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(54) IMPROVEMENTS IN AND RELATING TO A METHOD AND APPARATUS FOR DETECTION AND IDENTIFICATION OF OBJECTS

(71) We, IMPHY S.A., formerly known as METALIMPHY, a French corporate body of 8 rue de la Rochefoucauld 75009, Paris, France do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:-

The invention relates to a method and apparatus for detection and identification of coded labels carried by objects with a view to starting up an operation responding to the detected code or with a view to subsequent selective processing of these objects. The invention thus finds effective application in automatic sorting of mail, e.g. in the form or parcels or bags.

Methods exist of automatic detection or addressing by reading conventional magnetic tapes of magnetophone type or by counting of electroluminescent marks as for the sorting of letters. But such devices require accurate positioning of the member to which the tape or mark is attached with respect to the detection apparatus and generally a constant speed of movement. They are therefore ill adapted to reading labels carried by supports of very different shapes and orientation such as parcels or mail bags.

It has also been proposed to detect the presence of an object, even of very small dimensions, made of a metal exhibiting particular magnetic characteristics, without direct contact of the object with the detector apparatus. Such a proposal has been used for the prevention of thefts from libraries or shops, in which instance there is concealed in the objects to be protected a magnetic metal member of alloy or "permalloy" species and users of the library or shop must, in order to leave, pass through or near to a detector for detecting the presence of the concealed magnetic member. The detector comprises an excitation coil which creates an alternating magnetic field, and a balanced detector coil where normally no signal appears. The presence near the detector of a book bearing the magnetic member magnetically induces a current which unbalances the detector coil and generates a signal which can be detected by conventional means.

Such apparatus only enables the simple presence of an object in the region of the detector to be detected. The problem posed by automatic sorting of mail bags or parcels is primarily to be able to identify each of the objects in order, and then to distribute them to various regrouping zones corresponding, for example, with common directions of routing. At present the various parcels or bags are provided with a label with an indication of destination, and sorting is usually effected by an official before whom the various bags are made to pass and who by reading the labels routes the objects in a desired direction.

The present invention provides a method of identifying an object comprising providing the object with at least one member of a magnetic material, assigning an identifying code to the object by selectively removing a portion of the magnetic material from the member, and passing the member near to a detector circuit whereby to produce in the detector circuit a signal the amplitude of which varies in accordance with the location and extent of the removed portion.

Objects marked by thin magnetic tape or

wire may be identified by employing the method of detection of the passing of the magnetic tape through a detector zone including at least one frame with an excitation coil fed with alternating current in order to create an alternating magnetic field and a detector coil balanced so that no signal appears in the absence of magnetic bodies in proximity to the detector zone. However, when the magnetic tape passes through or near to the zone, each alternation of the field of excitation generates an unbalance in the detector coil and the appearance of a signal which is then applied to a device for detection and measurement of phase with respect to the field of excitation.

In order to assign a coded reference to an object, the magnetic tape is left intact or it is divided up selectively in predetermined variable locations by cuts of predetermined variable sizes, thus bringing about during the passing of the tape near to the detector circuits predetermined variable amplitudes of the resultant signal; decoding of the signal being achieved in the detector device by measurement of its amplitude.

In accordance with a particular form of the invention, in order to identify an object, a number of thin magnetic tapes or wires are employed which each exhibit different hysteresis loops characterised by different coercive fields, thus enabling a coded reference to be assigned to each object of as many characters as there are tapes or wires employed; each character of the reference is then assigned to a tape or wire in the order of values of their respective coercive fields, the signals corresponding with each tape then appearing in the detector device in the same order of phase shift as the order of the coercive fields, and each one with amplitudes corresponding with the values assigned during coding, thus reproducing the code completely in arrangement and amplitude.

In accordance with another particular form of the invention, thin composite magnetic tapes are employed, each constituted by the juxtaposition of a number of elemental tapes of magnetic characteristics which are identical or sufficiently close for the disturbance signals to be practically in phase, and each of the elemental tapes is divided up selectively and independently.

The invention likewise provides apparatus for identifying objects comprising at least one excitation coil arranged to be supplied with alternating current in order to create an alternating magnetic field, at least one detector coil balanced so that no signal appears in the absence of a member made from a magnetic material in proximity to the detector coil, and a detector device connected to the detector coil for the detection and measurement or phase and amplitude with respect to the field of excitation of a signal arranged to be produced, in use, by the passage through or near to the detector coil of an object bearing an identifying magnetic member generating at each alternation of the field of excitation an unbalance in the detector coil, the magnetic member being encoded by having a portion thereof removed at a predetermined location along its length, the detector device further including means arranged to decode the signal and thereby to identify the object.

In accordance with a more particular form of the invention, the apparatus includes in the path of the objects three successive frames in three mutually perpendicular planes so that the three fields generated, each one in each frame by the respective excitation coil, have mean directions along three mutually perpendicular directions.

In accordance with a preferred form of the invention each frame is constituted by two elemental frames arranged as Helmholtz coil, so generating a substantially constant field between the two elemental frames.

Equally in accordance with a preferred form of the invention, each elemental frame includes an excitation circuit which includes in series a main coil in the frame and an auxiliary balancing coil, whilst the detector circuit comprises in series a main coil frame, an auxiliary balancing coil and a signal output coil, the two auxiliary balancing coils of one set of two elemental frames being coupled inductively by an ironless coupling; the two excitation circuits of each set of two elemental frames are fed in parallel whilst the two output coils constitute the double primary of a transformer with a single secondary at the terminals of which a combined signal is produced.

The present invention furthermore provides a device for identifying an object, and comprising at least one member of a magnetic material arranged to be disposed on the object, said member being divided up by a cut, the position of which is indicative of a code identifying the object.

Features and advantages of the present invention will become apparent from the following description of embodiments thereof given by way of example, when taken in conjunction with the accompanying drawings, in which:-

Figure 1 is a diagrammatic and symbolic representation of the device for detection and identification of coded markings carried by a label attached to an object;

Figure 2 shows a label having only one magnetic tape, with a representation of the relative amplitudes of the signal picked up by the detector device from such a tape when coded in a number of different ways.

Figure 3 shows a label having a number of single magnetic tapes enabling a coding of several characters;

Figure 4 shows a label similar to that shown in Figure 3 but restricted to binary coding;

Figures 5 and *6* are generally similar to Figures 2 and 3 respectively, and shows labels having composite tapes enabling an increase in the levels of amplitude detectable;

Figure 7 shows diagrammatically an embodiment of certain members of a detector device using three double detector frames along the path of travel of an object to be identified; and

Figure 8 is a diagram of the supply and coupling of the excitation and detection circuits for a double frame as shown in Figure 7.

Figure 1 shows diagrammatically the elements of a device for detection of the presence in an object of a magnetic member. A frame 4 through which the objects to be detected are passed is used to support an excitation coil 6 represented here symbolically by a single turn fed with alternating current from a supply circuit for example the mains. The frame 4 also carries a detector coil 7 represented in the same fashion symbolically by a single turn. The coils 6 and 7 are connected in opposition in a balance circuit 8 constructed and arranged so that no signal appears at the output 10 from the unit in the absence of any metallic body in proximity to the frame. The output 10 is here applied by way of filter and balancing circuits 11 to the plates of an oscilloscope 12 which provides a visual indication of the signals detected.

When an object 15, such as a parcel or mail bag bearing a coded magnetic label 1 passes through the frame 4, the detector circuit becomes unbalanced and signals corresponding to the code on the label appear on the oscilloscope 12.

Of course the representation of the reading or indicating device as an oscilloscope is only an example; it may be replaced or complemented by a decoding logic circuit. The signal thus decoded may be employed for controlling a process and here, for example, in the automatic manipulation of points or conveyors for distributing the mail bags to regrouping areas corresponding with common destinations defined by the codes on the labels.

The label 1 shown in Figure 2 consists of a support of paper or cardboard on which one can write in the normal way and on the back it carries one thin metal film or tape 2 of ferromagnetic alloy having a substantially rectangular hysteresis loop. The label may be introduced into a coding compositor enabling the magnetic tape to be divided up locally by a cut of variable size and location. Thus in Figure 2 a) the tape is intact, which might, for example, correspond with a value 4, that is to say, indicate that the object bearing this label carries the sorting code 4. In Figure 2 b) the tape has been divided up near one end in order to indicate, for example, that the object carries the code 3. In Figure 2 c) the cut has been made further from the end and in Figure 2 d) the cut is wide and located towards the middle of the tape; these two other forms of coding will correspond, for example, with codes 2 and 1.

The cuts of variable size and position lead to the formation of demagnetizing fields which modify the disturbing effect of the tape in the field of excitation. Hence they reduce the amplitude of the signal picked up in the detector circuit, this being in proportions which depend upon the size of the cut and its position on the tape. The amplitude of the signal induced in the coil 7 depends upon the state of coding of the label and hence translates the code, 1, 2, 3 or 4 which the label bears. By the amplitude of the signal is to be understood here and in all that follows, not only the height of the signal as it would appear on an oscilloscope but also the area which it occupies. The electronic detector circuits may be more specifically sensitive to one or other of these characteristics of the signals.

Figure 3 shows one way of increasing the coding capacity by employing a plurality of magnetic foils or tapes on the same label. Thus the label 1 in Figure 3 is provided with seven thin metal tapes 2. Each tape 2 is of a different ferromagnetic alloy though all have a substantially rectangular hysteresis loop. The tapes 2 are disposed parallel to each other on the label in the same order as the coercive fields proper to each alloy employed. For example, the lefthand tape might be of mumetal with a coercive field practically zero, the next tapes going towards the right being of alloys the coercive fields of which progress up to, for example, 200 oersted. The label has been introduced into a coding compositor enabling each magnetic tape to be divided up locally by a cut of variable size and location, or else the tape to be left intact.

Here four types of cut have been shown with which five levels of amplitude of the signal can be produced. Hence each tape may be given the values, for example, 4, 3, 2, 1 or 0. If as in Figure 3 one assigns to the first tape, being intact, the meaning of the number 4 it may be seen that the third tape exhibits a small cut towards the end which brings about a reduction in amplitude of the signal to about 75% of its original value; the third tape will then have the meaning of the number 3. A small cut nearer the middle

may reduce the signal to 50% and give the tape the meaning of the number 2 as shown for the second tape; still nearer the middle the same cut will reduce the amplitude of the signal still more to correspond with the number 1. Finally a wide cut towards the middle of the tape will practically wipe out the signal picked up and will correspond with zero for the tape. It can be seen that by thus giving five values to each tape one may with a number of tapes N of different magnetic properties, number the object with N digits to the base five.

The passage through the frame 4 of an object 15 bearing a magnetic label 1 provided with seven tapes unbalances the detector circuit and the corresponding signals appear in the form of as many pulses as there are metal tapes on the label 1. The pulses are offset with respect to the field of excitation by an amount which increases steadily with the value of the coercive field of the metal employed. Hence there will be seen to appear on the oscilloscope a series of signals the relative positions of which reproduce the relative positions of the tapes 2 on the label 1. Hence one will be able to read the number coded on the label 1 using the oscilloscope.

It may be observed that the order of appearance of the signals of response from each tape 2 during the course of one alternation of the alternating magnetic field of excitation is independent of the position of the tape, hence of the orientation of the label with respect to the frame; it depends only upon the relative values of the respective coercive fields of each tape. The appearance of the signals or the absence of signal will therefore occur in the order of the values of the coercive fields, that is to say, in the order of reading the digits of the code number.

The label shown in Figure 4 is a particular case of that shown in Figure 3; here each tape 2 is simply kept intact or boldly cut in several places or frankly torn off. The signals obtained originating from each tape are then either the full signal or else a signal which is practically zero. Thus a binary coding is achieved which will be detected under the same conditions in the device for detection and decoding.

The coding capacities of the labels in accordance with Figures 2 or 3 are still limited, because in order to enable economic industrial production of the materials employed a certain tolerance must be accepted in the position and size of the cuts made in the tapes, and an exaggerated sensitivity must not be looked for in the detector apparatus. Hence in practice one will be restricted to five levels of amplitude per tape including the level zero as in the examples described by Figures 2 and 3.

The labels represented in Figure 5 are generally of the same type as those in Figure 2 but here each label 1 includes three metal tapes 21, 22 and 23 placed side by side, of the same ferromagnetic alloy with a substantially rectangular hysteresis loop.

The label may be introduced into a coding compositor which enables each of the elemental magnetic tapes to be divided up locally and independently by a cut of variable size and location. Thus in Figure 5 a) the three tapes are intact, which brings about the maximum magnetic disturbance and hence maximum amplitude of the detected signal. On the contrary in Figure 5 f) the three tapes have each been divided up by a wide cut at their middle, which practically entirely destroys the disturbing effect and corresponds to a zero signal level. If each elemental tape is left intact or else it is cut in three possible locations and with more or less wide cuts, three levels of signal amplitude will be obtained for each elemental tape without counting the zero level; as the signals from each elemental tape add up in the detector since they appear in phase, the juxtaposition of the three tapes will enable nine levels of amplitude to be defined besides the zero level, and this without having to increase the intensity of the field of excitation or the sensitivity of the detector apparatus.

From Figure 5 the method of obtaining amplitude levels intermediate between the zero level represented in f) and, for example, a level 9 represented in a) is as follows:

In Figure 5 b) only the tape 21 has been slightly divided up, and the amplitude of the signal will correspond with a level 8. In Figure 5 d) the effectiveness of the tape 21 has been practically cancelled by a wide cut in the middle whilst the tape 22 bears a less wide cut located at about 2/3 of its length; the resultant signal will arise from the full effect of the tape 23 and an effect reduced to about one third for the tape 22, with the result that the overall signal may be considered as representing a level 4. The levels of amplitude corresponding with the other representations shown explain themselves, and by simple transpositions positions of cut may easily be found which would lead to the amplitude levels omitted from the Figure.

Of course the number of elemental tapes juxtaposed in each composite tape might equally well be two or four or some other number, the choice depending above all upon the particular conditions of use. Similarly one might conceive that the juxtaposed elemental tapes are not of strictly identical magnetic characteristics. However, these characteristics should be sufficiently close for the signals generated in the detector coil by each of the elemental tapes to remain in phase in order to be able to be added

together in the detector device.

Neither is it obligatory that the amplitude levels of the signals are uniformly spaced, i.e. linear, as in the example described; they might have non-linear progressive spacing in order to take into account variation of the magnetic characteristics of the tapes.

Replacement of one thin tape by a composite tape of three elemental tapes, for example, may be applied also under the same conditions to the type of label as Figure 3; thus a label as shown in Figure 6 is obtained in which each of the tapes 2 carried by the label 1 is a composite tape consisting in turn of three side by side metal tapes 24, 25 and 26, of the same ferromagnetic alloy. The label has been introduced into a coding compositor enabling each of the elemental magnetic tapes to be divided up locally and independently by a cut of variable size and location.

The number represented by each composite tape is shown in Figure 6 and each tape is coded in the manner described in relation to Figure 5.

The curve shown below the label in Figure 6 shows the overall signal as it would approximately appear, for example, on an oscilloscope.

In the simplified diagram of the detector equipment shown in Figure 1, the detector frame 4 supports the excitation coil 6 and the detector coil 7. In such an arrangement the field is not strictly uniform inside the frame. On the other hand the orientation of the label is uncertain, depending upon the way in which the object carrying the label is arranged on the conveyor which causes it to pass through the frame. The result is that the same label may give signals of very variable intensities and in certain extreme cases the signals are difficult to detect accurately.

The devices shown in Figures 7 and 8 enable practically constant signals to be obtained whatever the position and orientation of the object and its label on the conveyor. Referring first of all to Figure 7 the path of travel of the objects to be identified occurs along the dash-dot line. Hence the objects firstly pass through a first set of two frames 41 each being formed like the frame 4 of Figure 1 and provided with an excitation coil and a detector coil. The two frames 41 are arranged parallel to each other and spaced a short distance apart so that they behave as a Helmholtz coil, that is to say, that the field generated by the two excitation coils is constant in direction and intensity in the space between the two coils. This field, represented by the arrow in the Figure, is here parallel with the mean direction of movement of the objects. The objects next pass between two similar frames 42, likewise arranged as Helmholtz coil. Here the two frames are horizontal so that the magnetic field formed is vertical and perpendicular to the direction of movement of the objects. Finally, a third set of two frames 43 is provided, likewise arranged as a Helmholtz coil, but here the frames are vertical and disposed on either side of the path of travel with the result that the field generated is horizontal and perpendicular to the direction of movement of the objects.

Reference will now be made to Figure 8 which shows in greater detail the supply and coupling of the various coils for a set of two frames arranged as a Helmholtz coil. The references indicated in Figure 8 refer to the particular case of the set of frames 41 but of course the sets 42 and 43 are equipped in a similar fashion.

The two excitation circuits relating to one of the sets of frames 41, are fed in parallel from an alternating current supply circuit. Each excitatiion circuit includes a main excitation coil 61 contained in the frame and an auxiliary balancing coil 81, the two coils 61 and 81 being connected in series. The two detector circuits are independent and each includes a main detector coil 71 contained in the frame 41 and an auxiliary balancing coil 91, the two coils 71 and 92 being connected in series with an output coil 51. Since the excitation circuits are fed with alternating current, filter circuits represented symbolically here by a capacitor 21 are included.

For each of the frames 41 the balancing coils 81 of the excitation circuit and 91 of the detector circuit are inductively coupled but without an iron core. The two output coils 51 are effectively in parallel and form a double primary of a transformer, and the signal is picked up at the output 20 from the secondary of the transformer.

It may be seen that when the object and its label pass in succession through or between the successive frames 41, 42 and 43 the disturbing magnetic action of the label is manifested in succession with respect to three magnetic excitation fields along three perpendicular directions. Even if the parcel and its label are in a poor position for the tapes to react to one of the fields it will inevitably be well orientated with respect to one at least of the other fields. Hence three signals will be picked up from the three sets of frames 41, 42 and 43 and the three signals will be combined into a final signal by conventional electronic circuits to provide a signal which will keep an amplitude which is very substantially constant whatever the orientation of the label.

Of course the invention is not strictly confined to the embodiments which have been described by way of example but equally covers embodiments which might differ from them only in detail, in variant embodiments or in the employment of

equivalent means. It is, for example possible to imagine excitation and detection without passing through the frame, but simply by passing the object to be identified near to one or a number of frames. One might also employ fine wires in place of thin tapes.

Neither is it strictly necessary that the thin tapes or wires be carried by a label. This solution enables the code also to appear plainly on the label, but the wires or tapes may also be carried directly by the object to be identified if the nature of it allows.

Finally the application of the method of identification is not confined to the problem of postal sorting. It might also be applied, for example, to automatic selective opening of gates to garages and parking areas, by attaching a coded label to authorized vehicles and by arranging a detector loop near the entrance.

Again one might employ such a method for the marking of migratory fish and the detection of their passing along certain rivers.

WHAT WE CLAIM IS:-

1. A method of identifying an object comprising providing the object with at least one member of a magnetic material, assigning an identifying code to the object by selectively removing a portion of the magnetic material from the member, and passing the member near to a detector circuit whereby to produce in the detector circuit a signal the amplitude of which varies in accordance with the location and extent of the removed portion.

2. A method according to claim 1, wherein the object is provided with a plurality of magnetic members each of which exhibit different hysteresis loops characterised by different coercive fields, thus enabling a coded reference to be assigned to each object of as many characters as there are magnetic members employed.

3. A method according to claim 2, wherein the magnetic members are arranged in order of the respective phase shifts of their coercive fields, and wherein the detector detects the phase of the signal corresponding to each member in the same order as the order of the coercive fields, each signal having an amplitude corresponding to the respective value assigned during coding, thus reproducing the coded reference.

4. A method according to claim 2 or 3, wherein the step of assigning an identifying code to the object comprises assigning a binary code to each member thereby to produce a binary coded reference.

5. A method according to any one of the preceding claims, wherein the selected portion of the magnetic material is removed from the respective member by a cut dividing up the member at a predetermined location.

6. A method according to claim 5, wherein the or each magnetic member comprises a plurality of juxtaposed elemental tapes or wires of magnetic characteristics which are identical or sufficiently close for their respective disturbance signals to be practically in phase, each of the elemental tapes or wires being divided up selectively and independently.

7. A method according to any one of the preceding claims, wherein the or each magnetic member is provided on a label tied to the object, the character assigned to the or each member being recorded in clear adjacent the respective member.

8. Apparatus for identifying objects comprising at least one excitation coil arranged to be supplied with alternating current in order to create an alternating magnetic field, at least one detector coil balanced so that no signal appears in the absence of a member made from a magnetic material in proximity to the detector coil, and a detector device connected to the detector coil for the detection and measurement of phase and amplitude with respect to the field of excitation of a signal arranged to be produced, in use, by the passage through or near to the detector coil of an object bearing an identifying magnetic member generating at each alternation of the field of excitation an unbalance in the detector coil, the magnetic member being encoded by having a portion thereof removed at a predetermined location along its length, the detector device further including means arranged to decode the signal and thereby to identify the object.

9. Apparatus according to claim 8, wherein a plurality of members is provided, each of which exhibits a different hysteresis loop, the decoding means being arranged to distinguish differences in phase in the signal arising from the different hysteresis loops.

10. Apparatus according to claim 9, wherein the detector device includes means for binary reading of the signals detected.

11. Apparatus according to claim 8 or 9, wherein the or each member is a composite member comprising a plurality of juxtaposed elemental members of magnetic characteristics which are identical or sufficiently close for their disturbance signals to be practically in phase, and wherein at least one of the elemental members is cut at a predetermined location to encode that member, the detector device including means for measuring the overall amplitude of each signal corresponding to the or each composite member.

12. Apparatus according to any one of claims 8 to 11, further including at least one frame arrangement, the or each frame

arrangement including an excitation coil and a corresponding detector coil.

13. Apparatus according to claim 12, wherein the or each frame arrangement consists of two elemental frames arranged as a Helmholtz coil, whereby to generate a substantially constant field between the two elemental frames.

14. Apparatus according to claim 12 or 13 comprising three frame arrangements disposed successively in the path of movement of the objects, the three frame arrangements being disposed in three orthogonal planes so that the three fields generated by each of the respective excitation coils have mean directions along three orthogonal directions.

15. Apparatus according to claim 13, or claim 14 when dependent on claim 13, further comprising an excitation circuit and a detection circuit associated with each elemental frame, the excitation circuit including in series a main excitation coil in the elemental frame and an auxiliary balancing coil, whilst the detection circuit comprises in series a main detector coil in the elemental frame, an auxiliary balancing coil and a signal output coil, the two auxiliary balancing coils of one set of two elemental frames being coupled inductively by an ironless coupling, and wherein the two excitation circuits of each set of two elemental frames are fed in parallel whilst the two signal output coils constitute a double primary of a transformer having a single secondary, a combined output signal being derived from the secondary.

16. Apparatus according to claim 14, wherein three output signals are derived from the three frame arrangements and are electronically combined to constitute a final signal.

17. A device for identifying an object, and comprising at least one member of a magnetic material arranged to be disposed on the object, said member being divided up by a cut, the position of which is indicative of a code identifying the object.

18. A device according to claim 17, wherein the member is elongate and the cut is transverse to the longitudinal axis of the member.

19. A device according to claim 17 or 18, wherein a plurality of members is provided at least two of which are divided up by cuts, the cut in one member being wider than the cut in another member.

20. A device according to claim 19, wherein each of the members exhibits a different hysteresis loop.

21. A device for identifying an object substantially as hereinbefore described with reference to the accompanying drawings.

22. A method for identifying an object substantially as hereinbefore described with reference to the accompanying drawings.

23. Apparatus for identifying an object substantially as hereinbefore described with reference to the accompanying drawings.

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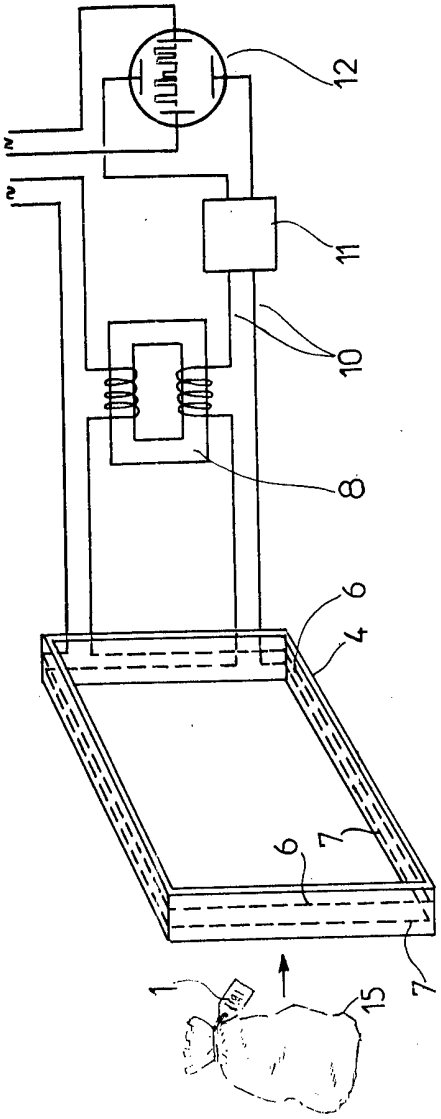

FIG 1

FIG 2

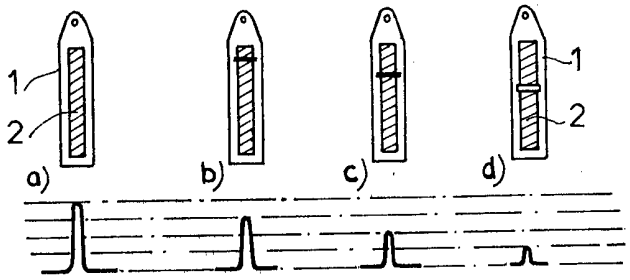

FIG 3

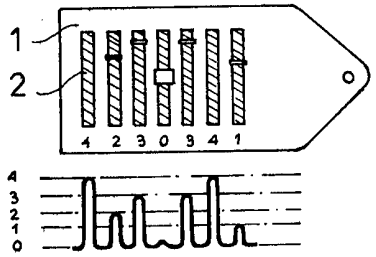

FIG 4

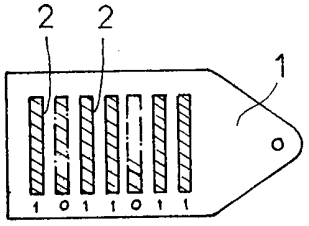

FIG 5

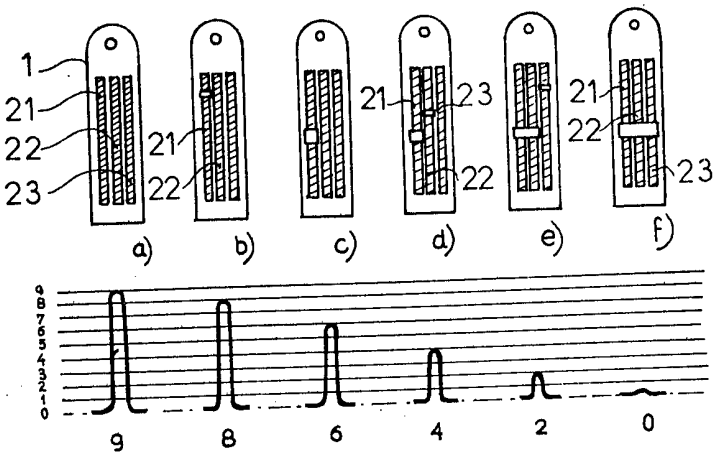
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FIG 6

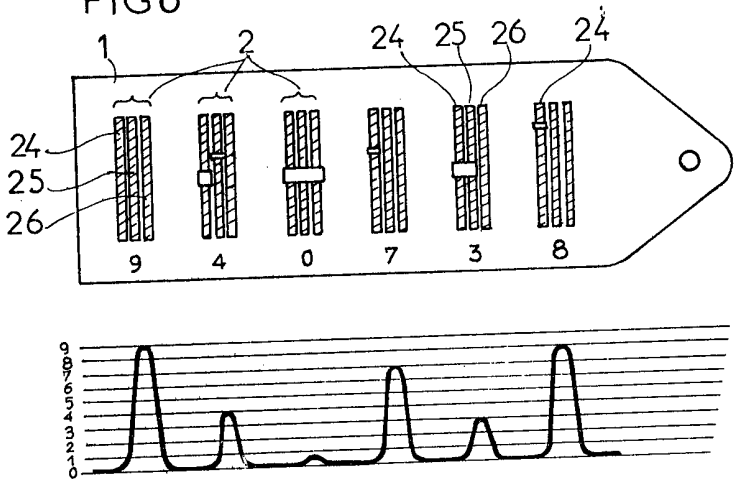
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FIG7

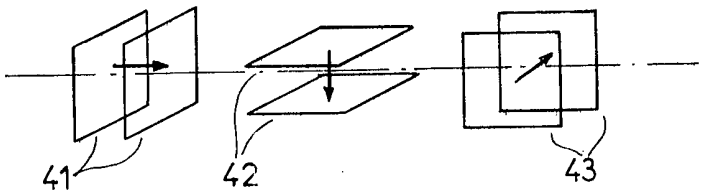

FIG8

