

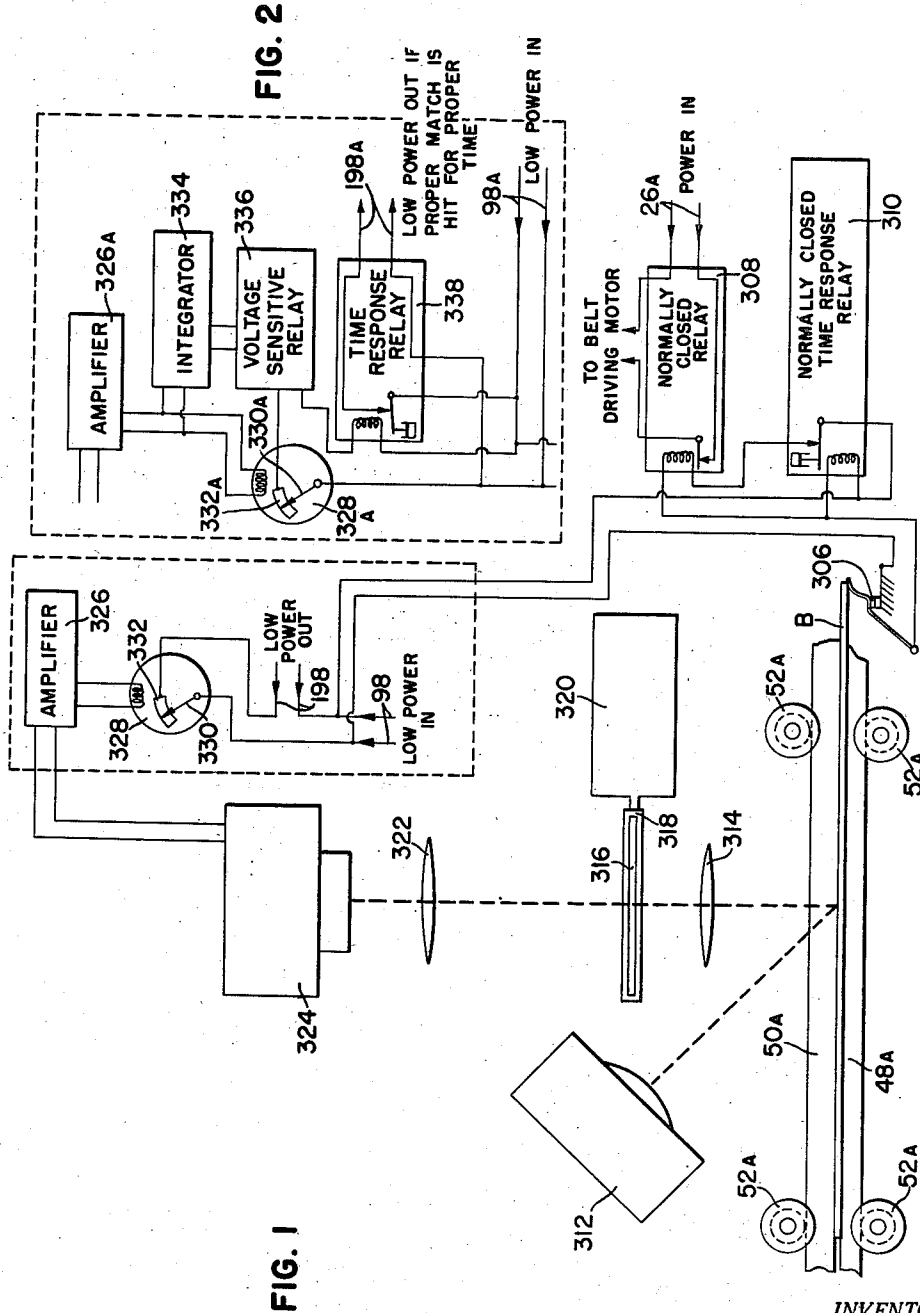
March 25, 1958

Filed Feb. 2, 1953

R. L. TIMMS
APPARATUS FOR IDENTIFYING PRINTED DOCUMENTS
AND THE LIKE AS GENUINE

2,827,822

3 Sheets-Sheet 1



INVENTOR.

ROSS L. TIMMS

BY *O. Selham & O. Selham*

ATTORNEYS

March 25, 1958

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3 Sheets-Sheet 2

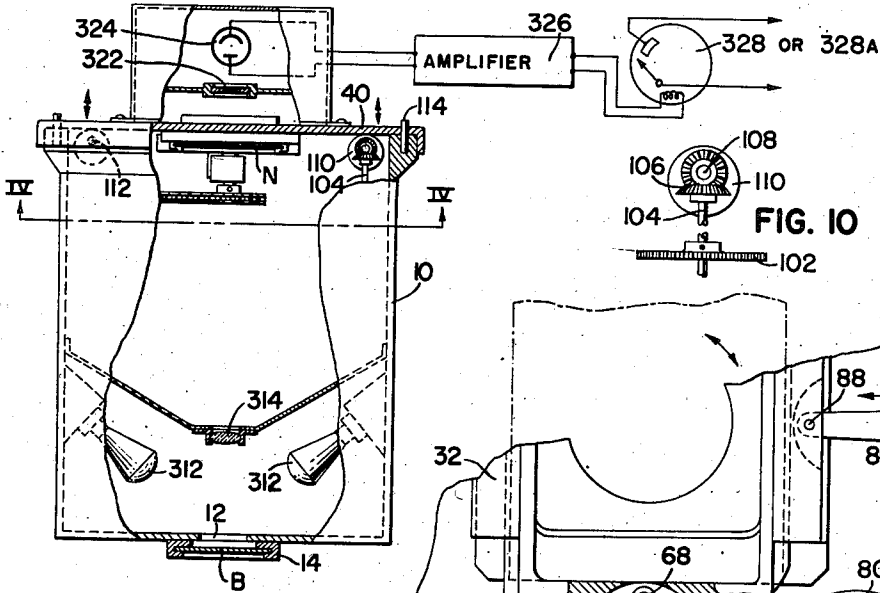


FIG. 3

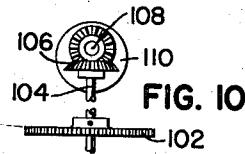


FIG. 10

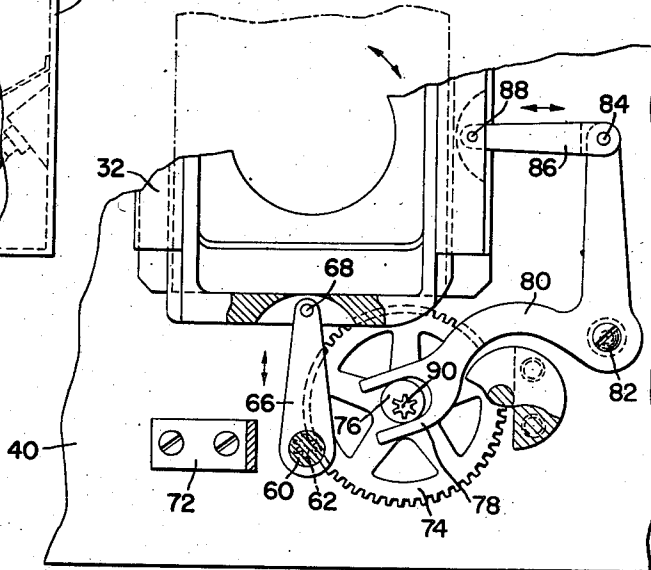


FIG. 6

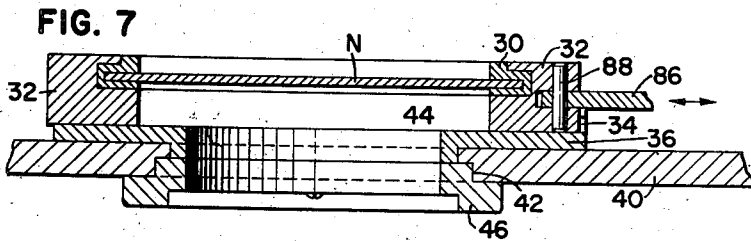


FIG. 7

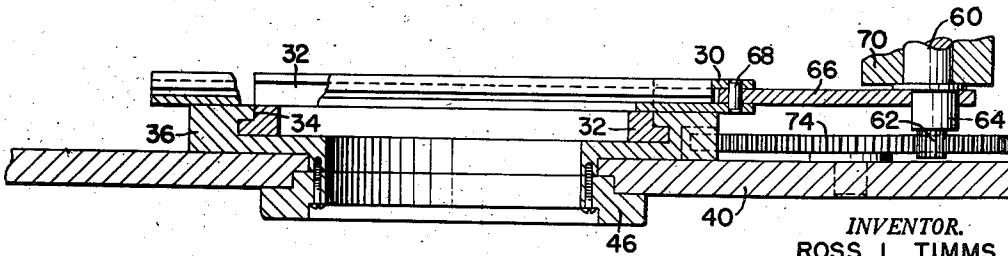


FIG. 8

INVENTOR.
ROSS L. TIMMS
BY *Olshum & Olshum*
ATTORNEYS

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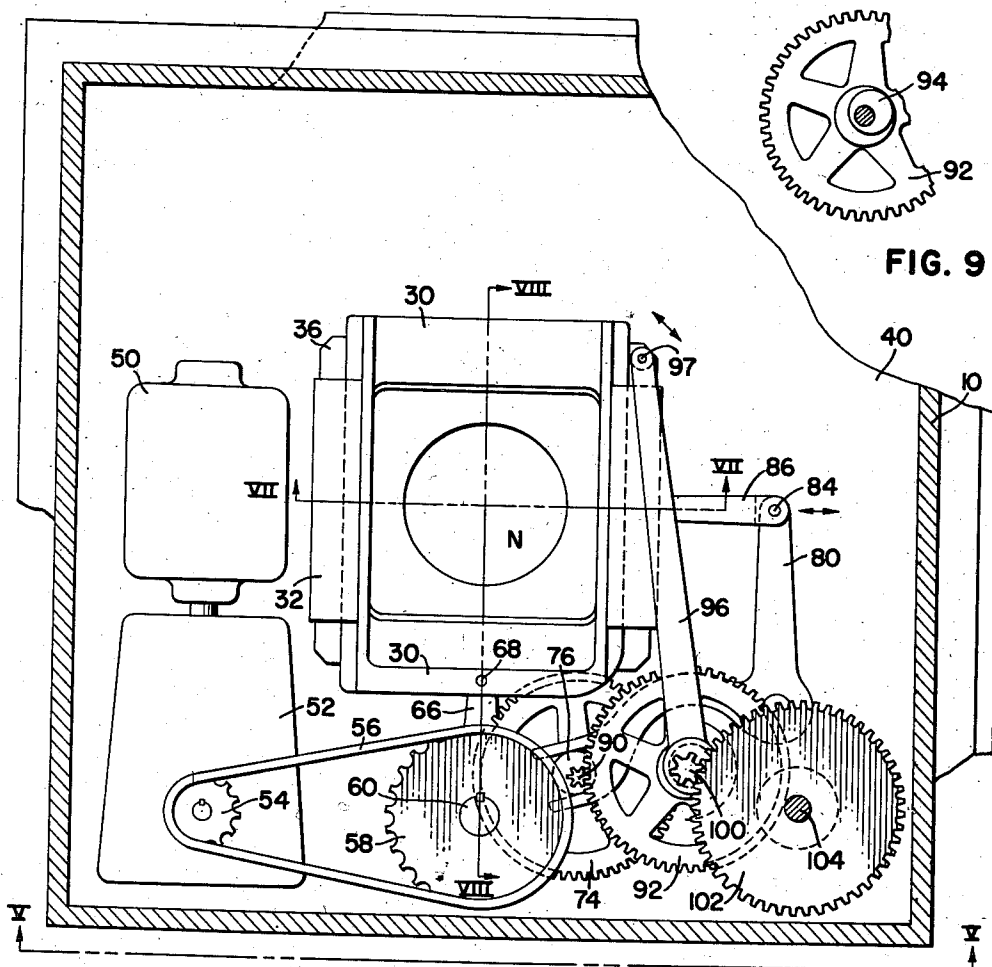


FIG. 4

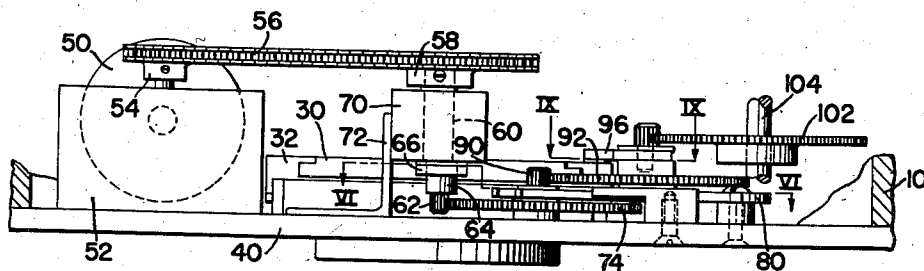


FIG. 5

INVENTOR.
ROSS L. TIMMS
BY *O. L. Latham & O. L. Latham*
ATTORNEYS

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2,827,822

APPARATUS FOR IDENTIFYING PRINTED DOCUMENTS AND THE LIKE AS GENUINE

Ross L. Timms, Akron, Ohio

Application February 2, 1953, Serial No. 334,684

4 Claims. (Cl. 88—14)

This invention relates to apparatus for automatically comparing paper money or other documents with a genuine specimen of the paper money or document to determine the genuineness of the money or document being examined.

This application is a continuation-in-part of my co-pending application entitled, "Apparatus For Identifying Paper Money, Or the Like, As Genuine, And For Making Change Or The Like," filed February 7, 1952, under Serial No. 270,326; and more specifically is concerned with the matching test apparatus of Figs. 11 and 11A of this application.

As stated in the identified application various mechanisms have been provided for determining rapidly and with a high degree of accuracy the genuineness of metal coins, but so far as I am aware, little or nothing has been done to determine automatically or with self-contained apparatus the genuineness of paper money or other documents. The inability of automatic vending and change-making equipment to accept paper money has limited automatic vending and the performance of similar services to relatively inexpensive articles, purchasable for comparatively small sums of money which can conveniently be reached by one or more metal coins, i. e., to the dispensing of cigarettes, soft drinks, and the like usually costing less than one dollar. Attempts have been made to merchandise items or services costing upwards to or even over one dollar, but such efforts have been complicated by the ordinary purchaser not carrying up to over one dollar's worth of metal coin change.

The general object of my invention is to avoid and overcome the foregoing and other difficulties of and objections to known apparatus and techniques by the provision of relatively inexpensive, readily operated apparatus for automatically determining the genuineness of paper money or other documents.

Another object of my invention is the provision of apparatus for automatically attempting to match a positive image of at least a portion of the paper money or other document being examined with a negative image of a genuine document or piece of paper money, together with means responsive to a match to indicate the genuineness of the money or document being examined.

Another object of my invention is the provision of mechanism for effecting relative scanning movement between images of a genuine article and an article being tested for genuineness, and having means responsive to substantially a match between the images for establishing that the article being tested is genuine.

Another object of my invention is to provide in apparatus of the character described means for effecting a relative longitudinal movement between the images being compared, means for effecting a relative lateral movement, means for effecting a relative angular movement, and means for effecting a relative change in scale of the images, or other combinations of these movements, the movements preferably being made at different rates where-

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by a complete scan between the images is achieved and to determine the possibility of match between the images.

The foregoing objects of my invention, and other objects which will become apparent as the description proceeds, are achieved by the provision of apparatus for determining the genuineness of paper money and the like, including means for imposing an enlarged portion of the positive image of the money being tested with respect to a similarly enlarged portion of a negative image of genuine money, means for effecting a plurality of scanning movements between the images, such as means for effecting a relative back and forth movement of the images substantially in the plane thereof to effect longitudinal alignment of the images, means for effecting a relative back and forth movement of the images substantially in the plane thereof to effect lateral alignment of the images and at a different rate than the longitudinal movement, means for effecting a relative angular oscillating movement of the images substantially in the plane thereof to effect angular alignment of the images and at a different rate than the lateral movement, means for effecting a relative change back and forth in the scale of the images and at a different rate than the angular movement, and means responsive to substantially a match between the images.

For a better understanding of my invention reference should be had to the accompanying drawings wherein:

Fig. 1 is a diagrammatic illustration, partially in vertical longitudinal section, of typical matching test apparatus of my invention;

Fig. 2 is a diagrammatic showing of the match integrating apparatus which may be substituted for the apparatus in the dotted box of Fig. 1;

Fig. 3 is a side elevation, partially broken away in vertical section, of a typical apparatus for effecting scanning movement between images to seek a match;

Fig. 4 is a view, taken substantially on line IV—IV of Fig. 3, and on a somewhat enlarged scale, illustrating in inverted plan the mechanism of the invention.

Fig. 5 is a view, largely in elevation, of the mechanism of Fig. 4 and taken substantially on line V—V thereof;

Fig. 6 is a view similar to Fig. 4, but with certain parts thereof being broken away, and taken substantially on line VI—VI of Fig. 5;

Fig. 7 is a cross-sectional view, on somewhat larger scale, and taken on line VII—VII of Fig. 4;

Fig. 8 is a cross-sectional view taken on line VIII—VIII of Fig. 4, and on a somewhat larger scale;

Fig. 9 is a cross-sectional view taken on line IX—IX of Fig. 5 and illustrating details of the eccentric drive; and

Fig. 10 is an enlarged fragmentary view illustrating the manner of driving the eccentrics for adjusting the relative scale of the images being examined.

Having more particular reference to the drawings, the matching test apparatus of Fig. 1 includes a bill B, and some suitable means for supporting the bill, such as V-belts 48A and 50A gripping the edges of the bill and idler rollers 52A for the V-belts. The microswitch 306 is normally open but is closed by being engaged by the front end of the bill B, and when closed closes a circuit from the low-power-in circuit 98A to the normally closed relay 308 (which may be a part of relay 28A) to open this relay to cut off the flow of current from the power-in circuit 26A to the belt driving motor 30A so that the bill B comes to a stop. A normally closed time response relay 310 is connected in the circuit to the relay 308, with the relay 310 functioning to cut off the flow of electric current to the belt driving motor 30A for the required number of seconds to complete the matching test herein described. Thereafter,

the time response relay 310 opens, thereby breaking the flow of current to the operating coil of the relay 308 to return the relay 308 to closed position to thereby connect the power-in circuit 26A with the belt-driving motor 39A to move the bill B out of the test apparatus.

Positioned above the bill B when it is brought to rest is one or more white light sources 312 which direct a beam of light at an angle other than a perpendicular towards the surface of the bill, for example, at an angle of 45°. Usually the light 312 is concentrated upon a portion of the bill best adapted for matching (by matching I mean complementary alignment with a negative of an identical portion of a genuine bill), and I have found that the best spots on U. S. currency are around one of the eyes of the picture on the center of the bill. Positioned at an angle, for example 90°, from the bill surface and focusing on the selected portion of the bill some one-half inch in diameter is a lens or lens system 314 which enlarges the selected portion of the bill and superimposes this positive image upon an enlarged negative image, to substantially the same orientation and scale, of an identical portion of a genuine bill. The negative 316 is mounted around its edges in a frame 318 carried by mechanism 320 which is adapted to move the frame 318 and negative 316 in a cyclic or periodically repeated scanning or match-seeking motion relative to the positive image focused upon the negative by the lens system 314. Usually this scanning motion moves the frame 318 in both a lateral and a longitudinal direction, as for example, a slow longitudinal movement plus a rapid lateral movement, in the plane of the negative to hunt or seek substantially a match or complementary alignment, between the enlarged positive image and the negative.

In addition, if greater accuracy is desired a third motion in the relative movement of the images may be added to rotate one of the images in relation to the other in the same plane to insure rotary alignment of the images, and a fourth motion, if desired, may be added to compensate for possible shrinkage of the bill being tested by focusing or movement of one of the images toward or away from the other.

It will be recognized that should the match be perfectly effected that black portions of the positive cover white portions of the negative and white portions of the positive cover black portions of the negative and no light will flow through the lens system 322 to the photocell pick-up 324. However, a perfect match or complementary alignment is not ordinarily effected, but even if an exact match is not consummated there is a definite diminishing of the amount of light passing through the photocell 324 when a match point is approached or substantially reached. Then, as shown in Figure 1, by feeding the output of the photocell 324 to an amplifier 326 having the output thereof connected directly to a galvanometer unit 328 having thereon needle 330 and short arcuate contact 332, I am able to energize the output circuit only when a substantially match or complementary alignment occurs. This energization may then be used to actuate any desired means to indicate the bill has passed this test.

In the operation of apparatus of the character described, I have discovered that there are a number of spurious or false matching points so that the output of the amplifier will rise and fall a plurality of times before a true complementary alignment or substantially a true complementary alignment and its consequent matching voltage drop is achieved.

I have found that the voltage changes resulting from spurious match points are greater in operations upon genuine bills than in operations upon counterfeit. Accordingly, I may and preferably do attach, as shown in Fig. 2, an integrator 334 to the output of the amplifier 326, the integrator adding up the changes in voltage re-

sulting from the spurious or false matches, and the output of the integrator being attached to a voltage sensitive relay 336 which is fired or operated when the voltage added up by the integrator 334 attains the predetermined amount. Closing of the voltage sensitive relay 336 completes the circuit to a time response relay 338 if the needle 330 of the galvanometer 328A is in engagement with the contact plate 332A. Closing the time response relay 338 closes a low-power-out circuit 198A to operate the stepping switch 68 or to perform any other described function.

It will be recognized that the low-power-out circuit is closed when a true or a substantially true match is obtained between the bill B being tested and the negative 316 resulting in a dip in the galvanometer 328 to bring the needle 330 into engagement with the arcuately short contact plate 332, as shown in Fig. 1 or when the integrator 334 has added up the changes in voltage resulting from the spurious or false matches between the bill and negative in an amount equal to operate the voltage sensitive relay 336, as shown in Fig. 2.

I have found that the matching test described, when employed in conjunction with an enlarged portion of a bill, for example, over an area about 1/2" square in the region of one of the eyes or eyebrows of the face on a bill, and usually including a portion of the cross-hatching within the oval of the picture and to one side of the face, provides a relatively efficient test. For example, I have been able to eliminate with this test substantially one hundred percent of counterfeit bills tested and to accept substantially one hundred percent of genuine bills tested.

Apparatus for effecting the scanning movement of the images is more fully illustrated in Figs. 3 to 10 and in one typical embodiment includes a box 10 having an opening 12 at its bottom surrounded by frame 14 which slidably receives a bill 8 being tested for genuineness, the bill being moved into position either by belts 48A and 50A or by a slide and frame such as indicated by the numerals 14 and 16 in my co-pending application Serial No. 270,326 and therein described. Suffice it to say here that the frame 14 receives and supports in flat steady manner the bill B to be examined for genuineness.

The bill so supported is illuminated by light 312 carried in the box 10, and the lens system 314 focuses the positive image of the bill onto the negative N of a genuine document, the negative being mounted for relative scanning movement, as hereinafter described.

The negative and positive images are in alignment with the lens system 322 and the photocell 324, the photocell being connected to the input of amplifier 326. The output of the amplifier 326 is connected to galvanometer 328 or 328A, as illustrated in Figs. 1 or 2, so as to indicate when substantially a match has been achieved between the images being examined to thereby prove the genuineness of the paper money or other document being examined.

Returning now to the negative N of a genuine document or piece of paper money, this usually is in the form of a glass negative removably but fixedly positioned in a frame 30 which is slidably mounted, as seen in Fig. 7 in a frame 32. The frame 32 is slidably mounted, as at 34, on a plate 36, the frame 32 being slidable in a direction at right angle to the direction in which the frame 30 slides in the frame 32.

In turn, the plate 36 is mounted for relative angular movement with respect to a cover 40, and this is achieved by providing a circular opening 42 in the cover 40, providing a flange 44 on the plate 36 which is rotatably received in the opening 42 in the cover 40, being held therein by a collar 46 which is secured to the flange 44.

Now in order to effect a relative scanning movement between the superimposed images of the bill B and the negative N, I provide a motor 50 which operates through

a gear box 52 to drive a pinion 54 connected by a belt or chain 56 to a sprocket 58. The sprocket 58 is secured to a shaft 60 having a small pinion 62 formed on or secured to its other end, and on which is mounted also an eccentric 64. The eccentric 64 is engaged by a strap 56 pivotally connected at 68 to the frame 30 so that as the shaft 60 is revolved by the motor 50 the frame 30 is given a back and forth motion in a longitudinal direction so that the images of B and N are moved in a relative longitudinal direction substantially in the plane of the images. The shaft 60 is rotatably supported in a bearing 70 secured by an angle bracket 72 to the cover 40.

The pinion 62 engages a gear 74 to rotate the same, the gear 74 being secured, as best seen in Fig. 6 to a shaft mounting an eccentric 76 engaged by the forked end 78 of a bell crank 80 pivotally secured to the cover 40 at 82. The other end of the bell crank 80 is pivotally connected at 84 to a link 86 which is pivotally fastened at 88 to the frame 32. Thus as the gear 74 is rotated by the pinion 62 the bell crank 80 is oscillated to move the frame 32 back and forth to thereby effect lateral scanning movement between the images B and N substantially in the plane of the images.

It will be recognized that the rate of relative movement between the images B and N in a lateral direction is different than the rate of relative movement between the images in the longitudinal direction. These rates differ by the gear ratio between the pinion 62 and the gear 74, or in the ratio in the mechanism shown of about 1 to 10. This ratio could be any other selected fixed ratio, for example sometimes a 3 to 1 ratio may be made to work, although a ratio of 1 to 10 has been found to be particularly satisfactory. The point is, of course, that a relative rapid scan is effected back and forth in a longitudinal direction while the relatively slow lateral scan is being effected to thereby insure that if the images of B and N can be matched that they will be brought into matched position at some point of the relative scanning movement.

Relative scanning movement in an angular direction is likewise effected between the images B and N, and this is achieved by providing a pinion 90 on the shaft of gear 74, the pinion 90 engaging with gear 92, which as best seen in Fig. 9 carries an eccentric 94 which is surrounded by a strap 96 connected pivotally at 98 to the plate 36. Thus, as gear 92 is rotated the plate 36 is moved back and forth in an angular relation so as to effect relative angular scanning movement between the images B and N. The relative angular scanning movement, as described, is at a rate different than the longitudinal and the lateral scanning movement, and may be in the ratio of 1 to 10, namely, the same ratio difference as has been described as existing between the longitudinal and the lateral scanning movement. This difference in ratio movement is the difference between the number of teeth on the pinion 90 and the teeth on the gear 92, and all of the remarks made above with respect to the purpose of and the difference in rate of scan between the longitudinal and lateral scan, apply with equal force to the angular scan.

One other relative scanning movement may be provided in the mechanism of my invention as described. This is to effect a relative change in scale of the images of B and N, and can be achieved by providing a pinion 100 upon the gear 92 which pinion drives a gear 102 rotatably supported (by bearings not shown) upon the cover 40. The gear 102, as best seen in Fig. 10, is splined to shaft 104 which is mounted in bearings carried on the sidewall of box 10, and which drives through beveled gearing 106 a shaft 108 journaled on the box 10 adjacent the cover 40. The shaft 108 carries eccentrics 110 engaging the cover 40 so that rotation of the shaft 108 moves the cover 40 and the negative N toward and from the bill B to effect relative change in scale between the images. The shaft 108 is adapted to be connected

by means (not shown) to a parallel shaft 112 at the other side of the cover 40, the shaft 112 likewise mounting eccentrics to move the cover 40 up and down in the manner described upon rotation of the shaft 108. Guide pins 114 keep the cover 40 and the box 10 in proper light-tight relation during relative movement thereof.

As previously described, the relative movement effecting change of scale between the images of B and N is at a different rate from the other relative scanning movements previously described, being determined by the relationship between the number of gear teeth on pinion 100 and on gear 102, but with this ratio being selected in the manner previously described with respect to the relationship of the other relative scanning movements. Suffice it to say in general that the relationship of the scanning movement as a whole is such that when all of the relative movements are considered in conjunction with each other the effect is to bring the negative and positive images of B and N into a matching relationship if the bill being examined is genuine, or into such a substantial match as to definitely effect a considerable drop in the amount of light passing to the photocell 324, the drop being within the ranges and in the amounts sufficient to operate through amplifier 326 to actuate galvanometer 328 or 328A, in the manner heretofore described.

In the operation of the apparatus described, it will be understood that the motor 50 drives link 66 to effect a longitudinal scanning movement, bell crank 80 and link 86 simultaneously effect a relative lateral scanning movement, strap 96 simultaneously effecting a relative angular scanning movement, and eccentrics 110 concurrently effecting a change in scale of the images B and N. It will be understood that it takes a definite period of time for a complete scanning movement to be made between the images B and N. In the ratio of movements described there will be one thousand relative longitudinal movements of the images, one hundred relative lateral movements, ten relative angular movements and one complete scale change movement to effect one complete scanning operation.

When the positive and negative images are brought into match or alignment position, or substantially into match and alignment, it will be recognized that the dark portions of the positive align with the light portions of the negative, and vice versa, so that the passage of light to the photocell is at a minimum, and if this minimum is maintained within the required limits and for a selected duration of time, then the galvanometer 328 is operated to identify the bill or document as genuine, all as previously described. It is also possible to utilize the galvanometer 328A in conjunction with the integrator and voltage sensitive relay in the manner described in conjunction with Fig. 2, as will be understood.

On the other hand, if the bill or document examined is not genuine then a match or alignment is never achieved between the images B and N in an amount and character sufficient to actuate the galvanometer 328 or 328A.

From the foregoing it will be recognized that the various objects of my invention have been achieved by the provision of relatively inexpensive, easily operated and substantially fool-proof apparatus for determining the genuineness of paper money or other documents, and usually involving a magnified comparison of portions of the document in question with similar portions of a genuine document. The apparatus of my invention is adapted to be used in conjunction with vending equipment or change making equipment, or combinations thereof, as more fully outlined in my co-pending application herein identified.

While in accord with the patent statutes certain best known embodiments of my invention have been illustrated and described, it is to be particularly understood that I am not to be limited thereto or thereby.

I claim:

1. Matching test apparatus for printed documents and

the like including means for receiving a document, illuminating means, conveyor means for effecting relative movement between the illuminating means and the document receiving means to position the document so that a portion thereof is illuminated, a negative of at least a portion of a genuine document enlarged to substantially the same scale and orientation as the enlarged portion of the document being tested, a lens system for enlarging at least a section of the illuminated portion of the document and superimposing the enlarged image of the document upon the enlarged negative, means for effecting a cyclic motion between the enlarged images and the negative, photocell means focused on the superimposed enlarged portion and the negative to measure a complementary alignment therebetween, means including a switch connected to the output of the photocell means to indicate an alignment, integrating means for adding up voltage changes resulting from spurious alignments, a voltage sensitive relay adapted to close when the voltage added up by the integrating means reaches a preselected amount, a time responsive relay adapted to be closed when the voltage sensitive relay is closed and the switch of the alignment indicating means are closed for a preselected time, and a signal circuit adapted to be actuated by the closing of the time responsive relay.

2. In a device for determining as genuine documents and the like, matching test apparatus including means to position a document so that a portion thereof is illuminated, a negative of at least a portion of a genuine document, a lens system for superimposing an image of at least a part of the illuminated portion of the document being tested on the negative, the image and negative being of substantially the same scale and orientation, means for effecting a cyclic motion between the image and the negative, photocell means focused on the superimposed image and the negative to measure a match therebetween, means including a switch connected to the output of the photocell means to indicate a match, integrating means for adding up voltage changes resulting from spurious matches, a voltage sensitive relay adapted to close when the voltage added up by the integrating means reaches a preselected amount, a time responsive relay adapted to be closed when the voltage sensitive relay and the switch of the

match indicating means are closed for a preselected time, and a signal circuit adapted to be actuated by the closing of the time responsive relay.

3. In a device for determining the genuineness of printed documents and the like, matching test apparatus including a source of illumination, transfer means to position a document so that at least a portion thereof is illuminated, a negative of at least a portion of a genuine document, a lens system for superimposing an image of at least a part of the illuminated portion of the document being tested on the negative, the image and negative being of substantially the same scale and orientation, means for effecting a cyclic motion between the image portion and the negative, photocell means focused on the superimposed portion and the negative to measure a complementary alignment therebetween, integrating means connected to the output of the photocell means for adding up voltage changes resulting from near matches, and signal means operated by the integrating means when the document tested is genuine.

4. Matching test apparatus for determining the genuineness of documents and the like, including conveyor means to position a document so that a portion thereof is illuminated, a negative of at least a portion of a genuine document, a lens system for superimposing an image of at least a part of the illuminated portion of the document being tested on the negative, the image and negative being of substantially the same scale and orientation, means for effecting a scanning motion between the image and the negative, photocell means focused on the superimposed portion and the negative to measure a match therebetween, integrating means for adding up voltage changes resulting from spurious matches, a voltage sensitive relay adapted to close when the voltage added up by the integrating means reaches a preselected amount, and a signal circuit adapted to be actuated by the closing of the relay.

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