Table VI, the clock pulses are identified at CP' in contrast to those (CP) considered in Table V. The clock pulses, CP, provided to channel **260** over line **282** are in phase with those provided to registration pulse generator **138** of FIG. **6** over line **144** such that units denominational value signals are generated by channel **260** for counting prior to the tens denominational value signals generated by channel **262**. The latter channel operates with clock pulses CP' which are time-delayed with respect to clock pulses CP to insure the operating relation between the channels which permits "carry" computations in the counting or totalizing apparatus fed by decimal converter **214**.

By way of summary of The foregoing, in the system of FIG. **3**, the apparatus of FIGS. **1** and **2** is adapted to provide *n* output signals on lines **84** to **90**, each of which is indicative of the denominational value of one of the *n* (four) exemplary coins herein. To this end, the *n* gating circuits **146** to **152** of detector **80** receive, as a common input, the registration signal provided by the second sensor means of discriminator **70**, and as another input the output of one of gates **145** to **151**, i.e. a signal changing in accordance with a selective one of the signals provided by the first sensor group of discriminator **68**. These denominational value indicating signals may be totalized separately, e.g. by *n* counters or by a single units counter with multiplier inputs of 25, 10 and five.

In the system of FIG. **7**, the apparatus of FIGS. **1** and **2** is adapted to provide *n* output signals on lines **206** to **212** indicative, separately or in combination, of the denominational values of the *n* (four) exemplary coins herein. To this end, the *n* gating circuits **252** to **258** of detector and encoder **202** receive, as a common input, the registration signal provided by the second sensor means of discriminator **70**, and as another input, the output of one of gates **222** to **228**, i.e. a signal changing in accordance with a selective one or a combination of the signals provided by the first sensor group of discriminator **68**. The denominational value signals on lines **206** and **208** contain units value information and the denominational value signals on lines **210** and **212** contain tens value information and the respective lines are applied to units pulse generators **260** and tens pulse generator **262**. These generators provide units and tens

denominational value pulses adapted for totalization by a single units and tens decimal input counter. By virtue of the encoding capacity of gates **222** to **228**, the signals on lines **206** to **210** are adapted for both controlling the pulse generator output pulse provision and for automatically resetting the pulse generators to a common state of preparedness for the next subsequent count pulse generation.

Whereas the invention has been disclosed by way of particularly preferred embodiments for arrangement of the sensor groups of FIG. **2**, for the systems of FIGS. **3** and **7** and for the logic circuit implementations thereof, various modifications thereof will be evident to those skilled in the art and can be introduced without departing from the spirit and scope of the invention. Such embodiments are thus intended in a descriptive and not in a limiting sense, the invention herein being defined in the following claims.

What is claimed is:

1. Apparatus for use in determining the denominational values of differently-sized coins in transit therethrough at random speeds comprising first sensor means generating signals varying in accordance with sensed coin size and second sensor means so positioned with respect to said first sensor means as to sense a coin then in transit concurrently with said first sensor means and to generate a signal of predetermined characteristics at a time at which said first output signals exhibit variation in accordance with sensed coin size indicative of the denominational value of said coin then in transit.

2. Apparatus for use in determining the denominational values of differently-sized coins in transit therethrough at random speeds, including first sensor means generating first output signals exhibiting changing characteristics indicative of coin sizes sensed during the time period in which a coin in transit is in the field of sensitivity thereof, and second sensor means generating second output signals positioned with respect to said first sensor means such that said coin in transit enters the field of sensitivity thereof during each said time period and such that a second output signal exhibiting changing characteristics is generated at a time during each said time period at which the coin size indication of said first output signals is definitive of the denominational value of said coin in transit.

3. The apparatus claimed in claim **2** wherein said coins are of n different sizes and wherein said first sensing means provides first output signals exhibiting changing characteristics indicative of the varying sizes exhibited only by individual coins in transit of $n-1$ of said n different sizes.

4. The apparatus claimed in claim **3** wherein said first sensor means comprises a group of $n-1$ sensors each providing one of said first output signals.

5. The apparatus claimed in claim **4** wherein said first sensor group and second sensor means include radiant energy sensors normally receiving excitation and thereby generating said first and second output signals, said characteristics thereof changing upon interruption of said excitation by coins in transit.

6. The apparatus claimed in claim **5** wherein said $n-1$ radiant energy sensors of said first sensor group are disposed in a common plane transverse to the direction of coin transit.

7. The apparatus claimed in claim **5** wherein said second sensor means comprises radiant energy sensors disposed in a common plane parallel to the direction of coin transit.

8. A system providing denominational value indicating signals comprising the apparatus claimed in claim **2** and circuit means including gating circuits providing said denominational value indicating signals, each gating circuit receiving said second output signal and another signal having a characteristic exhibiting change in accordance with one of said first output signals.

9. The system claimed in claim **8** wherein n said gating circuits are included, each gating circuit providing a diverse denominational value indicating signal.

10. The system claimed in claim **9** wherein said first sensor means comprises a group of $n-1$ sensors each providing one of said first output signals.

11. A system providing denominational value indicating signals comprising the apparatus claimed in claim **2** and circuit means including gating circuits providing said denominational value indicating signals, each gating circuit receiving said second output signal and another signal having a characteristic exhibiting change in accordance with one of said first output signals or a combination thereof.

12. The system claimed in claim **11** wherein said denominational value indicating signals are indicative of units or tens denominational value.

13. A system providing first and second count signals for respective excitation of units and tens denominational value counters for totalization of the values of differently-sized coins in transit, comprising the system claimed in claim **10** and first and second pulse generators receiving said denominational value indicating signals and respectively providing said first and second count signals.

14. The system claimed in claim **13** wherein said denominational value indicating signals are indicative of units or tens denominational value and wherein said first pulse generator receives said units value signals and said second pulse generator receives said tens value signals.

15. The system claimed in claim **14** wherein said pulse generators each comprise a serial chain of bistable elements, each bistable element receiving one of the denominational value signals received by said pulse generators.

16. The system claimed in claim **15** wherein said denominational value indicating value signals have characteristics adapted to change the states of said bistable elements both to provide said first and second count signals and to return all said bistable elements to a common state after provision of said count pulses.

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